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Augmented reality smart glasses use and acceptance: A literature review

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ABSTRACT

The research interest in the use of augmented reality smart glasses (ARSGs) has increased dramatically in recent years as they are utilised in many fields such as medicine and industry, as well as everyday life. This study aims to review the empirical research activity concerning the acceptance of ARSGs in all applicable fields. In total, 21 studies published from 2015 to 2022 have been reviewed. Their relative field, theoretical framework, methodological design, and the factors that were found to affect the acceptance or use of ARSGs were recorded. It was found that the research focuses more on users acting as consumers of the glasses than on professionals (e.g., doctors, teachers, athletes) using them in a specific field. Also, the majority of the studies base their theoretical framework either entirely or in part on the Technology Acceptance Model (TAM). Moreover, the research models of these studies extend TAM by using various additional variables, such as privacy risk and external influence. Methodologically speaking, most of the studies follow the quantitative approach, without giving the participants the opportunity to interact with the glasses. In addition, the factors which were found to influence the acceptance or use of the glasses are varied and can be categorised as utilitarian, social, personal, risk-related, and technological. This review adds value to the theory of technology acceptance. This is because it is one of the first to address the acceptance or use of ARSGs. Since there is no acceptance model for ARSGs, the findings of this review could lead researchers to propose models for accepting ARSGs in various fields, such as education.

1. Introduction

In recent years, the research interest in the use of all smart wearable technologies across a variety of fields, such as health (Aekanth & Tillinghast, 2023; Iovanel et al., 2023), well-being (Tikkanen et al., 2023), marketing (Bakhshian & Lee, 2023) and education (Al-Emran et al., 2023; Aranda-García et al., 2023) has increased dramatically. This is partly due to the fact that they can offer users many forms of human-computer interaction, in contrast to mobile devices (Stefana et al., 2021), while on the other hand this interest can also be attributed to the rapid development of the Internet of Things (IoT) (Malhotra et al., 2021), which includes smart glasses (Ferreira et al., 2021). These glasses appeared on the market in 2013 with the release of Google Glass (Klein et al., 2020), hence early definitions are associated with this device. For example, Aungst and Lewis (2015) defined Google Glass as a wearable device that is worn like eyeglasses, with the difference that Google Glass technical interface turns it into a computer interface. More recently, the definitions of smart glasses focus on the fact that they offer the ability to interact with the device, a range of applications, and the virtual or augmented reality experience (Romare & Skär, 2020; Wei et al., 2018).

One category of smart glasses is Augmented Reality Smart Glasses (ARSGs), which are defined as a wearable device with one or two screens that can merge virtual with real information in the user's field of vision (Danielsson et al., 2020). ARSGs are different from other mobile devices (e.g., smartphones, tablets) due to their affordances (e.g., the combination of real and virtual objects, immersive and personalised experience, hands-free access, and first-person view) (Bower & Sturman, 2015; Rauschnabel & Ro, 2016; Suh & Prophet, 2018). The market size of ARSGs is experiencing significant growth. According to Statista (Alsop, 2022), in 2019, unit sales of ARSGs totaled 170 thousand units and are expected to rise to 3.9 million units by 2024. Also, the consumer and enterprise ARSGs hardware and software revenue amounted to 1.85 billion U.S. dollars in 2021, while it is forecasted to rise to 35.06 billion U.S. dollars by 2026 (Alsop, 2022).

Given this expected increase in the use of ARSGs, it is important to examine the fields in which they have been exploited to date and what factors influence their use and acceptance by potential users in companies, organisations, universities, and schools. Previous studies in the field of information systems and innovation have shown that studying the acceptance factors of a new digital technology in the early stages of

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diffusion can facilitate its future integration (Attié & Meyer-Waarden, 2022; Bao & Lee, 2023; Rahi et al., 2019). According to Ro et al. (2018), early knowledge regarding these factors "can provide an advantage for companies that might increase efficiency when using ARSGs" (p. 170). For example, in the field of education, teachers' attitudes, beliefs and perceptions play an important role in the adoption of new technology in their teaching (Choi et al., 2023; Scherer et al., 2019). Therefore, several studies have been conducted to investigate and explain the factors that affect the use of ARSGs in diverse fields (e.g., Al-Maroof et al., 2021; Başoğlu et al., 2018; Bao & Lee, 2023; Han et al., 2019), based on specific acceptance models and theories such as the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), the Technology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989) and its extensions (Venkatesh & Bala, 2008; Venkatesh & Davis, 2000).

Therefore, this literature review aims to review existing studies on the significant factors of the acceptance of ARSGs among users in diverse fields, identify research gaps, and make proposals for future research. Previous literature reviews focused on the acceptance of smart wearable technologies in general, such as those by Kalantari (2017) and Niknejad et al. (2020), or on specific categories, such as wearable activity trackers, which were reviewed by Shin et al. (2019). Hence, there is a need for a review that includes studies focusing particularly on the acceptance of ARSGs. The fact that smart glasses are a new technology, creates a lot of uncertainty about whether they will be adopted by users, as is the case with other new technologies, e.g., fully automated vehicles (Rejali et al., 2023). The study of previous research findings (i.e., fields, theoretical background, methodology, acceptance determinants) on the acceptance of ARSGs, could provide valuable insight into the key acceptance models that are appropriate for different ARSG users (e.g., students, teachers, professionals, consumers) to adopt them in their everyday life, thus motivating future research in diverse fields with rigorous methodology. Furthermore, understanding the factors that affect the acceptance of ARSGs could assist researchers, technology practitioners, and policymakers of organisations, educational institutions (e.g., schools and universities) and informal learning environments (e.g., museums and galleries) (Leue et al., 2015; Litvak & Kuflik, 2020; Mason, 2016) to develop programmes that will enhance motivation and adoption of this immersive technology among professionals, educators, students, and visitors. Researchers, technology practitioners, and policymakers dealing with other new and advanced technologies in various fields, such as auditing, healthcare information systems, and smart energy technology, have benefited similarly (Afsay et al., 2023; Chong et al., 2022; Gimpel et al., 2020). In addition, new types of ARSGs with various affordances are already available nowadays, such as the Microsoft HoloLens 2 and Magic Leap 2 (Palumbo, 2022; Zari et al., 2023). Therefore, it is believed that identifying different factors regarding the acceptance of ARSGs could assist future researchers to propose new acceptance models regarding the new generation of smart glasses, and therefore help designers improve their affordances, functionalities, usability, and usefulness. Based on the above, the research questions that are answered here are:

RQ1: In which fields has the acceptance of ARSGs been investigated?
RQ2: What is the theoretical framework of the research, i.e., which acceptance models or theories have been applied?
RQ3: What is the research design of the studies?
RQ4: What are the factors influencing the acceptance or use of ARSGs?

This article is organised as follows. First, a literature review on augmented reality, ARSGs, technology acceptance theories and models, and previous reviews on the acceptance of smart wearables is presented, whereupon the methodology for this literature review is described. Afterwards, the findings of the review are presented and discussed. Then, the implications for research and practice are presented, while reference is also made to the limitations of the review and future research that should be undertaken. Finally, conclusions are provided.

2. Background

2.1. Augmented reality and smart glasses

Augmented Reality (AR) is an emerging technology (Suh & Prophet, 2018; Verhulst et al., 2021) that changes the way we view and experience the world. One of the first and most common definitions is provided by Azuma (1997), who defined AR as modifying the user's real environment by superimposing it with virtual elements, i.e., images, video, text, 3D objects, and sound. Later, definitions, such as the one described by Ibáñez et al. (2015), included the fact that real and virtual worlds coexist in real-time allowing the user to interact with both worlds. Recently, Rauschnabel et al. (2022) defined AR as "a hybrid experience consisting of context-specific virtual content that is merged into a user's real-time perception of the physical environment through computing devices" (p. 13). Compared to other digital technologies, AR has unique affordances. These include the creation of immersive hybrid learning environments that combine digital and physical objects (Dunleavy et al., 2009) and the concretization of abstract concepts (Arici et al., 2021). In addition, other affordances are the presentation of learning content from 3D perspectives (Suh & Prophet, 2018), the facilitation of learners' sense of presence, immediacy, and immersion, as well as the visualisation of the invisible (Garzón et al., 2019; Wu et al., 2013).

Research in diverse fields, such as marketing, medicine, entertainment, and education has shown that the use of AR has many advantages and positive results for users (Suh & Prophet, 2018; Villagran-Vizcarra et al., 2023). For example, in education, AR has been shown to promote enhanced learning performance (Akçayır & Akçayır, 2017; Chang et al., 2022), enhance students' motivation and engagement (Sırakaya & Alsancak Sırakaya, 2022), improve vocational skills (e.g., spatial visualisation skills, assembly skills) (Chiang et al., 2022) and computational thinking (Theodoropoulos & Lepouras, 2021). In the field of medical training, research has shown that AR provides contextual, situated, authentic, and simulated learning experiences (Barsom et al., 2016). In the field of patient education, AR positively affected knowledge retention and patient satisfaction (Urlings et al., 2022). In entertainment, the use of AR games fosters positive emotions such as enthusiasm, enjoyment, and curiosity (e.g., López-Faican & Jaen, 2020), promotes students' learning attitudes, satisfaction, and achievements (Wu, 2021), while also helping adolescents to have better relationships and increase their attention-concentration (Ruiz-Ariza et al., 2018).

In recent years, the use of AR has become more widespread among the majority of users due to technological innovation in telecommunications (e.g., 5G) and mobile technology devices such as smartphones and tablets. However, viewing AR through the screens of such mobile devices provides limited immersive and interactive experiences (Holdack et al., 2022). ARSGs are a type of wearable technology that incorporates a display or projection system that overlays digital information onto the wearer's real-world view (Bräker & Semmann, 2023). They use sensors and cameras to track the wearer's movements and the environment around them, displaying information, graphics, or virtual objects in the wearer's field of vision. Compared to mobile devices, these glasses provide a greater immersive experience, which is related to two categories of stimuli (Suh & Prophet, 2018): (a) sensory (i.e., visual displays, auditory modalities, haptic interfaces, and movement tracking) and (b) perpetual (i.e., interactivity, representation fidelity, imagination, haptic imagery, perceived sense of self-location, media richness, and perceived usability). The affordance of immersion via ARSGs is very important for fields like education since they transform the learning process into a full-body experience (Buchem, 2019; Motti, 2019).

Furthermore, in their study regarding the educational affordances of wearable devices (i.e., Google Glass and Oculus Fit), Bower and Sturman (2015) identified 14 affordances. These include hands-free access and first-person view, access to in-situ information, communication, and distribution of resources, recording and feedback, and simulation through re-enactment. In sum, the affordances of smart glasses make users' immersive experiences unique compared to other AR approaches using mobile devices (Buchem, 2019; Holdack et al., 2022).

2.2. Technology acceptance theories and models

Many researchers from information systems and social psychology fields have proposed and developed models and theories to explain and predict individuals' intentions and behaviour regarding the use and acceptance of digital technologies. The main models underlying the current literature review are briefly presented below.

The Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) is the theory which was used as a theoretical basis for the Theory of Planned Behaviour (TPB) (Ajzen, 1991) and the Technology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989). TRA proposed that the attitude toward the behaviour (Att) and subjective norm (SN) are the fundamental determinants of an individual's intention to adopt a specific behaviour. Attitude towards the behaviour is defined as "an individual's positive or negative feelings about performing the target behaviour" (Fishbein & Ajzen, 1975, p. 216) and subjective norms are defined as "the person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein & Ajzen, 1975, p. 302). The TRA model was expanded to TPB, including the variable of perceived behavioural control (PBC). This is defined as "people's perception of the ease or difficulty of performing the behaviour of interest" (Ajzen, 1991, p. 183). This new variable, together with attitude towards the behaviour and the subjective norm, is supposed to influence an individual's intention, which in turn affects the target behaviour.

TAM was also adapted from TRA (Davis, 1989; Davis et al., 1989) to address the issue of how individuals adopt and use digital technologies. The two key variables of TAM, which, together with attitude, explain and predict individuals' intention and use of technology, are perceived usefulness (PU) and perceived ease of use (PEOU). Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989, p. 320), while perceived usefulness refers to "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320).

Criticism of TAM for its over-simplicity (Shachak et al., 2019) led to its subsequent expansion and the development of Technology Acceptance Model 2 (TAM 2) (Venkatesh & Davis, 2000) and Technology Acceptance Model 3 (TAM 3) (Venkatesh & Bala, 2008), where social factors are introduced. In TAM 2, PEOU and intention are affected by "social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use)" (p. 198). TAM 3 is a combination of TAM 2 and variables that affect PEOU. These are computer self–efficacy, perception of external control, computer anxiety, computer playfulness, perceived enjoyment, and objective usability.

One extension of TPB, with variables from TAM, is the Decomposed Theory of Planned Behaviour (DTPB) (Taylor & Todd, 1995a; 1995b). More specifically, in this new model, attitude towards behaviour is influenced by PU and PEOU of TAM, as well as by the compatibility of the Innovation Diffusion Theory (Rogers, 1995). The latter is defined as "the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters" (Moore & Benbasat, 1991, p. 195). Subjective norms are influenced by peer influence and superior influence. In addition, perceived behavioural control is influenced by self-efficacy, i.e., the degree of confidence of a user towards the use of a technology and facilitating conditions – namely, the objective factors of an environment that can facilitate the user's work.

Another theory, the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) borrowed variables from eight theories and models. It consists of four direct determinants of intention to use the technology (i.e., performance expectancy, effort expectancy, social influence, facilitating conditions) and four moderators of the above variables (i.e., gender, age, experience, voluntariness of use). Performance expectancy is defined as "the degree to which an individual believes that using the system will help him or her to attain gains in the job" (Venkatesh et al., 2003, p. 447), while effort expectancy is "defined as the degree of ease associated with the use of the system" (Venkatesh et al., 2003, p. 450). According to the UTAUT, usage behaviour is affected by behavioural intention and facilitating conditions. Behavioural intention, in turn, is influenced by performance expectancy, effort expectancy, and social influence. Regarding the moderators, gender influences performance expectancy, effort expectancy and social influence. Age affects performance expectancy, effort expectancy, social influence, and facilitation conditions. Experience affects effort expectancy, social influence, and facilitating conditions. Finally, voluntariness of use, which is defined as "the degree to which use of the innovation is perceived as being voluntary, or of free will" (Moore & Benbasat, 1991, p. 195), affects social influence. Later, Venkatesh et al. (2012) added three variables (i.e., hedonic motivation, habit, and price value), to form UTAUT2, which is considered more suitable for the consumer context. Hedonic motivation was associated with the fun or pleasure that stems from using a technology, habit as the extent to which a system user automatically acts thanks to learning, and price value depicts the monetary cost that a consumer must bear to acquire a device (Venkatesh et al., 2012). According to this theory, age, gender, and experience moderate the impact of hedonic motivation, habit, performance expectancy, effort expectancy, and social influence on behavioural intention. Age and gender moderate the effect of price value on behavioural intention, as well as the effect that the facilitating conditions have on behavioural intention.

2.3. Previous reviews of the factors that influence the acceptance of smart wearable devices

There are several literature reviews in various fields regarding wearable devices. For example, in education, these reviews focused on the impact that wearables can have on learning, the methodologies and theoretical framework adopted by the researchers, the subjects in which wearable devices were used, and the types of devices that were used (e.g., Almusawi et al., 2021; Chu et al., 2022; Koutromanos & Kazakou, 2020). Additionally, in the health care sector, there are reviews that focus on the ways in which wearable devices and sensors are used by people with disabilities or diseases such as Dementia and Parkinson's in order to improve their quality of life, as well as by health professionals, for the collection of patients' medical data (Dizayee, 2022; Dos Santos et al., 2021; Harper & Ghali, 2020; Mughal et al., 2022; Saganowski et al., 2022; Site et al., 2021). Also, there are reviews that focus on a specific type of wearable device, such as that by Kim and Choi (2021), who reviewed the application fields of smart glasses, product, operation systems, sensors, and data visualisation, processing, and transfer methods mostly used together with smart glasses.

There are three reviews regarding wearable devices and their acceptance. The first is by Shin et al. (2019), who reviewed the data from 463 studies on wearable activity tracking. These topics focused on trackers' technological functions (technology focus), health care monitoring (patient treatment and medical settings), health-related habits (behaviour change), collection of personal information (self-monitoring data centred), concerns regarding security and protection (privacy), and the use or abandonment of using wearable activity trackers (acceptance and adoption). However, this review focuses on a specific wearable device. The other two (Kalantari, 2017; Niknejad et al., 2020) reviewed wearable devices in general, including ARSGs. There are currently no studies reviewing the acceptance of ARSGs. Given that the purpose of this study is to review the acceptance of ARSGs, this subsection focuses on these last two reviews.

Kalantari (2017) studied 50 articles published from 2009 to 2017 on the acceptance and diffusion of wearable technologies by consumers but made no reference to the methodology that she followed to conduct the literature review. Her purpose was to record the acceptance models or theories adopted by the researchers, as well as to identify the factors that influence the acceptance of wearable technologies, among which are the ARSGs. Kalantari (2017) recorded a total of 22 factors influencing the acceptance of wearable technologies by consumers, which she grouped into five categories: (1) perceived benefits, (2) technological characteristics, (3) individual characteristics, (4) social factors, and (5) perceived risks. However, according to Kalantari (2017), it should be noted that the factors recorded do not apply to all wearable devices. This happens for two reasons. The first is that wearable devices differ significantly from each other, while the second is that consumers perceive them differently. For example, smart glasses and smart clothing may be seen by consumers more as a fashion than as technology. Therefore, differing consumer perceptions of different wearable devices have a variety of factors that influence their acceptance.

Niknejad's et al. (2020) literature review, which studied 244 studies on the use of smart wearable technologies from 2010 to 2019, found that 58 of them related to the factors that influence the intention to accept or use these technologies. The researchers recorded 38 factors influencing the acceptance or use of smart wearable technologies. Among them, the following four factors that affect the intention are mentioned as the best predictors of the acceptance of smart wearable technologies: (1) perceived usefulness, (2) attitude towards technology, (3) social influence, and (4) privacy concern. The best predictors also include perceived usefulness, which affects attitude, and perceived ease of use, which affects perceived usefulness. The above factors were measured within the framework of either known acceptance models and theories, such as the Technology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989), Diffusion of Innovation Theory (DOI) (Rogers, 1995) and Unified Theory of Acceptance (UTAUT) (Venkatesh et al., 2003), or new conceptual frameworks developed by the researchers of the reviewed studies. Although the above-known acceptance models or theories have proven to be reliable in achieving the objectives of the studies presented in this review, according to Niknejad et al. (2020), the examination of the perceptions and intention of acceptance of users of smart wearable devices must be done through a single unified and comprehensive acceptance model.

Based on the findings of the above literature reviews, two conclusions emerge. First, it is not a given that the factors found to influence the acceptance or use of smart wearables in general also affect the acceptance or use of ARSGs. Second, there is no specific model or theory that explains the acceptance or intention to use smart glasses. Therefore, the recording of the factors that affect the acceptance or use of ARSGs needs to be done autonomously. Such a recording is considered essential because it will provide researchers with the necessary data to develop acceptance models specifically for ARSGs in various fields.

3. Methodology

To achieve the purpose of this study, a literature review of studies examining the acceptance or use of ARSGs was conducted. The review was conducted in 2022 through a search on the online databases "SpringerLink", "IEEExplore", "ACM Digital Library", "Emerald Insight", "Scopus", "Web of Science" and the Google Scholar search engine. The search covered the period from 2013 to 2023. The year 2013 was chosen as the starting point of the review because that was when the first smart glasses, Google Glass (Klein et al., 2020), were released.

The following search terms were used: "acceptance" OR "adoption" OR "acceptance model" AND "Augmented reality smart glasses" OR "ARSGs" OR "Google Glass" OR "AR Glass". Only open access databases or databases accessed by the authors' institutional library were utilised. The review was based on the PRISMA framework (Moher et al., 2009).

Given that ARSG research is still in its infancy, the search focused on journal articles, as well as conference papers and book chapters. A similar methodological approach was adopted in recent studies of other emerging technologies, such as the Metaverse (e.g., Tlili et al., 2022; Wu & Ho, 2023). Articles refer to studies that have been published in journals, while papers refer to the studies that have been published in conference proceedings or conference proceedings published as book chapters.

To select the studies, certain criteria were applied. Journal articles and conference papers should (a) be written in English, (b) refer either to the intention to accept and use the ARSGs or to factors that influence their acceptance and use, and (c) contain empirical data. Articles and papers that could not be accessed, duplicate articles and papers, extended abstracts, short papers, and those whose titles, summaries, keywords, or conclusions were not relevant to the purpose of the review were excluded.

The result of the search yielded 82 articles and papers, excluding duplicates. Then, 51 articles were excluded from the first screening due to irrelevant titles, keywords, or summaries, as well as another two for not being written in English. Afterwards, a full-text eligibility check was conducted. Eight more articles and papers were also excluded as being irrelevant to the aim and research questions of the current review. In total, 21 studies were found to meet the selection criteria. Of these, twelve are articles published in journals, four are conference papers, and another four are conference proceedings published as book chapters. Fig. 1 shows the process of screening and selecting articles and papers. These articles were then analysed based on the research questions of the present study.

Each study included in the current review was coded and analysed following the research questions. Initially, the researchers coded and analysed the studies independently, and then differences were resolved through discussion among the researchers. Specifically, a first categorisation was related to the field which is directly connected to research question RQ1. Following research question RQ2, studies were categorised according to the applied technology acceptance model. Studies were also categorised according to the applied research design to address research question RQ3. Finally, following research question RQ4, studies were categorised based on the factors that influence the acceptance or use of ARSGs. Furthermore, the data concerning these factors were coded into two categories: (a) factors emerging from the quantitative studies and (b) factors emerging from the qualitative studies. More specifically, a codebook was developed to extract data from the studies. It included the following elements: the purpose of the study, field, device, acceptance model or theory and its variables, type of research, sample, factors' significant effects, and factors emerging from qualitative studies. To assess their quality, studies should provide certain criteria. These included the provision of a clear purpose, research questions, methodology design, and well-presented results. The results were peer reviewed by the authors to ensure assessment quality. A similar coding process was followed by previous literature reviews on technology (e.g., Alonso-Fernández et al., 2019; Kay, 2012; Malegiannaki & Daradoumis, 2017; Ovčjak et al., 2015; Petrovich et al., 2019). The analysis of the findings of the 21 studies is presented in the next section.

4. Findings

The review of the research activity on the factors influencing the acceptance and use of smart glasses led to the identification of 21 studies, which are presented in Table 1. Specifically, the authors, year of publication, purpose, field of activity, model of the device used, theoretical framework (i.e., the acceptance model or theory on which they were based), and samples are presented. The following sections provide a more detailed presentation of the findings, based on the research questions of the review.

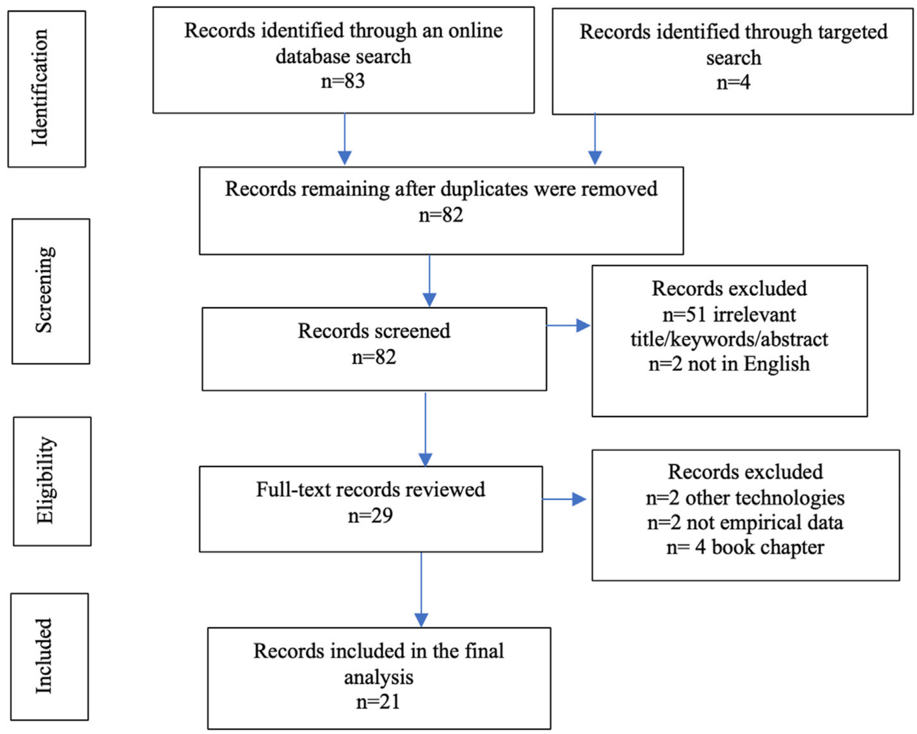

Fig. 1. PRISMA flow diagram for the study (Moher et al., 2009).

4.1. Fields

Regarding the first research question – namely, the fields - it was found that there are four categories of use. The first includes 12 studies (Adapa et al., 2018; Başoğlu et al., 2017; Ernst, 2016; Holdack et al., 2022; Kalantari & Rauschnabel, 2018; Nunes & Arruda Filho, 2018; Rauschnabel et al., 2015; Rauschnabel et al., 2016; Rauschnabel et al., 2018; Rauschnabel & Ro, 2016; Stock et al., 2016; Weiz et al., 2016) that are related to the commercial use of ARSGs. In this category, users of the glasses are treated as customers who would buy the glasses for personal use, i.e., to surf the internet or shoot videos. The second category consists of four studies and refers to the educational use of ARSGs. Three studies were conducted in tertiary education (AL-Maroof et al., 2021; Alfaisal et al., 2022; AlHamad et al., 2021) and focused on university students who would use the glasses to enhance their learning. The fourth was conducted in primary and secondary education (Kazakou & Koutromanos, 2022) and involved in-service teachers who would use the ARSGs to enhance their teaching. The third category is related to medical use and includes three studies in the field of medicine and health professionals (Başoğlu et al., 2018; Göken et al., 2016; Özdemir-Güngör et al., 2020). The last category includes the use of the ARSGs in other fields, such as tourism and sports. One of them involves museum visitors (Han et al., 2019), while another focuses on cyclists (Berkemeier et al., 2018).

4.2. The theoretical framework of the studies

Regarding the second research question – namely, the theoretical framework of the studies - the utilisation of a variety of theories and models is observed. Researchers either adopt a known model or theory, combine models, or select a model and add additional factors to it by presenting an extension or modification of it. In addition, some researchers propose a new conceptual framework as a model for accepting or using smart glasses. More specifically, in cases where the adoption of a particular model or theory was chosen, this model is most often TAM, which is used in four studies in medicine and marketing (Başoğlu et al., 2017, 2018; Göken et al., 2016; Özdemir-Güngör et al., 2020). In the other five cases where a combination of models or theories was chosen, they were found to include at least TAM (Adapa et al., 2018; Ernst, 2016; Han et al., 2019; Stock et al., 2016; Weiz et al., 2016), with the most common case being that of the combination of TAM and UTAUT (Adapa et al., 2018; Ernst, 2016; Stock et al., 2016). These studies were conducted in the fields of marketing and tourism. Additionally, studies proposing to extend or modify a model based their proposal on TAM (AlHamad et al., 2021; AL-Maroof et al., 2021; Alfaisal et al., 2022; Holdack et al., 2022; Kalantari & Rauschnabel, 2018; Kazakou & Koutromanos, 2022; Rauschnabel & Ro, 2016; Rauschnabel et al., 2016). The fields in which these studies were conducted were marketing and education.

4.3. Research design of the studies

Regarding the third research question – namely, the research design of the reviewed studies – it was found that most studies used a quantitative methodology (AlHamad et al., 2021; Alfaisal et al., 2022; AL-Maroof et al., 2021; Başoğlu et al., 2017; Ernst, 2016; Holdack et al., 2022; Kalantari & Rauschnabel, 2018; Özdemir-Güngör et al., 2020; Rauschnabel et al., 2015; Rauschnabel & Ro, 2016; Rauschnabel et al., 2016; Stock et al., 2016; Weiz et al., 2016). Four studies employed a qualitative methodology (Adapa et al., 2018; Han et al., 2019; Kazakou & Koutromanos, 2022; Nunes & Arruda Filho, 2018), while four others relied on both methodologies (Başoğlu et al., 2018; Berkemeier et al., 2018; Göken et al., 2016; Rauschnabel et al., 2018).

For their sample, researchers chose participants associated with the particular field being studied. Specifically, in three studies the sample consisted of health professionals, doctors or medical students (Başoğlu et al., 2018; Göken et al., 2016; Özdemir-Güngör et al., 2020), in another three it consisted of university students (AL-Maroof et al., 2021; Alfaisal et al., 2022; AlHamad et al., 2021), in one, it consisted of primary and secondary school teachers (Kazakou & Koutromanos, 2022), in another one it consisted of museum visitors (Han et al., 2019), and in another one it featured professional or amateur cyclists (Berkemeier et al., 2018).

Table 1
Studies on the acceptance and use of ARSGs.

A/A	Author/s	Purpose of the study	Field and device	Sample	Model and variables	Significant effects
1	Adapa et al. (2018)	Investigating the factors that either contribute to the acceptance of smart glasses and watches or limit them.	Marketing Google Glass	N = 25 students and university staff	TAM and UTAUT variables	*
2	Alfaisal et al. (2022)	Understanding the factors that influence Google Glass adoption in the context of educational projects.	Education Google Glass	N = 528 students	TAM: Intention (I), Perceived usefulness (PU), Perceived ease of use (PEOU) External variables: Functionality (F), Motivation (M), Trust & privacy (T&P)	1) PU→I, 2) PEOU→I, 3) F→I, 4) M→I, 5) T&P→I
3	AlHamad et al. (2021)	Introducing a Google Glass acceptance model based on TAM and other factors.	Education Google Glass	N = 429 students	TAM: Intention (I), Perceived usefulness (PU), Perceived ease of use (PEOU) External variables: Functionality (F), Trust & privacy (T&P)	1) PU→I, 2) PEOU→I, 3) F→PU, 4) T&P→PU, 5) PEOU→PU, 6) F→PEOU, 7) T&P→PEOU
4	AL-Maroof et al. (2021)	The proposal of a Google Glass acceptance model in an educational context.	Education Google Glass	N = 968 students	TAM: Intention (I), Perceived usefulness (PU), Perceived ease of use (PEOU) External variables: Functionality (F), Motivation (M), Trust & privacy (T&P)	1) PU→I, 2) PEOU→I, 3) M→PU, 4) T&P→PU, 5) PEOU→PU, 6) M→PEOU, 7) F→PEOU, 8) T&P→PEOU
5	Kazakou and Koutromanos (2022)	Exploring the factors that primary and secondary school teachers believe will influence them to use ARSGs in their teaching.	Education Epson Moverio AR BT-300	N = 91 teachers of primary and secondary education	Variables of Technology Acceptance Models and IDT	*
6	Başoğlu et al. (2017)	The recording of the "product characteristics" and the "use intention characteristics" of smart glasses.	Marketing Not specified	For the "product characteristics" N = 81, for the "use intention characteristics" N = 122, the status of the participants is not specified	TAM: Intention (I), Attitude (A), Perceived usefulness (PU), Perceived ease of use (PEOU) External variables: Enjoyment (E), Peer Influence (PE), External influence (EI), Self-efficacy (SE)	1) A→I, 2) PU→A, 3) E→PU, 4) EI→PU
7	Başoğlu et al. (2018)	Investigating the use and acceptance of ARSGs by physicians.	Medicine Not specified	1st phase N = 38 doctors 2nd phase N = 30 doctors 3rd phase N = 71 doctors and medical students	TAM: Intention (I), Attitude (A), Perceived (PU), Perceived ease of use (PEOU) External variables: Compatibility (C), Ease of reminding (EOR), Speech recognition, Ease of learning (EOL), Ease of medical education (EOME), External influence (EI)	1) A→I, 2) PU→A, 3) C→PU, 4) EOR→PU, 5) PEOU→PU, 6) EOL→PEOU, 7) EOME→PEOU, 8) EI→PEOU
8	Berkemeier et al. (2018)	Identifying the factors needed to support cycling training and those that affect the acceptance of smart glasses by cycling athletes.	Sport Not specified	Qualitative: N = 3 experts in cycling training Quantitative: N = 100 members of social networks for cycling races	UTAUT2: Behavioural intention (BI), Performance Expectancy (PEX), Effort Expectancy (EEX), Social Influence (SI), Hedonic Motivation (HM) External variables: Ubiquity (UBI), Unobtrusiveness (UNO), Context Awareness (CAW)	1) PEX→BI, 2) SI→BI, 3) HM→BI, 4) UBI→PEX, 5) UBI→EEX, 6) UNO→EEX, 7) UBI→SI, 8) UBI→HM, 9) CAW→HM
9	Ernst (2016)	Evaluation of the "perceived substitutability" factor in terms of the intention to use ARSGs.	Marketing Microsoft HoloLens	N = 109 the status of the participants is not specified	TAM: Perceived usefulness (PU), Perceived ease of use (PEOU) External variables: Perceived enjoyment (PE), Perceived Substitutability (PS) UTAUT: Behavioural intention (BI)	1) PU→BI, 2) PE→BI, 3) PS→PU, 4) PS→PE
10	Göken et al. (2016)	Examining whether the design factors of smart glasses affect the intention to use them in medicine.	Medicine Not specified	1st phase N = 8 doctors, 2nd phase N = 30 doctors and students at a technology school, 3rd phase N = 75 doctors	TAM: Intention (I), Attitude (A), Perceived (PU), Perceived ease of use (PEOU) External variables: Compatibility (C), Ease of reminding (EOR), Speech recognition (SR), Ease of learning (EOL), Ease of medical education (EOME), External influence (EI), Privacy (P)	1) A→I, 2) PU→A, 3) C→U, 4) EOR→PU, 5) PEOU→C, 6) EOL→PEOU, 7) EOME→PEOU, 8) EI→PEOU
11	Han et al. (2019)		Tourism Not specified	N = 28 visitors to ~~of~~ a gallery	Variables form IDT, TRA, TPB, TAM, UTAUT	*

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Table 1 (*continued*)

A/A	Author/s	Purpose of the study	Field and device	Sample	Model and variables	Significant effects
12	Holdack et al. (2022)	Investigation of the factors that contribute to the adoption of ARSG, in cultural tourism. Proposition of an acceptance model to predict the acceptance of ARSGs in the field of retailing, in the future.	Marketing Microsoft HoloLens	N = 143 customers of a commercial store	TAM: Behavioural intention to use (BI), Perceived (PU), Perceived ease of use (PEOU) External variables: Perceived enjoyment (E), Perceived informativeness (PINF)	1) AT→BI 2) PU→AT 3) PU→BI 4) PEOU→AT 5) PEOU→PU 6) PEOU→PI 7) PEOU→PE 8) PE→AT 9) PE→PU 10) PI→PE 11) PI→PU
13	Kalantari and Rauschnabel (2018)	Developing a model for understanding how people respond to ARSGs.	Marketing Microsoft HoloLens	N = 116 students	TAM: Intention (I), Perceived (PU), Perceived ease of use (PEOU) External variables: Hedonic motivation (HM), Image (IM), Technology risk (TR), Privacy risk (PR), Injunctive norms (IN), Descriptive norms (DN)	1) PU→I, 2) PEOU→I, 3) IM→I, 4) TR→I, 5) DN→I
14	Nunes and Arruda Filho (2018)	Analysing consumer behaviour towards Google Glass using the social network Reddit.	Marketing Google Glass	Reddit users	New conceptual framework	*
15	Özdemir-Güngör et al. (2020)	The proposal of a model of acceptance of smart glasses for the doctors of hospitals.	Medicine Not specified	N = 119 doctors and medical students	TAM: Intention (I), Perceived (PU), Perceived ease of use (PEOU) External variables: Integration with IS (IIS), Documentation (D), Technological Compatibility (TC), External effects (EE), Hands-free (HF)	1) A→I, 2) PU→A, 3) PEOU→PU, 4) IIS→PU, 5) D→PU, 6) TC→PEOU, 7) EE→PEOU, 8) HF→PEOU
16	Rauschnabel et al. (2015)	Examining the role of a consumer's personality in adopting Google Glass.	Marketing Google Glass	1st study N = 146 students 2nd study N = 201 consumers of a shopping centre	1st study: Big Five Model: Openness (O), Extraversion (E), Neuroticism (N) 2nd study: Big Five Model: Openness (O), Extraversion (E), Neuroticism (N) Control variables: Brand Attitude (BA), Age (A), Gender (G), Familiarity with Google Glass (F) External variables: Expected Functional Benefits (EFB), Expected Social Conformity (ESC), Adoption Intention (AI)	1) EFB→AI, 2) ESC→AI, 3) BA→AI, 4) O→EFB, 5) N→EFB, 6) E→ESC, 7) N→ESC
17	Rauschnabel and Ro (2016)	The development and measurement of a model with factors that affect the intention to use ARSGs.	Marketing Google Glass	N = 201 consumers of a shopping centre	TAM: Adoption Intention (AI), Attitude towards using smart glasses (ATU), Expected ease of use (EEOU) External variables: Social norms (SN), Self-presentation benefits (SPB), Functional benefits (FB), Attitude towards manufacturer brand (ATMB), Data privacy image of the manufacturer brand (DPI), Technology innovativeness (TI), Familiarity with smart glasses (F), Age (A), Gender (G)	1) SN→AI, 2) TI→AI, 3) ATMB→AI, 4) FB→ATU, 5) EEOU→ATU, 6) TI→ATU
18	Rauschnabel et al. (2016)	The investigation of whether ARSGs are considered by consumers as a fashion or technology, and the relationship that this view has with the intention to use them.	Marketing Microsoft HoloLens, Epson Moverio, Sony SmartEyeglass, Zeis Glasses, Everysight Raptor, Google Glass, ODG R-7	1st study N = 266 students 2nd study - N = 1682 customers of a commercial store	1st study TAM: Purchase intention (PI) External variables: Expected utilitarian benefits (EUB), Expected social benefits (ESB), Perception as technology (PAT), Perception as Fashion (PAF) 2nd study TAM: Adoption intention for technologists (AIT), Adoption intention for Fashionists (AIF), Adoption intention for Fashnologists (AIFa), Perceived ease of use (PEOU) External variables: Expected utilitarian benefits (EUB), Expected hedonic benefits (EHB), Expected	1st study 1) EUB→PI, 2) ESB→PI, 3) PAT→PI, 4) PAF→PI 2nd study 1) EUB→AIT, 2) PEOU→ AIF, 3) ESB→AIF, 4) PPPR→AIF, 5) PEOU→AIFa, 6) EUB→ AIFa, 7) EHB→ AIFa, 8) ESB→AIFa, 9) PPPR→ AIFa

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Table 1 (*continued*)

A/A	Author/s	Purpose of the study	Field and device	Sample	Model and variables	Significant effects
					social benefits (ESB), Perceived public privacy risks (PPPR)	
19	Rauschnabel et al. (2018)	Development and measurement of a theoretical model for the evaluation of the use of ARSGs.	Marketing Microsoft HoloLens, Epson Moverio, Sony SmartEyeglass, Zeis Glasses, Everysight Raptor, Google Glass, ODG R-7	1st study N = 285 students 2nd study - N = 21 the status of the participants is not specified	New conceptual framework: Purchase intention (PI), Utilitarian benefits (UB), Hedonic benefits (HB), Symbolic benefits (SB), Personal privacy (PP), Other people's privacy (OPP), Loss of autonomy (LOA)	1) UB→PI, 2) HB→PI, 3) SB→PI, 4) OPP→PI
20	Stock et al. (2016)	Evaluation of the effect of "perceived health risk" and "perceived enjoyment" factors on the intention to use smart glasses.	Marketing Microsoft HoloLens	N = 109 the status of the participants is not specified	TAM: Perceived enjoyment (PE) UTAUT: Behavioural intention (BI) External variables: Perceived health risk (PHR)	1) PE→BI, 2) PHR→PE
21	Weiz et al. (2016)	Investigating the influence of "subjective norms" and "perceived usefulness" on the use of smart glasses.	Marketing Google Glass	N = 111 users of Google+ and Reddit	TAM: Actual system use (ASU), Perceived usefulness (PU) Theory of Reasoned Action (TRA): Subjective norms (SN)	1) PU→ASU, 2) SN→PU

* = Qualitative study.

In the remaining 12 studies on the commercial use of smart glasses, the sample consisted of either students or university staff (Adapa et al., 2018; Kalantari & Rauschnabel, 2018), social media users (Nunes & Arruda Filho, 2018; Weiz et al., 2016) or mall consumers (Holdack et al., 2022; Rauschnabel et al., 2015, 2016, 2018; Rauschnabel & Ro, 2016) while in four of them, the sample was not specified (Başoğlu et al., 2017; Ernst, 2016; Rauschnabel et al., 2018; Stock et al., 2016).

The process followed by the researchers to present the glasses to the participants is detailed in the following cases. (a) The active participation of the sample. This means that the participants interacted with the ARSGs and were subsequently interviewed. This was the case in only three studies (Adapa et al., 2018; Han et al., 2019; Holdack et al., 2022). (b) The passive participation of the sample. This means that the participants did not interact with the glasses. More specifically, in the study conducted by the Kazakou and Koutromanos (2022), only the researchers interacted with the glasses. The participants watched this interaction remotely through a ZOOM meeting. In 12 studies, the glasses were presented to the participants through short videos, as well as a list of official images and an explanation of their technical characteristics and basic functions (Başoğlu et al., 2017; Başoğlu et al., 2018; Berkemeier et al., 2018; Ernst, 2016; Kalantari & Rauschnabel, 2018; Rauschnabel et al., 2015; Rauschnabel et al., 2016; Rauschnabel et al., 2018; Rauschnabel & Ro, 2016; Stock et al., 2016; Weiz et al., 2016; Özdemir-Güngör et al., 2020). The participants did not interact with the glasses here either. (c) The unspecified participation of the sample. Five studies did not specify whether the glasses were presented or if a demonstration was provided, nor did they offer information on whether participants were able to interact with the glasses (AL-Maroof et al., 2021; Alfaisal et al., 2022; AlHamad et al., 2021; Göken et al., 2016; Nunes & Arruda Filho, 2018).

4.4. Factors that affect the intention to accept or use ARSGs

Factors influencing the intention to accept or use ARSGs fall into two categories: those that emerged from quantitative research and those that emerged from qualitative research. First, the variables of quantitative studies are presented, followed by those of qualitative studies. The variables of the quantitative studies that had a statistically significant effect are presented in Tables 1 and 2. The statistically significant influence does not apply to the variables of the qualitative studies. Therefore, they are presented separately per study.

Seventeen of the reviewed studies utilised a variety of variables to determine the factors that affect the intention to accept or use ARSGs, following either a quantitative methodology or a mixed-methods methodology. Some of the variables are components of well-known acceptance theories and models (e.g., TAM, UTAUT, and TPB) such as PEOU, which is a key variable of TAM, while other variables have been incorporated into acceptance models or theories to enhance their effectiveness, such as the variable of "motivation," incorporated into the TAM in the AL-Maroof et al. (2021) study.

Table 1 presents all the variables (independent variables, moderators, and control variables) measured in the context of the 17 studies that used quantitative or mixed methodology and had a statistically significant effect. These factors were divided into five categories and are presented separately in Table 2. This classification was based on Kalantari's review (2017) and includes the following categories: (1) utilitarian factors which appear in 17 studies and refer to a specific gain or benefit, (2) social factors which appear in ten studies and are related to the influence that derives from society, (3) personal factors which appear in ten studies and refer to users' personality traits or psychological characteristics, (4)

Table 2
Factors that affect the intention to accept or use ARSGs.

Utilitarian factors	Technological factors	Personal factors	Social factors	Risk factors
Perceived usefulness Perceived ease of use	Functionality	Motivation	External influence	Trust and privacy
Ease of learning	Speech recognition	Attitude	Social influence	Privacy
Ease of reminding	Ubiquity	Compatibility	Image	Technology risk
Ease of medical education	Unobtrusiveness	Technological compatibility	Descriptive norms	Perceived public privacy risks
Performance expectancy Hedonic motivation	Content awareness	Brand attitude Openness	External effects	Other people's privacy
Perceived enjoyment Perceived substitutability	Integration of IS Documentation	Neuroticism	Expected social conformity	Perceived health risk
Expected functional benefits	Hands-free	Extraversion	Social norms	
Functional benefits		Attitudes towards the use	Social benefits	
Expected ease of use		Brand attitude	Subjective norms	
Utilitarian benefits		Technology innovativeness		
Hedonic benefits		Perception as technology		
Symbolic benefits				
Perceived informativeness				

risk-related factors appearing in eight studies and are related to privacy, health or technology risks, and (5) technological factors which appear in seven studies and refer to specific technological characteristics and functions of ARSGs.

The remaining four studies (Adapa et al., 2018; Han et al., 2019; Kazakou & Koutromanos, 2022; Nunes & Arruda Filho, 2018) recorded the factors that can affect the acceptance or use of ARSGs by adopting a qualitative methodological design. One of these studies is by Adapa et al. (2018), in which 25 participants were divided into two groups of users: university students and staff. Participants used Google Glass and were then interviewed by the researchers. It was found that the factor "look and feel" is very important for the acceptance of ARSGs. Also, it was found that participants felt that battery-related issues such as battery life and heating are important acceptance factors. Other factors contributing to the decision to accept smart glasses are the availability of GPS and messaging, as well as social media applications. Also, the hands-free feature, functionality, compatibility, form factor, and battery life were recorded as factors that influence users' beliefs about the usefulness of smart glasses.

Kazakou and Koutromanos (2022) explored the perceptions of 91 teachers of primary and secondary education regarding the factors affecting intention to use ARSGs. Their study followed a qualitative methodological design and applied variables from technology acceptance models. The results showed that if teachers are convinced of the usefulness of ARSGs in the educational process, they will use them in the classroom. The factors in question were perceived usefulness, compatibility, facilitating conditions (i.e., training on technical and pedagogical issues, supply of educational material, infrastructure and equipment of the school, support from educational leadership, and affordability of purchasing glasses) privacy risk, and potential health risk.

Han et al. (2019) investigated the factors that contribute to the adoption of ARSGs in cultural tourism. Specifically, they interviewed 28 visitors of a gallery in the United Kingdom. Based on participants' answers, researchers proposed an acceptance model for ARSGs. This includes four categories of factors: (a) perceived attributes of innovation that refer to personal innovativeness, interaction, and obtrusiveness, (b) visitor benefits (i.e., perceived enjoyment and perceived usefulness), (c) visitor resistance, such as privacy, risk of use and its cost, and (d) social impact (i.e., social acceptability and social interaction).

Nunes and Arruda Filho (2018) analysed consumer behaviour towards Google Glass using the social network Reddit. They adopted a qualitative methodology; namely, the netnographic approach utilising the comments of 86 users of the social network Reddit over a period of four months. Three categories and two subcategories of consumers were found: (a) socially satisfied, (b) socially constrained, and (c) early adopters who are distinguished into enthusiasts and visionaries. In the context of the above analysis of consumer behaviour, the factors related to the acquisition or use of Google Glass were also recorded. According to the research findings, the use and diffusion of ARSGs are associated with several problems, including the incompatibility of the device with the current social standards of fashion and privacy. There is little reference by users to the usefulness of ARSGs and when they do refer to it, it concerns comfort and access to information. There is an equally rare mention of hedonism by users, which they combined with the ease of recording images. Instead, the social aspect of smart glasses was extensively discussed by users. Some users believe that smart glasses have a high social value because they are rare, while at the same time, the use of wearable devices is increasing. Others prefer smart glasses to be compatible with the fashion standards associated with glasses in general.

5. Discussion

The purpose of this review was to study the empirical research documenting the acceptance of ARSGs in any field. The following paragraphs address and discuss the research questions. In addition, research gaps are highlighted and implications are noted.

Regarding the first research question - the fields in which the acceptance of smart glasses has been researched - it was found that almost half of the studies were related to marketing, i.e., the commercial use of ARSGs. Consumers' behaviour and experience within the Metaverse is considered a challenge for marketers, resulting in an expanding research agenda (Barrera & Shah, 2023; Dwivedi et al., 2023). Moreover, given that the field of marketing includes a wide range of the daily life of consumers and firms (i.e., retailing, branding, advertising) and economic activities (Navarro, 2023), it is expected that researchers will focus more on the acceptance of ARSGs and less on fields such as that of education. However, a previous literature review regarding applications for smart glasses conducted by Kim and Choi (2021) documented that smart glasses, augmented or mixed reality, are used in a variety of fields and not limited exclusively to marketing. More specifically, by reviewing 57 studies on smart glasses in applied sciences from 2014 to 2020, they identified seven categories of fields and 16 sub-fields in which smart glasses, augmented or mixed reality are used. These are computer science (human-computer interaction, object recognition, and visualisation), healthcare (clinical and surgical assistance, disability support, and therapy), education (nursing, physical training, and physics), industry (work support, maintenance, and safety), services (culture and tourism, and e-commerce), and social sciences (information security, marketing, and psychology). Therefore, while ARSGs are being used in a number of fields, it seems that no research has yet been conducted on the factors affecting their acceptance or use. It is therefore highly recommended that ARSG researchers not only include new fields (e.g., work support, e-commerce) in their interests, but also expand their research to fields that have already been researched.

Regarding the second research question, which refers to the theoretical framework of the reviewed studies, it was found that the researchers chose to use well-known acceptance models or theories such as TAM (Davis, 1989) and UTAUT (Venkatesh et al., 2003). Most of the reviewed studies were based on key variables of TAM or on extended or modified TAM. Even in cases where the researchers combined two models, TAM was one of them. The fact that TAM seems to be used as a theoretic basis to determine ARSG acceptance is probably due to the fact that along with its two main variables (i.e., perceived ease of use, perceived usefulness), it is still a valid model (Davis et al., 2023) and has been successfully applied to explain the acceptance of diverse technologies (e.g., AlHadid et al., 2022; Harris & Rogers, 2023; Ho et al., 2023; Saleh et al., 2022). The above findings were previously confirmed by reviews on the acceptance of smart wearable devices (King & He, 2006; Niknejad et al., 2020).

Regarding the third research question - the research design of the reviewed studies - two conclusions were drawn. The first is that researchers used quantitative methodology more often than qualitative or mixed methodologies. This finding is consistent with both the King and He (2006) and Niknejad et al. (2020) reviews on the acceptance of smart wearable devices since both reviews ascertained the limited use of qualitative methodologies in the reviewed studies. Indeed, the primary research method employed by researchers investigating technology acceptance across various fields is the quantitative one (Firmansyah et al., 2023; Hussin et al., 2023; Sarya et al., 2023). However, especially for ARSGs, the research community should consider using both quantitative and qualitative data collection tools more often. For example, an experienced user of smart glasses can perceive a different level of sickness (Vovk et al., 2018), usability, presence (Beckmann et al., 2019; Vrellis et al., 2020) and sense of weight (tom Dieck et al., 2016; Han et al., 2019) compared to someone else who has no experience using smart glasses or wears glasses for distance vision. Also, battery-related issues such as battery life and overheating negatively impact their use (Adapa et al., 2018; tom Dieck et al., 2016). Such factors may influence the acceptance of smart glasses and may not be fully captured in a technology-specific acceptance questionnaire. In this case, it is suggested that future researchers consider such issues not only in their questionnaires, but also through interviews and user observation. The second conclusion is that most of the studies did not give the participants the opportunity to interact with or even wear the glasses. Nonetheless, hands-on experience of ARSGs is important. In order to form a more well-rounded point of view regarding their use, it would be best for users to interact with them. This is particularly true because ARSGs have a peculiarity in relation to other devices, including other wearable devices (e.g., smart watches) - they provide a highly personalised (Kim & Choi, 2021) and immersive experience (Verhulst et al., 2021). Therefore, only by wearing the glasses can a user fully realise the affordances that can be offered to him or her.

Regarding the fourth research question - the factors influencing the acceptance or use of ARSGs - 51 factors were recorded and grouped into five categories: (1) utilitarian, (2) social, (3) personal, (4) risk-related, and (5) technological factors. One of the conclusions that can be drawn is that the number of studies investigating the effect of these factors on the acceptance or use of ARSGs is, in many cases, small, so they cannot be characterised as best or promising predictors. For example, only one study identified "image" as a variable with a statistically significant influence on intention. In addition, variables that the research literature has highlighted as determinants of technology acceptance either by individuals or by organisations, such as facilitating conditions (Chong et al., 2022; Khechine et al., 2016), have not been widely measured. Future research needs to conduct a more larger scale investigation, and rely on different contexts, including cultural or professional, to determine which of the above factors can be utilised for the theoretical foundation of the acceptance of ARSGs. Another conclusion is that the factors (e.g., perceived usefulness, perceived ease of use, attitudes, perceived enjoyment, and social factors) found in previous models and determined to be critical for the acceptance of various technologies (e.g., Chocarro et al., 2023; Lee et al. al., 2019; Salloum et al., 2019; Vahdat et al., 2021; Woo & Yoo, 2023) were found to be important in the acceptance of ARSGs as well. Finally, in the models used in the present review, it seems that only factors affecting user intention were examined. Future research should be expanded to also examine whether intention influenced the purchase or use of ARSGs. Finally, it was found that in acceptance models researchers ignored many of the technological and learning affordances of ARSGs. Such technological affordances include immersion, presence, and interaction (Chen et al., 2023) and such learning affordances include simulation, engagement, and gamification (Bower & Sturman, 2015). These affordances give ARSGs a relative advantage over other mobile technology devices and should be considered in future adoption models.

Compared to previous reviews by Kalantari (2017) and Niknejad et al. (2020), this review agrees on the factors found to influence the acceptance of wearable devices. However, these reviews did not explore the different fields in which the acceptance of wearable devices was examined, while the present review did so for the ARSGs. Furthermore, while this review focused on one specific device, ARSGs, the previous two reviews studied the factors influencing the acceptance of wearable devices in general. Meanwhile, these factors may be influential for a certain type of wearable device and not for another. For example, perceived enjoyment may influence the acceptance of smartwatches, but not wellness wearable devices (Kalantari, 2017). This is due to the differences, peculiarities, and different affordances of wearable devices. Therefore, this review offers a more comprehensive framework for understanding the acceptance of a specific device - ARSGs.

6. Implications for research and practice

This review provides findings and implications that could be of interest to researchers, practitioners, and policymakers. It provides data that can be used by researchers to develop an acceptance model for ARSGs. It seems that established acceptance models lack comprehensive and thorough knowledge of the affordances (e.g., the combination of real and virtual objects, immersive and personalised experience, hands-free access, and first-person view) of smart glasses. This means that they do not include them and therefore need to be expanded or modified. As a result, the development of a comprehensive and specialised model, which takes into account the affordances of ARSGs to explain and predict the intention to use the glasses, is necessary. Also, understanding the factors that influence the acceptance of ARSGs can help practitioners improve the technological characteristics of glasses, as well as create appropriate applications for them to increase their acceptance. In addition, the knowledge of these factors can guide policymakers to make informed decisions, thus providing more opportunities for the effective use of glasses across various fields.

More specifically, from a consumer's point of view, an acceptance model for ARSGs could include the key variables of the TAM - perceived usefulness and perceived ease of use, as well as the variables of perceived risk and perceived trust - that have proven to be important for the acceptance of innovative technologies (Frank et al., 2023). Another variable that could be included is price value from UTAUT2 (Venkatesh et al., 2012), which has been shown to have an effect on behavioural intention regarding technologies that emphasise utilitarian value, both in an individual and organisational context (Tamilmani et al., 2018). Furthermore, depending on the field in which ARSGs are used, corresponding variables could be added. For example, the variable of hands-free use could be utilised in the areas of industry, medicine, and sports, along with the variables of immersion and presence in the areas of tourism and culture.

Education is another field that could also benefit from the use of ARSGs in both formal and informal learning environments. For the last decade, education has incorporated emerging technologies, including AR. As we head into the Metaverse era (Kaddoura & Al Husseiny, 2023), education will increasingly take advantage of AR, which is inextricably linked to this new era. Its exploitation is expected to bring about important changes in the field. Stakeholders - teachers and students - will play a leading role in these changes. If teachers accept ARSGs as educational technology, it will be more likely that they will be successfully introduced and integrated into schools. To measure the acceptance of ARSGs in education, an acceptance model specifically designed for this technology is required. Such an acceptance model could also be based on TAM and its key determinants, i.e., perceived usefulness and perceived ease of use. Furthermore, it could include the variable of facilitating conditions, which has been found to influence attitudes of users of information systems and innovations, ultimately playing an important role in their acceptance and use (Dwivedi et al., 2019). In particular, previous studies have found that conditions such as lack of infrastructure, support from the school environment, and free and appropriate AR applications for educational purposes prevent teachers from using AR in their teaching (Arici et al., 2021; Huang et al., 2016; Jang et al., 2021; Koutromanos & Jimoyannis, 2023; Ozdamli & Karagozlu, 2018). Additionally, apart from the hands-free and speech recognition that some models included, other technological and learning affordances of smart glasses, which add value to the learning process, could also be included in an acceptance model. For example, new variables could be developed to measure whether immersion, presence, interactivity, and the combination of virtual and real objects in the real environment offered by ARSGs compared to other mobile technology devices influence the acceptance of glasses. Accordingly, the relative advantage variable of Diffusion of Innovations (Rogers, 1995) could examine whether the perception that ARSG users have regarding their advantages and affordances are better than those of other mobile technologies.

Finally, the present review provides new directions for future research in the field. These are the inclusion of new fields in the research on the acceptance of ARSGs, integration of technological characteristics and affordances of ARSGs into acceptance models, hands-on experience of smart glasses provided via interaction with them, use of qualitative methodological design to record the experiences of ARSG users when measuring their acceptance, as well as measurement of the factors identified in this review on larger samples with a diverse professional and cultural background.

7. Limitations and future research

This review is limited by two factors. First, only articles and papers written in English were analysed which were either open accessed or available through the authors' institutional library. It is possible that the application of the above research selection criteria precluded research related to the purpose of this literature review. Second, the review focused on specific online databases and search engines.

This study could be extended by measuring the factors that were identified by the review (e.g., utilitarian factors, risk factors) within the framework of acceptance models in different contexts. The goal of this measurement would be the proposal of an acceptance model specifically for ARSGs. One field that could benefit from the formation of such an acceptance model would be education. Teacher and student acceptance of ARSGs would be measured in this context.

8. Conclusions

The study presented a literature review of research on the factors that influence the acceptance or use of ARSGs. The analysis of the 21 studies that met the selection criteria of the review was based on four research questions: (1) the field, (2) the theoretical framework, (3) the methodological design, and (4) the factors that affect the acceptance or use of ARSGs. The main conclusions of the review are that (a) research on the acceptance of these smart glasses has not yet been conducted across all fields where they are used (e.g., work support, e-commerce), (b) a specialised acceptance model adapted to the affordances of smart glasses does not yet exist, (c) a rigorous research methodology including the interaction of users with ARSGs is necessary, and (d) further research is needed to identify the factors that could be described as best or as promising predictors of the acceptance of ARSGs.

ARSGs are an emerging trend, representing a dynamic and rapidly changing field. This review is timely as new ARSG devices are expected to appear on the market and their sales will rise. The main contribution of this review is that it fills the existing research gap regarding the acceptance of ARSGs, as it is one of the first to address their acceptance or use. It provides a comprehensive review of ARSG acceptance by highlighting key research topics in the field. Academic researchers could benefit from the findings and implications of the present review as the existing limitations and gaps are provided.

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Statements on open data and ethics

The data of this review can be provided upon requests by sending e-mails to the corresponding author.

Declaration of competing interest

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References

Adapa, A., Nah, F. F., Hall, R., H, Siau, K., & Smith, S. N. (2018). Factors influencing the adoption of smart wearable devices. *International Journal of Human-Computer Interaction, 34*(5), 399–409. https://doi.org/10.1080/10447318.2017.1357902

Aekanth, S. G., & Tillinghast, D. J. (2023). The emergence of wearable technologies in healthcare: A systematic review. In V. G. Duffy, M. Ziefle, P. L. P. Rau, & M. M. Tseng (Eds.), *Human-automation interaction. Automation, collaboration, & E-services* (Vol. 12). Cham: Springer. https://doi.org/10.1007/978-3-031-10788-7_3.

Afsay, A., Tahriri, A., & Rezaee, Z. (2023). A meta-analysis of factors affecting acceptance of information technology in auditing. *International Journal of Accounting Information Systems, 49*, Article 100608. https://doi.org/10.1016/j.accinf.2022.100608

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review, 20*, 1–11. https://doi.org/10.1016/j.edurev.2016.11.002

Al-Emran, M., Al-Nuaimi, M. N., Arpaci, I., Al-Sharafi, M. A., & Anthony Jnr, B. (2023). Towards a wearable education: Understanding the determinants affecting students' adoption of wearable technologies using machine learning algorithms. *Education and Information Technologies, 28*, 2727–2746. https://doi.org/10.1007/s10639-022-11294-z

Al-Maroof, R. A., Alfaisal, A. M., & Salloum, S. A. (2021). Google glass adoption in the educational environment: A case study in the gulf area. *Education and Information Technologies, 26*, 2477–2500. https://doi.org/10.1007/s10639-020-10367-1

Alfaisal, R., Alhumaid, K., Alnazzawi, N., Samra, R. A., Aburayya, A., Salloum, S., Shaalan, K., Al Khasoneh, O., & Monem, A. A. (2022). Predicting the intention to use google glass in the educational projects: A hybrid sem- ml approach. *Academy of Strategic Management Journal, 21*(6), 1–13. https://doi.org/10.5267/j.ijdns.2021.6.002

AlHadid, I., Abu-Taieh, E., Alkhawaldeh, R. S., Khwaldeh, S., Masa'deh, R. E., Kaabneh, K., & Alrowwad, A. A. (2022). Predictors for E-government adoption of SANAD app services integrating UTAUT, TPB, TAM, trust, and perceived risk. *International Journal of Environmental Research and Public Health, 19*(14), 8281. https://doi.org/10.3390/ijerph19148281

AlHamad, A. Q. M., Akour, I., Alshurideh, M., Al-Hamad, A. Q., Al Kurdi, B., & Alzoubi, H. (2021). Predicting the intention to use google glass: A comparative approach using machine learning models and PLS-SEM. *International Journal of Data and Network Science, 5*(3), 311–320. https://doi.org/10.5267/j.ijdns.2021.6.002

Almusawi, H. A., Durugbo, C. M., & Bugawa, A. M. (2021). Wearable technology in education: A systematic review. *IEEE Transactions on Learning Technologies, 14*(4), 540–554. https://doi.org/10.1109/TLT.2021.3107459

Alonso-Fernández, C., Calvo-Morata, A., Freire, M., Martínez-Ortiz, I., & Fernández-Manjón, B. (2019). Applications of data science to game learning analytics data: A systematic literature review. *Computers & Education, 141*, Article 103612. https://doi.org/10.1016/j.compedu.2019.103612

Alsop, T. (2022). *AR glasses unit sales worldwide 2019-2024* [Chart]. Statista https://www.statista.com/statistics/610496/smart-ar-glasses-shipments-worldwide/#statisticContainer.

Aranda-García, S., Otero-Agra, M., Fernández-Méndez, F., Herrera-Pedroviejo, E., Darné, M., Barcala-Furelos, R., & Rodríguez-Núñez, A. (2023). Augmented reality training in basic life support with the help of smart glasses. A pilot study. *Resuscitation, 14*, Article 100391. https://doi.org/10.1016/j.resplu.2023.100391

Arici, F., Yilmaz, R. M., & Yilmaz, M. (2021). Affordances of augmented reality technology for science education: Views of secondary school students and science teachers. *Human Behavior and Emerging Technologies, 3*(5), 1153–1171. https://doi.org/10.1002/hbe2.310

Attié, E., & Meyer-Waarden, L. (2022). The acceptance and usage of smart connected objects according to adoption stages: An enhanced technology acceptance model integrating the diffusion of innovation, uses and gratification and privacy calculus theories. *Technological Forecasting and Social Change, 176*, Article 121485. https://doi.org/10.1016/j.techfore.2022.121485

Aungst, T. D., & Lewis, T. L. (2015). Potential uses of wearable technology in medicine: Lessons learnt from google glass. *International Journal of Clinical Practice, 69*(10), 1179–1183. https://doi.org/10.1111/ijcp.12688

Azuma, R. T. (1997). A survey of augmented reality. *Presence: Teleoperators and Virtual Environments, 6*(4), 355–385. https://doi.org/10.1162/pres.1997.6.4.355

Bakhshian, S., & Lee, Y. A. (2023). Influence of extrinsic and intrinsic attributes on consumers' attitude and intention of using wearable technology. *International Journal of Human-Computer Interaction, 39*(3), 562–574. https://doi.org/10.1080/10447318.2022.2041904

Bao, H., & Lee, E. W. (2023). Examining the antecedents and health outcomes of health apps and wearables use: An integration of the technology acceptance model and communication inequality. *Behaviour & Information Technology*, 1–22. https://doi.org/10.1080/0144929X.2023.2183062

Barrera, K. G., & Shah, D. (2023). Marketing in the Metaverse: Conceptual understanding, framework, and research agenda. *Journal of Business Research, 155*, Article 113420. https://doi.org/10.1016/j.jbusres.2022.113420

Barsom, E. Z., Graafland, M., & Schijven, M. P. (2016). Systematic review on the effectiveness of augmented reality applications in medical training. *Surgical Endoscopy, 30*, 4174–4183. https://doi.org/10.1007/s00464-016-4800-6

Başoğlu, N. A., Göken, M., Dabić, M., Özdemir-Güngör, D., & Daim, T. U. (2018). Exploring adoption of ARSGs: Applications in the medical industry. *Front. Eng. Manag., 5*(2), 167–181. https://doi.org/10.15302/J-FEM-2018056

Başoğlu, N. A., Ok, A. E., & Daim, T. U. (2017). What will it take to adopt smart glasses: A consumer choice based review? *Technology in Society, 50*, 50–56. https://doi.org/10.1016/j.techsoc.2017.04.005

Beckmann, J., Menke, K., & Weber, P. (2019). Holistic evaluation of AR/VR-Trainings in the ARSuL-project. In *Proceedings of the INTED2019 conference* (pp. 4317–4327). IATED. https://doi.org/10.21125/inted.2019.1079.

Berkemeier, L., Menzel, L., Remark, F., & Thomas, O. (2018). Acceptance by design: Towards an acceptance smart glasses-based information system based on the example of cycling training. In *Proceedings of multikonferenz wirtschaftsinformatik (MKWI)*. Germany https://mkwi2018.leuphana.de.

Bower, M., & Sturman, D. (2015). What are the educational affordances of wearable technologies? *Computers & Education, 88*, 343–353. https://doi.org/10.1016/j.compedu.2015.07.013

Bräker, J., & Semmann, M. (2023). Is there more than pokémon go?–exploring the state of research on causal modeling in the field of augmented reality. In *Proceedings of the 56th Hawaii international conference on system sciences*. https://hdl.handle.net/10125/102793.

Buchem, I. (2019). Design principles for wearable enhanced embodied learning of movement. In *Proceedings of learning and collaboration technologies. Ubiquitous and virtual environments for learning and collaboration: 6th international conference, LCT 2019, held as part of the 21st HCI international conference, HCII 2019*. Orlando, FL, USA: Springer International Publishing. https://doi.org/10.1007/978-3-030-21817-1_2. *Part II 21,* 13–25.

Chang, H. Y., Binali, T., Liang, J. C., Chiou, G. L., Cheng, K. H., Lee, S. W. Y., & Tsai, C. C. (2022). Ten years of augmented reality in education: A meta-analysis of (quasi-) experimental studies to investigate the impact. *Computers & Education, 191*, Article 104641. https://doi.org/10.1016/j.compedu.2022.104641

Chen, J., Zhou, Y., & Zhai, J. (2023). Incorporating AR/VR-assisted learning into informal science institutions: A systematic review. *Virtual Reality*, 1–17. https://doi.org/10.1007/s10055-023-00789-w

Chiang, F. K., Shang, X., & Qiao, L. (2022). Augmented reality in vocational training: A systematic review of research and applications. *Computers in Human Behavior, 129*, Article 107125. https://doi.org/10.1016/j.chb.2021.107125

Chocarro, R., Cortinas, M., & Marcos-Matás, G. (2023). Teachers' attitudes towards chatbots in education: A technology acceptance model approach considering the effect of social language, bot proactiveness, and users' characteristics. *Educational Studies, 49*(2), 295–313. https://doi.org/10.1080/03055698.2020.1850426

Choi, S., Jang, Y., & Kim, H. (2023). Influence of pedagogical beliefs and perceived trust on teachers' acceptance of educational artificial intelligence tools. *International Journal of Human-Computer Interaction, 39*(4), 910–922. https://doi.org/10.1080/10447318.2022.2049145

Chong, A. Y. L., Blut, M., & Zheng, S. (2022). Factors influencing the acceptance of healthcare information technologies: A meta-analysis. *Information & Management, 59*(3), Article 103604. https://doi.org/10.1016/j.im.2022.103604

Chu, S. L., Garcia, B. M., & Rani, N. (2022). *Research on wearable technologies for learning: A systematic review*. https://doi.org/10.48550/arXiv.2201.11878. *arXiv* preprint arXiv:2201.11878.

Danielsson, O., Holm, M., & Syberfeldt, A. (2020). ARSGs for operators in production: Survey of relevant categories for supporting operators. *Procedia CIRP, 93*, 298–1303. https://doi.org/10.1016/j.procir.2020.04.099

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982–1003. https://www.jstor.org/stable/2632151.

Davis, F. D., Granić, A., & Marangunić, N. (2023). *The technology acceptance model 30 years of TAM.* Cham: Springer.

tom Dieck, M. C., Jung, T., & Han, D. I. (2016). Mapping requirements for the wearable smart glasses augmented reality museum application. *Journal of Hospitality and Tourism Technology*. https://doi.org/10.1108/JHTT-09-2015-0036

Dizayee, F. S. (2022). The impact of google glass technology on disabled people's daily activities: A systematic literature review. In *Proceedings of the 8th international engineering conference on sustainable technology and development (IEC)* (pp. 212–217). IEEE. https://doi.org/10.1109/IEC54822.2022.9807555.

Dos Santos, A. D. P., Suzuki, A. H. G., Medola, F. O., & Vaezipour, A. (2021). A systematic review of wearable devices for orientation and mobility of adults with visual impairment and blindness. *IEEE Access, 9*, 162306–162324. https://doi.org/10.1109/ACCESS.2021.3132887

Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. *Journal of Science Education and Technology, 18*, 7–22. https://doi.org/10.1007/s10956-008-9119-1

Dwivedi, Y. K., Hughes, L., Wang, Y., Alalwan, A. A., Ahn, S. J., Balakrishnan, J., Barta, S., Belk, R., Buhalis, D., Dutot, V., Felix, R., Filieri, R., Flavián, C., Gustafsson, A., Hinsch, C., Hollensen, S., Jain, V., Kim, Y., Krishen, A. S., … Wirtz, J. (2023). Metaverse marketing: How the metaverse will shape the future of consumer research and practice. *Psychology and Marketing, 40*(4), 750–776. https://doi.org/10.1002/mar.21767

Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., & Williams, M. D. (2019). Re-examining the unified theory of acceptance and use of technology (UTAUT): Towards a revised theoretical model. *Information Systems Frontiers, 21*, 719–734. https://doi.org/10.1007/s10796-017-9774-y

Ernst, C.-P. (2016). *The drivers of wearable device usage: Practice and perspectives* (1st ed.). Cham: Springer.

Ferreira, J. J., Fernandes, C. I., Rammal, H. G., & Veiga, P. M. (2021). Wearable technology and consumer interaction: A systematic review and research agenda. *Computers in Human Behavior, 118*, Article e106710. https://doi.org/10.1016/j.chb.2021.106710

Firmansyah, E. A., Masri, M., Anshari, M., & Besar, M. H. A. (2023). Factors affecting fintech adoption: A systematic literature review. *FinTech, 2*(1), 21–33. https://doi.org/10.3390/fintech2010002

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research.* Reading, MA, USA: Addison-Wesley.

Frank, D. A., Chrysochou, P., & Mitkidis, P. (2023). The paradox of technology: Negativity bias in consumer adoption of innovative technologies. *Psychology and Marketing, 40*(3), 554–566. https://doi.org/10.1002/mar.21740

Garzón, J., Pavón, J., & Baldiris, S. (2019). Systematic review and meta-analysis of augmented reality in educational settings. *Virtual Reality, 23*(4), 447–459. https://doi.org/10.1007/s10055-019-00379-9

Gimpel, H., Graf, V., & Graf-Drasch, V. (2020). A comprehensive model for individuals' acceptance of smart energy technology–A meta-analysis. *Energy Policy, 138*, Article 111196. https://doi.org/10.1016/j.enpol.2019.111196

Göken, M., Başoğlu, A. N., & Dabic, M. (2016). Exploring adoption of smart glasses: Applications in medical industry. In *Proceedings of the 2016 portland international conf. On management of engineering and technology (PICMET)*. https://doi.org/10.1109/PICMET.2016.7806835. Honolulu, HI, USA, 3175–3184.

Han, D.-I. D., Tom Dieck, M. C., & Jung, T. (2019). Augmented Reality Smart Glasses (ARSG) visitor adoption in cultural tourism. *Leisure Studies, 38*(5), 618–633. https://doi.org/10.1080/02614367.2019.1604790

Harper, M., & Ghali, F. (2020). A Systematic review of wearable devices for tracking physiological indicators of Dementia related difficulties. In *Proceedings of the 13th international conference on developments in eSystems engineering (DeSE), 406–411)*. IEEE. https://doi.org/10.1109/DeSE51703.2020.9450793.

Harris, M. T., & Rogers, W. A. (2023). Developing a healthcare technology acceptance model (H-TAM) for older adults with hypertension. *Ageing and Society, 43*(4), 814–834. https://doi.org/10.1017/S0144686X21001069

Holdack, E., Lurie-Stoyanov, K., & Fromme, H. F. (2022). The role of perceived enjoyment and perceived informativeness in assessing the acceptance of AR wearables. *Journal of Retailing and Consumer Services, 65*, Article 102259. https://doi.org/10.1016/j.jretconser.2020.102259

Ho, M. T., Mantello, P., & Ho, M. T. (2023). An analytical framework for studying attitude towards emotional AI: The three-pronged approach. *MethodsX.* , Article 102149. https://doi.org/10.1016/j.mex.2023.102149

Huang, Y., Li, H., & Fong, R. (2016). Using augmented reality in early art education: A case study in Hong Kong kindergarten. *Early Child Development and Care, 186*(6), 879–894. https://doi.org/10.1080/03004430.2015.1067888

Hussin, S. F., Abdollah, M. F., & Ahmad, I. B. (2023). Acceptance of IoT technology for smart homes: A systematic literature review. In M. Al-Emran, M. A. Al-Sharafi, & K. Shaalan (Eds.), *Lecture notes in networks and systems: Vol. 550. International Conference on information Systems and intelligent applications, ICISIA 2022*. Cham: Springer. https://doi.org/10.1007/978-3-031-16865-9_16.

Ibáñez, M., Di-Serio, Á., Villarán-Molina, D., & Delgado-Kloos, C. (2015). Augmented reality-based simulators as discovery learning tools: An empirical study. *IEEE Transactions on Education, 58*(3), 208–213. https://doi.org/10.1109/TE.2014.2379712

Iovanel, G., Ayers, D., & Zheng, H. (2023). The role of wearable technology in measuring and supporting patient outcomes following total joint replacement: Review of the literature. *JMIR Perioperative Medicine, 6*(1), Article e39396. https://doi.org/10.2196/39396

Jang, J., Ko, Y., Shin, W. S., & Han, I. (2021). Augmented reality and virtual reality for learning: An examination using an extended technology acceptance model. *IEEE Access, 9*, 6798–6809. https://doi.org/10.1109/ACCESS.2020.3048708

Kaddoura, S., & Al Husseiny, F. (2023). The rising trend of metaverse in education: Challenges, opportunities, and ethical considerations. *PeerJ Computer Science, 9*, e1252. https://doi.org/10.7717/peerj-cs.1252

Kalantari, M. (2017). Consumers' adoption of wearable technologies: Literature review, synthesis, and future research agenda. *International Journal of Technology Marketing, 12*, 274–307. https://doi.org/10.1504/IJTMKT.2017.089665

Kalantari, M., & Rauschnabel, P. (2018). Exploring the early adopters of ARSGs: The case of Microsoft HoloLens. In T. Jung, & M. Tom Dieck (Eds.), *Progress in ISAugmented reality and virtual reality: Empowering human, place and business* (pp. 229–245). Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-319-64027-3_16.

Kay, R. H. (2012). Exploring the use of video podcasts in education: A comprehensive review of the literature. *Computers in Human Behavior, 28*(3), 820–831. https://doi.org/10.1016/j.chb.2012.01.011

Kazakou, G., & Koutromanos, G. (2022). Augmented Reality Smart Glasses in Education: Teachers' Perceptions Regarding the Factors that Influence Their Use in the Classroom. In M. E. Auer, & T. Tsiatsos (Eds.), *New Realities, Mobile Systems and Applications. IMCL 2021. Lecture Notes in Networks and Systems, 411* pp. 145–155). Cham: Springer. https://doi.org/10.1007/978-3-030-96296-8_14.

Khechine, H., Lakhal, S., & Ndjambou, P. (2016). A meta-analysis of the UTAUT model: Eleven years later. *Canadian Journal of Administrative Sciences - Revue Canadienne des Sciences de l Administration, 33*(2), 138–152. https://doi.org/10.1002/cjas.1381

Kim, D., & Choi, Y. (2021). Applications of smart glasses in applied sciences: A systematic review. *Applied Sciences, 11*(11). https://doi.org/10.3390/app11114956. Article e4956.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information Management, 43*(6), 740–755. https://doi.org/10.1016/j.im.2006.05.003

Klein, A., Sørensen, C., de Freitas, A. S., Pedron, C. D., & Elaluf-Calderwood, S. (2020). Understanding controversies in digital platform innovation processes: The Google Glass case. *Technological Forecasting and Social Change, 152*, Article e119883. https://doi.org/10.1016/j.techfore.2019.119883

Koutromanos, G., & Jimoyannis, A. (2023). Augmented Reality in education: Exploring Greek teachers' views and perceptions. In A. Reis, J. Barroso, P. Martins, A. Jimoyiannis, R. YM. Huang, & R. Henriques (Eds.), *Technology and Innovation in Learning, Teaching and Education. TECH-EDU 2022. Communications in Computer and Information Science, 1720* pp. 31–42). Cham: Springer. https://doi.org/10.1007/978-3-031-22918-3_3.

Koutromanos, G., & Kazakou, G. (2020). The use of smart wearables in primary and secondary education: A systematic review. *Themes in eLearning, 13*, 33–53.

Lee, J., Kim, J., & Choi, J. Y. (2019). The adoption of virtual reality devices: The technology acceptance model integrating enjoyment, social interaction, and strength of the social ties. *Telematics and Informatics, 39*, 37–48. https://doi.org/10.1016/j.tele.2018.12.006

Leue, M. C., Jung, T., & tom Dieck, D. (2015). Google glass augmented reality: Generic learning outcomes for art galleries. In *Proceedings of the information and communication technologies in tourism 2015: International conference in lugano* (pp. 463–476). Switzerland: Springer International Publishing. https://10.1007/978-3-319-14343-9_34.

Litvak, E., & Kuflik, T. (2020). Enhancing cultural heritage outdoor experience with augmented-reality smart glasses. *Personal and Ubiquitous Computing, 24*, 873–886. https://doi.org/10.1007/s00779-020-01366-7

López-Faican, L., & Jaen, J. (2020). EmoFindAR: Evaluation of a mobile multiplayer augmented reality game for primary school children. *Computers & Education, 149*, Article 103814. https://doi.org/10.1016/j.compedu.2020.103814

Malegiannaki, I., & Daradoumis, T. (2017). Analyzing the educational design, use and effect of spatial games for cultural heritage: A literature review. *Computers & Education, 108*, 1–10. https://doi.org/10.1016/j.compedu.2017.01.007

Malhotra, P., Singh, Y., Anand, P., Bangotra, D. K., Singh, P. K., & Hong, W.-C. (2021). Internet of Things: Evolution, concerns and security challenges. *Sensors, 21*(5), Article e1809. https://doi.org/10.3390/s21051809

Mason, M. (2016). The MIT museum glassware prototype: Visitor experience exploration for designing smart glasses. *Journal on Computing and Cultural Heritage (JOCCH), 9*(3), 1–28. https://doi.org/10.1145/2872278

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred reporting Items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine, 6*(7), Article e1000097. https://doi.org/10.1136/bmj.b2535

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*(3), 192–222. https://doi.org/10.1287/isre.2.3.192

Motti, V. G. (2019). Wearable technologies in education: A design space. In *Proceedings of the learning and collaboration technologies. Ubiquitous and virtual environments for learning and collaboration: 6th international conference, LCT 2019, held as part of the 21st HCI international conference*. Springer International Publishing. https://doi.org/10.1007/978-3-030-21817-1_5. *HCII 2019, Orlando, Part II 21*, 55–67.

Mughal, H., Javed, A. R., Rizwan, M., Almadhor, A. S., & Kryvinska, N. (2022). Parkinson's disease management via wearable sensors: A systematic review. *IEEE Access*. https://doi.org/10.1109/ACCESS.2022.3162844

Navarro, J. G. (2023). *April 3). Marketing worldwide - statistics & facts. Statista*. https://www.statista.com/topics/8954/marketing-worldwide/#topicOverview.

Niknejad, N., Ismail, W. B., Mardani, A., Liao, H., & Ghani, I. (2020). *A comprehensive overview of smart wearables: The state of the art literature, recent advances, and future challenges* (Vol. 90). Engineering Applications of Artificial Intelligence, Article e103529. https://doi.org/10.1016/j.engappai.2020.103529

Nunes, G. S., & Arruda Filho, E. J. M. (2018). Consumer behavior regarding wearable technologies: Google Glass. *Innovation & Management Review, 15*(3), 230–246. https://doi.org/10.1108/INMR-06-2018-0034

Ovčjak, B., Heričko, M., & Polančič, G. (2015). Factors impacting the acceptance of mobile data services–A systematic literature review. *Computers in Human Behavior, 53*, 24–47. https://doi.org/10.1016/j.chb.2015.06.013

Ozdamli, F., & Karagozlu, D. (2018). Preschool teachers' opinions on the use of augmented reality application in preschool science education. *Croatian Journal of Education: Hrvatski časopis za odgoj i obrazovanje, 20*(1), 43–74. https://doi.org/10.15516/cje.v20i1.2626

Özdemir-Güngör, D., Göken, M., Başoğlu, A., Shaygan, N., Dabić, M., & Daim, T. U. (2020). An acceptance model for the adoption of smart glasses technology by healthcare professionals. In J. Larimo, M. Marinov, S. Marinova, & T. Leposky (Eds.), *Palgrave studies of internationalization in emerging marketsInternational business and emerging economy firms* (pp. 163–194). Cham, Switzerland: Palgrave Macmillan. https://doi.org/10.1007/978-3-030-27285-2_6.

Palumbo, A. (2022). Microsoft hololens 2 in medical and healthcare context: State of the art and future prospects. *Sensors, 22*(20), 7709. https://doi.org/10.3390/s22207709

Petrovich, M., Jr., Shah, M., & Foster, A. (2019). From virtual to real: An expanded systematic review of augmented reality learning. *Proceedings of the Society for Information Technology & Teacher Education International Conference*, 980–989. *Association for t*he Advancement of Computing in Education (AACE) https://www.learntechlib.org/primary/p/207766/.

Rahi, S., Ghani, M. A., & Ngah, A. H. (2019). Integration of unified theory of acceptance and use of technology in internet banking adoption setting: Evidence from Pakistan. *Technology in Society, 58*, Article 101120. https://doi.org/10.1016/j.techsoc.2019.03.003

Rauschnabel, P. A., Brem, A., & Ivens, B. S. (2015). Who will buy smart glasses? Empirical results of two pre-market-entry studies on the role of personality in individual awareness and intended adoption of google glass wearables. *Computers in Human Behavior, 49*, 635–647. https://doi.org/10.1016/j.chb.2015.03.003

Rauschnabel, P. A., Felix, R., Hinsch, C., Shahab, H., & Alt, F. (2022). What is XR? Towards a framework for augmented and virtual reality. *Computers in Human Behavior, 133*, Article 107289. https://doi.org/10.1016/j.chb.2022.107289

Rauschnabel, P. A., Hein, D. W. E., He, J., Ro, Y. K., Rawashdeh, S., & Krulikowski, B. (2016). Fashion or technology? A fashnology perspective on the perception and adoption of ARSGs. *I-Com, 15*(2), 179–194. https://doi.org/10.1515/icom-2016-0021

Rauschnabel, P. A., He, J., & Ro, Y. K. (2018). Antecedents to the adoption of ARSGs: A closer look at privacy risks. *Journal of Business Research, 92*, 374–384. https://doi.org/10.1016/j.jbusres.2018.08.008

Rauschnabel, P. A., & Ro, Y. K. (2016). Augmented reality glasses: An investigation of technology acceptance drivers. *International Journal of Technology Marketing, 11*(2), 123–148. https://doi.org/10.1504/IJTMKT.2016.075690

Rejali, S., Aghabayk, K., Esmaeli, S., & Shiwakoti, N. (2023). Comparison of technology acceptance model, theory of planned behavior, and unified theory of acceptance and use of technology to assess a priori acceptance of fully automated vehicles. *Transportation Research Part A: Policy and Practice, 168*, Article 103565. https://doi.org/10.1016/j.tra.2022.103565

Ro, Y. K., Brem, A., & Rauschnabel, P. A. (2018). Augmented reality smart glasses: Definition, concepts, and impact on firm values creation. In T. Jung, & C. M. Tom Dieck (Eds.), *Progress in ISAugmented reality and virtual reality: Empowering human, place and business* (pp. 169–181). Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-319-64027-3_12.

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: The Free Press.

Romare, C., & Skär, L. (2020). Smart glasses for caring situations in complex care environments. *Scoping Review. JMIR Mhealth Uhealth, 8*(4), Article e16055. https://doi.org/10.2196/16055

Ruiz-Ariza, A., Casuso, R. A., Suarez-Manzano, S., & Martínez-López, E. J. (2018). Effect of augmented reality game Pokémon GO on cognitive performance and emotional intelligence in adolescent young. *Computers & Education, 116*, 49–63. https://doi.org/10.1016/j.compedu.2017.09.002

Saganowski, S., Perz, B., Polak, A., & Kazienko, P. (2022). Emotion recognition for everyday life using physiological signals from wearables: A systematic literature review. *IEEE Transactions on Affective Computing*. https://doi.org/10.1109/TAFFC.2022.3176135

Saleh, S. S., Nat, M., & Aqel, M. (2022). Sustainable adoption of E-learning from the TAM perspective. *Sustainability, 14*(6), 3690. https://doi.org/10.3390/su14063690

Salloum, S. A., Alhamad, A. Q. M., Al-Emran, M., Monem, A. A., & Shaalan, K. (2019). Exploring students' acceptance of e-learning through the development of a comprehensive technology acceptance model. *IEEE Access, 7*, 128445–128462. https://doi.org/10.1109/ACCESS.2019.2939467

Sarya, I. N., Arief, M., Saroso, H., & Bandur, A. (2023). The effect of information technology adoption entrepreneurial orientation on dynamic capabilities and company performance. *Journal of Theoretical and Applied Information Technology, 101*(1), 161–171.

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education, 128*, 13–35. https://doi.org/10.1016/j.compedu.2018.09.009

Shachak, A., Kuziemsky, C., & Petersen, C. (2019). Beyond TAM and UTAUT: Future directions for HIT implementation research. *Journal of Biomedical Informatics, 100*, Article 103315. https://doi.org/10.1016/j.jbi.2019.103315

Shin, G., Jarrahi, M. H., Fei, Y., Karami, A., Gafinowitz, N., Byun, A., & Lu, X. (2019). Wearable activity trackers, accuracy, adoption, acceptance and health impact: A systematic literature review. *Journal of Biomedical Informatics, 93*, Article e103153. https://doi.org/10.1016/j.jbi.2019.103153

Sırakaya, M., & Alsancak Sırakaya, D. (2022). Augmented reality in STEM education: A systematic review. *Interactive Learning Environments, 30*(8), 1556–1569. https://doi.org/10.1080/10494820.2020.1722713

Site, A., Nurmi, J., & Lohan, E. S. (2021). Systematic review on machine-learning algorithms used in wearable-based eHealth data analysis. *IEEE Access, 9*, 112221–112235. https://doi.org/10.1109/ACCESS.2021.3103268

Stefana, E., Marciano, F., Rossi, D., Cocca, P., & Tomasoni, G. (2021). Wearable devices for ergonomics: A systematic literature review. *Sensors, 21*(3). https://doi.org/10.3390/s21030777. Article e777.

Stock, B., dos Santos Ferreira, T. P., & Ernst, C.-P. H. (2016). Does perceived health risk influence smartglasses usage? In C.-P. Ernst (Ed.), *Progress in ISThe drivers of wearable device usage: Practice and perspectives* (pp. 13–23). Cham: Springer. https://doi.org/10.1007/978-3-319-30376-5_2.

Suh, A., & Prophet, J. (2018). The state of immersive technology research: A literature analysis. *Computers in Human Behavior, 86*, 77–90. https://doi.org/10.1016/j.chb.2018.04.019

Tamilmani, K., Rana, N., Dwivedi, Y., Sahu, G. P., & Roderick, S. (2018). Exploring the role of' price value for understanding consumer adoption of technology: A review and meta-analysis of UTAUT2 based empirical studies. *Proceedings of the PACIS 2018 Conference, 64*. https://aisel.aisnet.org/pacis2018/64.

Taylor, S., & Todd, P. A. (1995a). Assessing IT Usage: The role of prior experience. *MIS Quarterly, 19*(4), 561–570. https://doi.org/10.2307/249633

Taylor, S., & Todd, P. A. (1995b). Understanding information technology usage: A test of competing models. *Information Systems Research, 6*(2), 144–176. https://www.jstor.org/stable/23011007.

Theodoropoulos, A., & Lepouras, G. (2021). Augmented reality and programming education: A systematic review. *International Journal of Child-Computer Interaction, 30*, Article 100335. https://doi.org/10.1016/j.ijcci.2021.100335

Tikkanen, H., Heinonen, K., & Ravald, A. (2023). Smart wearable technologies as resources for consumer agency in well-being. *Journal of Interactive Marketing, 58*(2–3), 136–150. https://doi.org/10.1177/10949968221143351

Tlili, A., Huang, R., Shehata, B., Liu, D., Zhao, J., Metwally, A. H. S., & Burgos, D. (2022). Is metaverse in education a blessing or a curse: A combined content and bibliometric analysis. *Smart Learning Environments, 9*(1), 1–31. https://doi.org/10.1186/s40561-022-00205-x

Urlings, J., Sezer, S., Ter Laan, M., Bartels, R., Maal, T., Boogaarts, J., & Henssen, D. (2022). The role and effectiveness of augmented reality in patient education: A systematic review of the literature. *Patient Education and Counselling, 105*(7), 1917–1927. https://doi.org/10.1016/j.pec.2022.03.005

Vahdat, A., Alizadeh, A., Quach, S., & Hamelin, N. (2021). Would you like to shop via mobile app technology? The technology acceptance model, social factors and purchase intention. *Australasian Marketing Journal, 29*(2), 187–197. https://doi.org/10.1016/j.ausmj.2020.01.002

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences, 39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*(2), 186–204. https://www.jstor.org/stable/2634758.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478. https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly, 36*(1), 157–178. https://doi.org/10.2307/41410412

Verhulst, I., Woods, A., Whittaker, L., Bennett, J., & Dalton, P. (2021). Do VR and AR versions of an immersive cultural experience engender different user experiences? *Computers in Human Behavior, 125*, Article 106951. https://doi.org/10.1016/j.chb.2021.106951

Villagran-Vizcarra, D. C., Luviano-Cruz, D., Pérez-Domínguez, L. A., Méndez-González, L. C., & Garcia-Luna, F. (2023). Applications analyses, challenges and development of augmented reality in education, industry, marketing, medicine, and entertainment. *Applied Sciences, 13*(5), 2766. https://doi.org/10.3390/app13052766

Vovk, A., Wild, F., Guest, W., & Kuula, T. (2018). Simulator sickness in augmented reality training using the Microsoft HoloLens. In *Proceedings of the 2018 CHI conference on human factors in computing systems* (Vols. 1–9). https://doi.org/10.1145/3173574.3173783

Vrellis, I., Delimitros, M., Chalki, P., Gaintatzis, P., Bellou, I., & Mikropoulos, T. A. (2020). Seeing the unseen: User experience and technology acceptance in Augmented Reality science literacy. In *Proceedings of the 2020 IEEE 20th international conference on advanced learning technologies (ICALT), 333–337*. IEEE. https://10.1109/ICALT49669.2020.00107.

Wei, N., Dougherty, B., Myers, A., & Badawy, S. (2018). Using google glass in surgical settings: Systematic review. *JMIR Mhealth Uhealth, 6*(3). https://doi.org/10.2196/mhealth.9409. Article e54.

Weiz, D., Anand, G., & Ernst, C.-P. H. (2016). The influence of subjective norm on the usage of smartglasses. In C.-P. Ernst (Ed.), *The Drivers of wearable device usage: Practice and perspectives. Progress in IS*. Cham: Springer. https://doi.org/10.1007/978-3-319-30376-5_1.

Woo, C., & Yoo, J. (2023). Exploring the determinants of Blockchain acceptance for research data management. *Journal of Computer Information Systems, 63*(1), 216–227. https://doi.org/10.1080/08874417.2022.2049019

Wu, M. H. (2021). The applications and effects of learning English through augmented reality: A case study of pokémon go. *Computer Assisted Language Learning, 34*(5–6), 778–812. https://doi.org/10.1080/09588221.2019.1642211

Wu, H. K., Lee, S. W. Y., Chang, H. Y., & Liang, J. C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education, 62*, 41–49. https://doi.org/10.1016/j.compedu.2012.10.024

Wu, T. C., & Ho, C. T. B. (2023). A scoping review of metaverse in emergency medicine. *Australasian emergency care, 26*(1), 75–83. https://doi.org/10.1016/j.auec.2022.08.002

Zari, G., Condino, S., Cutolo, F., & Ferrari, V. (2023). Magic Leap 1 versus Microsoft HoloLens 2 for the visualization of 3D content obtained from radiological images. *Sensors, 23*(6), 3040. https://doi.org/10.3390/s2306304