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Research Article

Measuring Success Factors Supporting the Experience of using Virtual Glasses Stores

Rima Alhussaini[1], Yasser Kotb[1,2]
[1]*Information Systems Department, College of Computer and Information Sciences, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia*
[2]*Computer Science Division, Department of Mathematics, Faculty of Science, Ain Shams University, Cairo, Egyp*

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ABSTRACT

This study investigates the key success factors that support user satisfaction when utilizing augmented reality (AR) applications in virtual glasses stores. With the rise of e-commerce and AR technologies in Saudi Arabia, the research focuses on measuring user experience through factors such as ease of use, perceived usefulness, presence, immersion, flow, and emotion. Using an experimental design, 60 participants interacted with the ZeeLool AR Try-On application and completed a structured questionnaire. Statistical analyses revealed that participants reported moderate satisfaction, with the highest contributing factors to success being presence, flow, and immersion. In contrast, emotion showed limited influence on overall satisfaction. Demographic variables such as age, gender, and educational level had no significant impact on user satisfaction. The findings highlight that technical interactivity and realistic engagement are more crucial than emotional reactions for AR shopping success. These insights can guide AR developers and retailers in enhancing customer experience and increasing the adoption of virtual try-on technologies.

Keywords: Virtual Glasses Stores, Augmented Reality (AR).

1.Introduction

1.1 Background

The advancement of Information and Communication Technologies (ICT) has led to constant evolution of our lives. There is a wide variety of internet platforms where more and more actions can be carried out around to facilitate our lives and to provide us with innovative methods for carrying out various daily activities. This new virtual environment allows constant communication with others, sharing multimedia content, enjoying online games in a group, and running different Web Applications. Considering the growth of electronic commerce in Saudi Arabia and the continuous improvement of conditions to guarantee the population's access to technological tools, every day more companies use web applications to carry out their businesses (Iatsyshyn et al., 2020).

A virtual store is a new type of ecommerce experience powered by virtual and augmented reality technologies. Instead of showing static product grids, virtual stores simulate real-life in-store environments, provide immersive shopping experiences, and enable product interactions via computers or phones (Baltierra, 2023). E-commerce is a concept that has revolutionized the ways in which business initiatives and financial markets operate. The elements that make E-commerce possible are linked to Information and Communication Technologies, forming a new infrastructure for business processes, which allows the development of business activities in an increasingly globalized environment, and with increasingly more virtual relationships between the different agents that make up the value chain (Li et al., 2021).

1.2 Augmented Reality in E-commerce

AR has been used in advertising and marketing, with the rise in the use of mobile devices and the high level of Internet access, this technology is applicable to various sectors of the economy such as the publishing market, clothing, jewelry, entertainment, medicine and in education, where there is great application potential for all areas of knowledge, as it facilitates the learning process thanks to the multimedia management of information (Baltierra, 2023). In addition, AR has practical applications in strategic sectors where the physical location of things and their

context are predominant, such as medicine, monitoring systems, security and defense, training, recreation, simulation, architecture, design, real estate business, tourism, demonstration of hotels and destinations, recreations in museums and historical monuments, entertainment, games, among others (Arena et al., 2022). It is useful in electronic commerce because it is used to index, organize and demonstrate information about products and services. It is possible that it will be widely adopted in B2C sectors such as online tourism, hotels, restaurants, retail trade in general and in virtual product catalogs, and also in industrial sectors where the demonstration of processes is necessary and in foreign trade to visualize export and import products. AR is also used in product demonstration and product testing in virtual stores with the option to view products in three dimensions using AR (Tan et al., 2022).

1.3Main Objective

The current research aimed to identify the aspects that satisfy users when they use AR application to try on glasses virtually.

1.3.1 Secondary objective:

- To analyze the factors influencing user satisfaction with the augmented reality virtual try-on technology.
- To identify the key success factors that contribute to the effectiveness of the augmented reality application in enhancing the virtual glasses try-on experience.

2.Literature review

2.1 Augmented Reality

Augmented reality (AR) is an emerging technology that is being used in the retail sector through exhibiting products in 3D and 360 modes on smart phones. Pfeifer et al. (2023) was an experimental study that aimed to compare Augmented Reality Smart Glasses (ARSG) and AR glasses through touchscreen mobile phones. The ARSG adds features such as capturing photos, viewing notifications, or making calls. They are like having a minicomputer installed on the face. AR glasses, conversely, are specialized tools with a primary function which is to superimpose digital information onto the real world. The study sample consisted of 317 participants who were recruited from a large university and who took course credits in exchange for participation. The study followed the experimental approach with two groups, one group for the ARSG and the other for touchscreen device. The study participants were then randomly distributed to the two groups. The study procedures were segmented into three phases, the introduction, the try-on and the questionnaire. Testing with a retail application showed that ARSGs are superior to AR on touchscreen devices for evoking consumers' perceptions of immersion and mental intangibility. The study also found that participants in the ARSGs group evaluated the shopping experience more positively than AR on touchscreen group.

2.2 Virtual Try- On Image Applications

Virtual Try-On technology has been increasingly used since the eruption of the pandemic and lockdowns that were implemented in most countries of the world. Online clothing retailers use this technology in an attempt to increase their sales and to get a footstep in this booming sector. There are different types of Try-On technologies, either the user has a camera-equipped device to try on the wearable virtually or download an image to the app to see the virtual wearable on the picture. Zhang et al. (2017) aimed to investigate how try-on image interaction technology affects online shoppers' purchase decision. It aimed to identify the UX's attitudes towards online purchases, and to identify their perceived usefulness, perceived ease of use, perceived product risk, perceived transaction risk, perceived enjoyment, and perceived socialization. The study adopted the quantitative design and utilized a web-based survey to identify the 6 components of purchase intention.

2.3 Theoretical Framework

The theoretical framework of this study is based on six key dimensions that contribute to the success of an augmented reality (AR) application for virtual try-ons. These dimensions represent critical factors that impact the user's experience and satisfaction with the AR technology, and each dimension influences the effectiveness of the virtual try-on application.

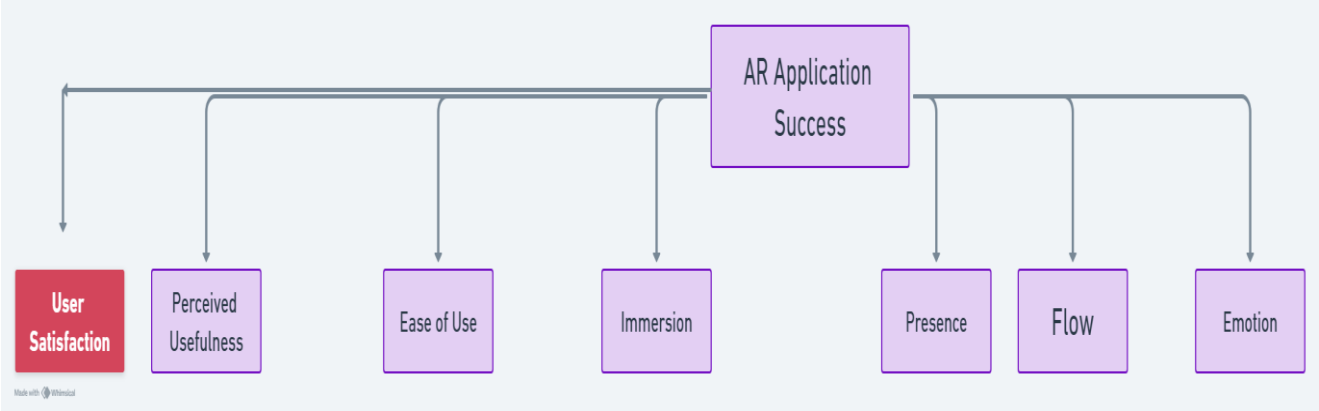

Fig. 1: Theoretical Framework for the current study

3.Methodology

3.1 Research Design

This study adopts the experimental design as it aims to compare user experiences between virtual try-on frames and actual physical frames and measure the success factors of the virtual try-on application, particularly in terms of user satisfaction, perceived usefulness, easiness of use and intent to purchase. In other words, the study aims to investigate how well the virtual try-on application simulates the real experience of trying on frames and to identify key success factors supporting the adoption and satisfaction with the application.

3.2 Population and Sample

Target Population: The study population consisted of individuals interested in purchasing glasses, representing potential users of virtual try-on applications. The sample size consisted of 60 participants who signed an informed consent before participating in the experiment. Participants were recruited via social media, glasses retail outlets and local university contacts. Convenience sampling was used, based on participants' availability and willingness to participate in the study.

3.3 Experiment Procedures

Upon approval to participate in the study, participants were introduced to the study objectives and the process. They were also informed about the procedures and the ability of anyone to withdraw from the experiment at any stage without giving any reasons. They were asked to sign an informed consent form indicating their voluntary participation.

Application:

The application is called AR ZeeLool Try-On Glasses. It is available on both Android and iOS systems and has more than 1 million downloads at Google Store, with a rating of 4.8/5 on Apple store. The application allows the user to see different glasses frames on pictures but to see glasses on your face another adds-on has to be installed. In the current case the researcher installed AR Google Play Services. Google Play Services for AR is a crucial application that facilitates augmented reality (AR) experiences on Android smartphones. This service, formerly referred to as ARCore, enables the incorporation of diverse augmented reality features within applications, permitting users to engage with their surroundings in novel manners. Google Play Services for AR serves as an intermediary between the device's hardware capabilities and the augmented reality experiences provided by the application.

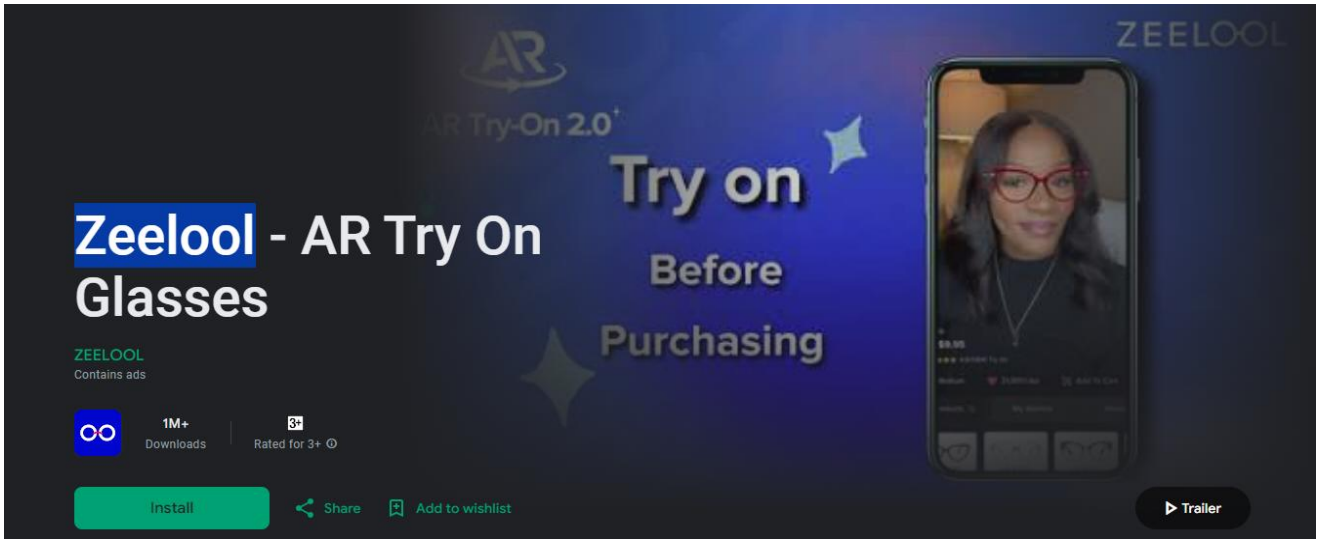

Figure 1: Zeelool Application

3.4 Instrumentation

A semi-structured questionnaire was given to participants following the experiment. It included questions that addressed various aspects of user experience, perceived usefulness, ease of use, emotions, and satisfaction with the virtual try-on technology. The questionnaire was divided into several key sections as follows: Descriptive Statistics were used to summarize participant demographics and their responses to the questionnaires. Pearson's rank-order correlation will be used to assess the relationships between user satisfaction, perceived usefulness, and intention to purchase virtual frames. Mean and standard deviation was extracted for the User satisfaction. The Mann-Whitney U test was used to identify any statistically significant differences between study participants in user satisfaction levels based on gender. For success factors, mean and median were extracted to identify the most factors that may drive the user to buy the glasses among the following factors: emotion, immersion, flow and presence. Finally, the ANOVA test was used to identify if there are any statistical differences between user satisfaction and educational level.

4.Results

4.2 Demographic characteristics:

Item	Frequency	Percentage %
Gender		
Male	35	58.3
Female	25	41.7
Total	60	100.0
Age Groups		
18-25	5	8.3
26-33	27	45.0
34-40	18	30.0
More than 40 years	10	16.7
Total	60	100%
Level of Education		
Didn't complete high school	2	3.3
High school	12	20.0
Bachelor Degree	30	50.0
Master Degree	14	23.3
Doctorate Degree	2	3.3
Total	60	100.0
Occupation		
Student	7	11.7
Employed full time	23	38.3

Employed part time	9	15.0
Self-employed	14	23.3
Unemployed	7	11.7
Total	60	100.0
Level of VR, AR knowledge		
1 (Low knowledge)	8	13.3
2	6	10.0
3	32	53.3
4	8	13.3
5 (High Knowledge)	6	10.0
Total	60	100.0
1	8	13.3

Table 1: Demographic characteristics of participants

Table 2 shows the demographic characteristics of participants. The study included 60 participants, with 58.3% male and 41.7% female, primarily aged 26–40 years (75%). Most participants held a Bachelor's degree (50%) or higher education, and the majority were either employed full-time (38.3%) or self-employed (23.3%). Regarding VR/AR knowledge, over half (53.3%) rated their knowledge level as average, while 13.3% rated it high and 13.3% low.

4.3 The factors influencing user satisfaction with the augmented reality virtual try-on Technology and whether these factors vary significantly across demographic variables

To identify the user satisfaction level, we extracted the mean and standard deviation for the user satisfaction dimension. The numerical scale for Likert is as follows, according to Posi et al. (2023).

Score	Meaning
1 - 1.99	Dissatisfied
2 -2.99	Neutral
3 -3.99	Satisfied
4-5	Highly Satisfied

Item	Mean	Standard Dev.	RII	Rank
1.This virtual Try-on experiment was exciting	3.47	0.98	0.69	Fifth
2.The experiment helped me to choose the best glasses frame that suits me	3.45	0.91	0.69	Sixth
3.The experiment of virtual Try-on was efficient more than offline shops	3.98	0.79	0.80	First
4. I think the virtual try technology on has no future prospects.	2.42	1.06	0.48	Eighth
5.I am satisfied with the overall experience of using the virtual try-on application.	3.33	0.72	0.67	Seventh
6.After this experiment I would regularly using the virtual try on technology before purchasing in the future	3.78	0.739	0.76	Third
7.After this experiment I would talk about the virtual try on technology with friends or family	3.80	0.953	0.76	Second
8.After this experiment I would recommend using the virtual try on to my friends or family	3.68	1.28	0.74	Fourth

Item	Mean	Standard Dev.	RII	Rank
Total User Satisfaction Score	3.48	0.93	0.69	-

Table 2: User satisfaction mean and standard deviation

Table 3 shows that the study sample are satisfied with the overall experiment, with mean score of 3.48/5, and standard deviation ± 0.93. The most aspects that satisfied the users are 'its distinction from virtual shops- item 3" (mean= 3.98, St. Dev.= ±.79), followed by "intention to talk about Virtual Try-On technology with friends and family- item 7" (mean = 3.80, St. Dev.= ±.0.953), and "Using the technology again-Item 6" (mean = 3.78, St. Dev. = ± .739).

The Relative Importance Index (RII) is an important tool in research and analysis, especially in studies where multiple factors, variables, or items need to be ranked based on their perceived importance or significance. For the current research, the items no. 2 " the experiment of virtual Try-on was efficient more than offline shops" and item no. 7 "After this experiment I would talk about the virtual try on technology with friends or family got the highest RII score, with 0.80 and 0.76 respectively.

To identify any user satisfaction differences between study participants based on gender, the Mann-Whitney U test was used. The researcher preferred it to other t-sample tests because of the sample size. The results are shown in table 4.

Mann-Whitney U	409.000
Wilcoxon W	734.000
Z	-.430-
Asymp. Sig. (2-tailed)	.667

Table 3: Mann- Witney U test for Gender

Table 4 shows Mann-Whitney U test that was performed to compare user satisfaction between males and females in the current experiment. There was not a significant difference in user satisfaction between males and females as the z = -0.430, p-value = 0.66 which is higher than the significance level 0.05.

4.4 The key success factors that contribute to the effectiveness of the augmented reality application in enhancing the virtual glasses try-on experience

To identify the key success factors that contribute to the effectiveness of Virtual Try On technology, the mean and standard deviation for the six dimensions in the questionnaire were calculated. A cut-off score of 3 on the 5-point Likert scale was used to determine which dimensions were considered positive contributors to the success of the application (Batterton & Hale, 2017).

Score	Meaning
1 - 1.99	Disagree
2 -2.99	Neutral
3 -3.99	Agree
4-5	Strongly Agree

Table5: cut-off score on Likert Scale

Table 5 shows the scoring for the Likert scale items whereas table 7 shows the mean, standard deviation, relative importance Index and rank of the questionnaire items for the 6 axes.

Statement	N	Mean	Std. Dev	RII	Rank
Easiness of Use					
9. My interaction with this virtual Try-On technology was easy for me	60	2.93	1.056	0.59	4
10. Learning to use this virtual Try-On technology was easy for me	60	3.30	1.124	0.66	3
11. I expect to acquire more skills through using this technology	60	3.43	.909	0.69	1

Statement	N	Mean	Std. Dev	RII	Rank
12. I expect the virtual Try-On technology to be easy to use for my friends	60	3.35	1.022	0.67	2
Total	**60**	**3.25**	**0.75**	**0.65**	**-**
Perceived Usefulness					
13. The virtual try-on application allows me to quickly try on different glasses.	60	3.45	.811	0.69	4
14. The virtual try-on application makes it easier to compare different styles of glasses.	60	3.62	1.059	0.724	1
15. It is worthwhile to use the virtual-Try on technology to decide the best fit glasses.	60	3.45	1.032	0.69	3
16. The virtual try-on application accurately represents how the glasses will look on me.	60	3.50	.983	0.7	2
Total		**3.50**	**0.76**	**0.7**	**-**
Emotion					
17. I enjoyed being in this virtual environment]	60	2.98	.651	0.60	2
18. I didn't get tense in the virtual environment]	60	2.62	1.059	0.52	3
19. I enjoyed the experience so much that I feel energized.]	60	3.17	.587	0.63	1
Total	**60**	**2.92**	**0.76**	**0.58**	**-**
Presence					
20. My interactions with the virtual environment seemed natural	60	3.47	.812	0.69	3
21. I felt engaged by the visual aspects of the virtual environment.	60	3.87	.892	0.77	1
22. I was able to examine objects closely while I tried on the glasses virtually.	60	3.6	.887	0.72	2
Total	**60**	**3.65**	**0.86**	**0.73**	**-**
Immersion					
23. I became so involved as I was wearing a real glass.	60	3.63	.843	0.73	2
24. I got scared by something happening in the virtual environment since it seems like a real environment.	60	3.30	1.078	0.66	3
25. I become so involved in the virtual environment that I lose all track of time	60	3.73	.936	0.75	1
Total	**60**	**3.55**	**0.95**	**0.71**	**-**
Flow					
26. I would like to share the emotions that I feel in this experiment	60	3.60	.848	0.72	1
27. I felt I was experiencing an exciting moment	60	3.60	1.061	0.72	2
Total	**60**	**3.60**	**0.95**	**0.72**	**-**

Table 6: the mean, standard deviation, relative importance Index and rank of the questionnaire items for the 6 axes.

Table 6 shows the the mean, standard deviation, relative importance index (RII) and ranks of the questionnaire items for the 6 variables. Through the analysis of the relative important index (RII) we found that Presence variable came in first place which denotes its importance in the success of the application, followed by Flow and Immersion variables. Conversely, Emotion variable came in last place with 0.58 IRR score which denotes its partial importance in the success of the application (Table 9).

	Mean	Std. Deviation	IRR	Rank
Easiness of use	3.25	0.75	0.65	5
Perceived usefulness	3.50	0.76	0.70	4
Emotion	2.92	0.76	0.58	6
Presence	3.64	0.86	0.73	1
Immersion	3.55	0.95	0.71	3
Flow	3.6	0.95	0.72	2

Table 7: mean and standards deviation for potential success factors of the application

Table 7 shows the summary of the mean, standard deviation, IRR and ranks of the six dimensions. It shows that there are 5 dimensions of the six who have overall "Approval" degree regarding effectiveness in the Virtual Try-On experiment, excluding "emotion" variable which got a score of 2.92, which is lower than 3. (2.92). Thus, we conclude that the most important success factors that contribute to the effectiveness of the augmented reality application in enhancing the virtual glasses try-on experience are, in descending order, Presence, Flow, Immersion, Perceived Usefulness and Easiness of use.

5. Discussion

User Satisfaction

The current research aimed to identify the user satisfaction, and success factors, of an AR application for try-on of glasses. The results indicated that the user satisfaction of participants was moderate, with an average of 3.48 /5. The current results are consistent with Xue et al. (2018) which found that most participants were satisfied with the AR glasses and the AR applications. In both studies, AR technology helped the participants to accomplish the task quite well. In the current study, the main factors that contributed to this moderate level of user satisfaction are ease of use and efficiency. This can be explained by Majeed and Ali (2020) which argued that ease of use and speed play a role in promoting satisfaction among AR applications' users. We can argue here that ZeeLool AR application's straightforward user interface and intuitive interaction were critical for making users to feel satisfied. In addition, ZeeLool application has simplified navigation and clear guidance on how to use AR technology which helped in boosting user satisfaction level among participants. In addition, the relative importance index (RII) scores emphasized the importance of efficiency to users and how it boosts their satisfaction levels and induced their intentions to talk about the technology with friends/family.

Several factors may have contributed to participants' inability to form strong positive perceptions of the experience, which in turn limited their satisfaction to a moderate level. The first factor in this regard is the mismatch between expectation and reality. According to Aslam and Davis (2024) users form their perceptions and expectations about the AR applications based on their imagination and what they hear from marketing channels, which may be unauthentic or misleading. Another factor is the over-exaggeration of the capabilities of AR in the retail industry (Singh, 2024).

The current research found that the demographic variables (gender, age, educational level, and occupation) did not significantly impact user satisfaction, with p-values consistently higher than the 0.05 significance threshold. This is contradictory to Mkpojiogu et al. (2020) which found that the age of users significantly influences users' perceived satisfaction in mobile banking apps. The main reason for the contradiction between the two studies may be due to the different context of the two studies and the different technologies, as the banking applications are based on traditional technology that is used by most people to conduct their daily activities whereas AR technology is not prevalent as the traditional technology used in smart phones. In addition, the demographic characteristics of participants might also differ between the two studies as Mkpojiogu et al. (2020) used a sample from Nigeria which has a higher technology illiteracy than Saudi Arabia (Alghanmi & Amuda, 2024), which means that the Nigerian participants had different technological access and experience compared to Saudi participants. In addition, the majority of participants in the current study were in the 26-40 age range and held at least a bachelor's degree, which could imply a more tech-savvy audience. Furthermore, most participants rated their VR/AR knowledge as average, which implies that education and social class have no leverage on the prevalence of these new technologies.

5.2 Presence factor

The current research found that 'presence' is the most important factor in the application's success. Several studies suggest a positive relationship between "presence' and AR application success. Cao et al. (2020) discovered that social presence relates to better usability and confidence. According to Marto et al. (2022) "presence' is an important factor in AR technology as it influences the user's experience significantly through different aspects. The first aspect is the realism and interaction aspect that 'presence' provides for the user. According to Regenbrecht & Schubert (2021) when the application is characterized by more interactive and realistic features, this boosts the user's sense of presence, which consequently contributes to the application success. Furthermore, the current study finding that puts "presence" at the top of the success factors for AR application is consistent with Chou (2021) which found that the sense of presence that the user feels during the try-on experience is a significant factor in choosing the try-on application.

5.3 Flow and Immersion

The current study found that 'flow' and 'immersion" came in second and third places, respectively, regarding the success factors of the AR application. According to Tan et al. (2022) "presence' is a prerequisite for experiencing flow, and both "presence' and 'flow' can facilitate immersion. So, it is logical for presence to precede immersion and flow regarding hierarchical factors of application success. In addition, according to Molinar and Szuts (2019) without a strong sense of presence, users cannot effectively move to higher states of engagement, such as immersion and flow.

5.4 Perceived usefulness and ease of use

The current results indicate that perceived usefulness and ease of use are crucial factors for AR applications as they came in fourth and fifth places respectively. While presence, immersion and flow proved to be influential factors in the success of the AR application, perceived usefulness and ease of use proved to be of moderate impact in this regard. A study on the ease of use of AR for mobile applications showed that the design of AR systems must ensure ease of use to keep users engaged and prevent frustration (Awang et al.,2019). In addition, ease of use is paramount for all applications and technologies as it is difficult for some users, especially those who are not tech-savvy, to continue using an application or a technology that is hard to use (Anifa, 2022). So, we can deduce here that creating an AR application that has the feature of easiness of use makes its success odds bigger.

The importance of "easiness of use' factor in constituting success for AR application is supported by Alkarney and Almakki (2022) who found that the intention to use a virtual store is associated with perceived easiness of use. The latter study found a positive correlation between perceived easiness of use and the intent to purchase, which is an indication that the AR application is fulfilling the expectations of both the users and its commercial entity. In addition, Fetscherin and Lattemann (2008) found that perceived easiness of use had a direct and positive impact on behavioral intention to use the technology. The latter study also discovered that "ease of use" had a positive correlation with users' online purchasing behavior which signifies the significance of this factor in AR application success.

"Perceived usefulness" proved to be one of success factors for AR applications. It is related to the perceptions that the user has about the benefits that the application provides for him. Madi et al. (2023) perceived usefulness provides a value for application and has a role in promoting repeat use among users and in convincing them to adopt or utilize the AR technology. Like ease of use, perceived usability impacts users regarding whether they reuse the application or technology or not. If users find that the AR application provides value, in the current case offers a seamless experience of glasses try-on, they are more likely to reuse the application/ technology (Madi et al., 2023).

5.5 Emotion

The current results found that "emotion" is not among the factors that users consider as necessary for an application to be successful. Harley et al. (2016) discovered that positive emotions such as enjoyment and curiosity were evident during augmented reality learning sessions. Nonetheless, these happy emotions were not the principal determinants of success in the application. The efficacy of the AR application was more associated with its outcomes and user involvement than with mere emotional responses. Gómez-Rios et al. (2022) discovered that whereas augmented reality applications typically elicit good feelings such as enjoyment and interest, negative emotions including dissatisfaction, anxiety, and dizziness may impact the user experience in a negative way.

There is a recurring theme in research that, despite the importance of emotions, particularly positive ones such as curiosity and enjoyment, for engagement and motivation, they do not consistently correlate with the long-term success of an application or the achievement of specific objectives such as learning or product selection. Emotion is frequently inferior to other factors, such as perceived usefulness, presence, and ease of use, in terms of their impact on the overall efficacy of AR applications. The current findings are supported by both Harley et al. (2016) and Gómez-Rios et al. (2022) findings which suggest that emotion may not be a critical success factor in augmented reality applications, particularly in scenarios that emphasize objectives such as learning and goods selection. Emotions, while important for engagement, may not be as critical for the application's ultimate success when compared to factors such as perceived usefulness and presence.

Conclusion

The current research delineates the success factors of AR applications by addressing two research questions, the first is related to the level of user satisfaction with AR application for virtual try-on of glasses and the second is the success factors for the AR application. The research has posited a framework that contains 6 factors and found that 5 of these 6 factors are instrumental in constituting positive perceptions about the application. The study results indicate that the factors that correlate with application success are, in order, presence, immersion, flow, perceived usefulness and ease of use. On the other hand, the "emotion' factor was found to have little significance to users when they decide about the application's performance.

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