University of East Anglia

NORWICH BUSINESS SCHOOL

Exploring Augmented Reality App Usability: A Socially Practised Affordance Perspective

Arwa Ahmad Almashyakhi

Thesis submitted to Norwich Business School, University of East Anglia for the Degree of Doctor of Philosophy

December 2022

.

Acknowledgments

Firstly, I would like to express my sincere gratitude to my advisors Dr. Tomás Harrington and Dr. Brad McKenna who supported my study by making a great effort to provide me with valuable feedback and guidance. They have been always very patient and caring whenever I have faced difficulties, not only with my studies but personal difficulties as well. They made me aware of my abilities and skills in conceptualising unexpected knowledge through their critical comments on my work. They have encouraged and helped me academically whenever I needed them throughout my study.

My deep thanks go to my supportive parents, Dalal and Ahmad who have always prayed for me and encouraged me. Thanks for your patience and support. Next, my heartful thanks go to my brother Mohammed who stayed with me and supported me during this journey. Your smile and encouraging words have always supported me; you have been unconditionally supportive throughout this long journey, and I am so grateful for your continuing support. Also, I would like to thank my other family members Ashwaq, Khalid, Amjad and Afnan, for their prayers and support.

Finally, special thanks go to my husband, Dr.Fahad, and my best friends, Reem and Asma, who always encourage and support me and have always reminded me about my aim when I have felt discouraged. Without your support, my doctoral study in UEA, U.K. wouldn't be possible.

Declaration of authorship

I declare that the work in this thesis submitted by me for the degree of Doctor of Philosophy is my work and it is original, to the best of my knowledge, except where stated, referenced and acknowledged.

Arwa Almashyakhi

Abstract

Augmented Reality (AR) apps have the potential to transform the way in which users experience products and services. However, AR adoption rates have not yet reached the expectations of developers and the service sector. Users' expectations and experiences of AR apps can influence the adoption of AR technology. This thesis explores AR user behaviour; specifically, by focusing on the usability of AR and the underlying motives that drive users to adopt or reject AR technology. To achieve this aim, qualitative methods and multiple sources of data (858 online reviews, 62 users' reflections, multiple apps) have been used to inform a better understanding of AR app use. Affordance theory was applied using the *'walkthrough technique'* to identify AR affordances arising from the application of AR technology. Ten AR app affordances and five user goals were identified by investigating the performance and usage aspects of various applications. Then, social practice theory (SPT) elements (meanings, materials, competency) were applied to understand the three major characteristics of usability (interactivity, compatibility, credibility) associated with current AR apps that may prevent potential users from actualising their affordances. This study contributes to knowledge by introducing a new theory of *"socially practised affordances"* (SPA) which allows AR app users to actualise an app's affordances when there is a coherence between SPT elements. Moreover, it sheds new light on how AR apps, users, and social practices are interconnected by explaining connections between materials e.g., AR apps, expected and developed meanings, user and system competencies and how these elements might drive AR apps' users' behaviour. This study concludes by discussing theoretical and practical implications that can give future direction to AR developers through the development of a SPA framework for AR applications.

Keywords: AR applications, Users' expectation and experience, Usability, Socially practised affordance (SPA).

.

Table of contents

List of Figures

List of Tables

List of Publications

Almashyakhi, Arwa, Harrington, Tomás and McKenna, Brad (2022) Augmented Reality and User Behaviour: A Socially Practised Affordance Perspective. In: 14th Mediterranean Conference on Information Systems. UNSPECIFIED. (In Press)

Introduction

Chapter 1

1.1 Background

Mobile technologies have become a necessary and fundamental component of everyday life (Hedman et al., 2019). In terms of consumption patterns, the ‘smartphone’ is now part of users’ everyday lives, which has caused an exponential growth in, and adoption of, mobile-based applications. Moreover, the ‘service’ industry has increasingly come to rely on mobile phone devices (Rauschnabel and Ro, 2016). For example, the retail sector responded quickly to the growing trend of ‘smart lifestyles’ in global consumer and business markets by increasingly incorporating ‘smart retail’ concepts into its business models (Nikhashemi et al., 2021). One area of focus has been the adoption of augmented reality (AR) to simulate service aspects that have been reserved particularly for in-store (physical) shopping experiences (Brynjolfsson et al., 2013). The use of AR facilitates a world view in the form of 2D and 3D objects that has enabled new ways of reproducing valuable and attractive information (Chung et al., 2015), Neuburger and Egger (2017). While adoption rates have been poor to-date (Shen et al., 2022). The COVID-19 pandemic has seen a rise in interest levels in AR apps, due to their ability to provide users with an opportunity to ‘try out’ products ‘at home’ before purchasing them (Castillo and Bigne, 2021). Moreover, the use of AR on large interactive screens and smartphone devices is becoming used widely in the retail industry, enabling users to experience products virtually (Javornik, 2016). However, while AR research emerged in the late 1990s, the field has only gained broader attention from practitioners and academics from a technical perspective since the 2010s (Wang et al., 2016).

AR is an emerging, interactive technology (Poushneh, 2018) that contextualises products by integrating virtual content in the physical environment of users, interactively, as well as in ‘real-time’ (Azuma et al., 2001). In addition, AR technology aims to link the real world with the virtual world by developing a virtual mirror, whereby the users gets the most interactive and realistic experience; for example, the users may see an image of their body or part of their body, such as their hand, face, or head, onto which they can superimpose add-ons, such as glasses, hats, clothes, and makeup (Faqih and Jaradat, 2021). Moreover, AR technology has been defined as a marketing tool that engages users’ senses and affects their perception, judgement, and behaviour (Krishna, 2012). Different AR apps have been developed and tested by many brands for examining the setting most suitable for their customers (Wang et al., 2016). For example, many leading companies have developed AR apps for their customers to engage with their products or services. For example, the Ikea Place app allows its users to place IKEA products within their home's real-time environment, and the Gucci app allows users to try on clothes, sunglasses styles, and other Gucci products virtually.

According to the latest industry report, the immersive experience that AR technology has the potential to provide, as well as the emergence of real-life use cases of AR technology, are expected to contribute to significant market growth. Specifically, the global AR market size is anticipated to reach $ 597.54 billion globally, expanding at a compound annual growth rate (CAGR) of 40.9% from 2022 to 2030 (Grand View Research, 2022). However, Fenn and LeHong (2011) indicated that inflated expectations raise concerns about the business reality of these market projections, since AR apps have not yet been extensively adopted and have not yet met expectations (Yim and Park, 2019). This gap, between the market projections for AR Apps and less-than-impressive implementations, is the central problematic that this research addresses. For example, why value is currently not being fully realised post the AR app development process. One factor here appears to be the scant attention paid to 'usability', in terms of user experience and expectations.

One of the reasons for this problem is that AR technology is still in its early phase of development (Jung et al., 2015), and therefore its value is currently not fully realised by users, despite its increasing commercial use. Additionally, Chiang et al. (2021) suggested that potential users of AR have concerns about the use of AR apps. For example, Rauschnabel (2021) investigated the acceptance of holographic AR substitutes and demonstrated that the utility features of the product/technology are not visible to users, because they are unfamiliar with AR technology. Therefore, increased user awareness is necessary to realise the full benefits of AR apps (Cipresso et al., 2018, Rauschnabel and Ro, 2016).

Current AR experiences have also failed to impress users (Hilken et al., 2018). Poor content quality, and certain technical software and hardware limitations, for example, are ongoing challenges in the design of AR apps. Parekh et al. (2020), and Heller et al. (2019) suggested that this is because the technology is in its infancy. This raises the important question of whether AR app developers lack an understanding of user expectations of AR app use. If they do, this may cause users to experience a difference in the features offered and those that are expected, and therefore feel that AR apps are not easy to use (Fan et al., 2020). Meanwhile, Heller et al. (2019) observed that one of the reasons behind the slow adoption of AR technology by users is that AR apps do not currently attract much word-of-mouth. Moreover, 'bad news travels fast', so users may be reluctant to recommend apps to their friends and family, because of their own poor experiences, when compared to their expectations (Chen et al., 2021). Therefore, it is important for developers to better understand users' behaviour, and how AR can be used to create compelling user experiences, based not only on users' star ratings in app stores (Rauschnabel et al., 2019), but also on understanding what they expect from AR technology, since AR software and systems are highly beneficial when the needs of the users are prioritised by their providers (Kaufmann, 2003). For example, when designing AR education apps, it is critical that user interfaces and display types are appropriate for the program and educational goals i.e., an application teaching blind individuals geometric forms of famous architectural structures should employ appropriate input and output devices (Kaufmann, 2003).

Due to the low acceptance of AR among users, developers and retailers remain reluctant to adopt AR technology widely (Daassi and Debbabi, 2021, Ponzoa et al. 2021). Neuburger and Egger (2017) indicated that a key challenge concerning the adoption of AR by organisations stems from issues related to the 'usability' of AR apps. For example, usability issues such as installation issues, digital fatigue, slow response time, and privacy concerns considered to have slowed the adoption of AR apps (Feng and Xie, 2018, Yim and Park, 2019). Consequently, there is a high risk when developing AR solutions in that prospective users may not embrace them, because of the high cost of adopting the technology and the low return on investment (Yim and Park, 2019). In this regard, previous researchers argued that such systems' usability is one of the significant factors of user adoption (Gebauer et al., 2010, Dinh et al., 2013, Herskovic et al., 2011). Here, the lack of uniqueness present in many apps, poor design, and a lack of understanding of user needs and expectations are significant elements that influence adoption rates (Prewitt and Ware, 2006). According to Javornik (2016), an AR system is only adoptable by users when they decide that it is a 'must-have' for their convenience.

However, there remains a gap in the AR app development process, as little attention is currently paid to usability, especially in terms of user experience and expectations. The usability of AR apps represents/includes the features of the AR app that might help the user to achieve their expected goals through their use. The present research focuses primarily on exploring the usability of AR apps from users' perspectives, in order to understand how best to improve the adoption of such apps. This will enable AR managers/developers to benefit from academic insights concerning how user expectations and experiences can impact the usability of AR apps.

1.2 Significance of The Study

The field of AR is seen as one of the most promising developments in mobile technologies (Rauschnabel et al., 2019). In particular, companies are currently exploring the potential of AR technology to offer a customised and interactive experience to their users (Neuhofer et al., 2015). Indeed, several businesses are currently in the process of introducing new products online, and utilising AR technology to give users an immersive experience (Fan et al., 2020). Moreover, the value of AR apps has gained prominence, especially during and post-COVID-19, when brick-and-mortar retailers closed and e-commerce sales increasing resulted in a rise in the use of AR apps at home (Salem and Nor, 2020). Both AR and 3D visualisation enable users to virtually try products in real time, before making a purchasing decision (Poushneh and Vasquez-Parraga, 2017). However, as AR app experiences continue to fail to impress users (Hilken et al., 2018), developers and companies introducing such apps currently seek an understanding of why the uptake of AR apps is poor, and what efforts might be required to increase their level of uptake among users (Rese et al., 2017). Hence, the researcher was motivated to explore the usability issues of current AR apps through a better understanding of what impact users' expectations and experiences have on AR App use.

Users of AR like to share both positive and negative experiences via social network (Sung (2021). Hence, AR users' past experiences and future expectations can play a critical role in determining whether or not a new technology is adopted widely (Smink et al., 2020, Sung, 2021). Moreover, Hilken et al. (2017) indicated that users differ significantly in their views of the benefits of AR apps, and the degree to which they are willing to adopt them. Hence, a current research focus is the need to inform app design post the analysis of users' behaviour. Although the study by Iancu and Iancu (2020) demonstrated that >50% of the issues identified involved usability in various new emerging apps, there is surprisingly little research regarding how usability might be improved by capturing the expectations and real experiences of AR users. The study by Nikhashemi et al. (2021) called for more research concerning online users' shared experiences to inform how best to improve the usability of AR apps. Also, Faqih and Jaradat (2021) indicated that the investigation of mobile AR technology adoption in various industries is absent from existing literature. Hence, this present study can be best positioned as "problematisation". (Steffen et al., 2019), the central focus is to explore AR app usability issues that may prevent users from actualising their affordances and understand the underlying motives that may drive users to use and adopt such technologies. This study employs multiple sources of data collection, including online reviews, user reflections and walkthrough technique to explore the motives that might drive user behaviour (while recognising that behaviour may not be only be shaped by motives). Specifically, the twin aspects of user experiences and expectations, and the role these might play in influencing users to adopt emerging technologies.

1.3 Context

1.3.1 AR App Usability

According to ISO (International Organisations for Standardisation) standards, usability concerns a software’s attractiveness to users, as well as its capability to be learned, understood, and employed by users under particular conditions (Abran et al., 2003). Arguably, AR apps can save time, money, cost, and stress, especially when users are unfamiliar with the products concerned (Linaza et al., 2012, Hassan et al., 2018). Moreover, AR apps can provide meaningful and valuable information that is attractive and eye-catching, and which serves to offer a real user experience to customers that may help them make buying decisions (Allerstorfer, 2013; Hassan et al., 2018). Consequently, several companies are currently interested in adopting AR technology as part of their future business plans.

Since usability is a complex concept that researchers regard as multidimensional, different methods have been utilised and suggested for its evaluation. Ideally, usability considers the use of a product by a user in an authentic setting (Olsson et al., 2013). Thus, the concept depends on the context or situation in which the user is situated (Abran et al., 2003). Meanwhile, Holden and Rada (2011) explained that usability also concerns technological learning and the degree to which technologies are user-friendly, specifying three elements of usability: ease of use, quality, and learning. Moreover, the existing literature identified multiple factors under the umbrella of usability, such as creditability, safety, and security (Dinh et al., 2013, Herskovic et al., 2011, Karahasanović et al., 2009); speed, loading, and reaction time (Dantas et al., 2009, Dinh et al., 2013); accessibility (Wang and Liao, 2007); functionality, responsiveness, and interactivity (Delagi, 2010, Gebauer et al., 2010); information quality (Tan et al., 2019); and usefulness, value-adding, and ease of use (Dantas et al., 2009, Karahasanović et al., 2009). The present study focuses on the forms of usability that may dictate the adoption of AR apps, and determine their success (Arghashi and Yuksel, 2022). Many of the aforementioned concepts are present within the three essential categories of usability: interactivity, creditability, and the compatibility of interactive systems. This study considers these three usability factors as the basis of AR usability characteristics, in order to better frame an understanding of users' expectations and experiences, since it is these expectations and experiences that develop behaviours regarding AR apps.

1.3.2 Users' Expectations and Experiences

According to McLean and Wilson (2016), user expectations are linked with their previous experience; word-of-mouth, such as positive and negative feedback; company promises; personal opinions; personal needs; and ranking by other users. Most of the current literature failed to consider the emotional aspects and expectations of systems, because they are not related directly to measuring the performance of interactive systems (Mahlke and Thüring, 2007). However, Olsson et al. (2013) argued that user expectations, values, requirements, and needs related to interactive systems are closely associated with their experiences, which in turn inform their behaviour. Meeting these user requirements would aid in enhancing the adoption of AR apps by users. Based on the extant literature in the field, it can be argued that user experience encompasses the broad perspective of technology-user-interaction that connects with users' expectation of emerging technologies.

In their study, Immonen et al. (2018) discussed how user values might address the expected usability of a system. For example, user expectations of app characteristics and how the user conceptualises human interactive technology is vital, although the relationship between users' prior expectations and experiences is complex (Olsson and Salo, 2011, Kujala et al., 2017). In contrast, the study by Ahn and Lee (2016) highlighted that user experience primarily concerns the usefulness and perceived interesting features of an app, and the major difficulties encountered that influence its use. Intelligent apps are continually poorly rated, due to developers' lack of understanding of user behaviour, which also subsequently affects the poor adoption of new apps by users (Tafesse, 2021, Iancu and Iancu, 2020). However, only a limited number of previous studies addressed the link between user expectations and experiences, and their behaviour in adopting AR apps. The matter of underutilised systems is currently a challenge (Ong and Lai, 2006), therefore understanding the gap between expectations and experiences, and its effect on technology usage, is of paramount importance to both AR app research and practice. Since the existing literature suggested that user expectations are complicated (Olsson and

Salo, 2012, Kujala et al., 2017), and virtual experiences differ for different users, depending on their knowledge and previous understanding (Söderman, 2005), its exploration has the potential to provide unique insights into AR apps.

1.3.3 Affordance and Social Practice Theories

Much of the existing literature concerning AR technology focused on generic technology adoption models (Rese et al., 2014). For example, the technology acceptance model (TAM) and its extended theories were employed by many researchers to understand users' willingness to accept AR technology (Chiang et al., 2021). As Hilken et al. (2017) suggested, most current AR research is limited to exploring it via the TAM, and fails to consider critical usability characteristics, such as interactivity, credibility, and compatibility, that drive user behaviour.

The present thesis extends current knowledge of AR technology and the use of AR apps by applying affordance theory and social practice theory (SPT) together in a theoretical framework. These theories were selected because of their ability to explore the underlining motives that drive users to adopt AR apps, or not. Specifically, while the use of the TAM focuses on obtaining insights into why users either accept or reject new technology, the application of affordance and SPT has the potential to offer a better understanding of the underlining motives that drive AR users' behaviour in their adoption and use of AR apps.

Originally, affordance theory assessed the environment-agent relationship, whereby the agent behaves by being influenced by, or in using the environment (Gibson, 1977). However, in the context of technology, the focus of affordance is typically based on the human-artefact relationship, rather than the basic animal-environment interaction (Zheng and Yu, 2016). According to Xiangming and Song (2018), the technology affordance concept can be explained according to the value offered by the technology to the individual in achieving their goals. For the purpose of the present research, AR affordance represents the possibilities of actions that users may take through their interactions with AR apps. Previous studies concerning information systems (IS) and affordance highlighted that particular user types perceive the affordances of the same technology differently (McKenna, 2020). It is therefore essential to identify the potential AR affordances of AR apps, in order to better understand user expectations and experiences that drive their behaviour in the context of such apps.

However, affordance theory ignores the relevance of technological characteristics. This gap can be studied by exploring the interaction between the technology and the user through the elements of SPT, namely meanings, materials, and competencies (Shove et al., 2012). For example, affordance defines the relationship between AR apps and users, while the environment in this context would include the materials and competencies related to the users and AR apps. To the best of our knowledge, the current literature lacks similar research that investigates the adoption of AR apps empirically by applying the rich combination of affordance and SPT theories. Therefore, this study enriches the existing academic research, and explores the key usability characteristics of AR app usage. Further details regarding the elements of each theory selected for use by this study, and how they aid in exploring the usability of AR, are discussed in Chapter 3.

The next section presents the research objective and questions proposed for this study.

1.4 Research Objectives and Questions

The overall objective of this research is to explore how the usability of AR might be impacted by user experiences and expectations. This is addressed via following two research questions:

RQ#1. How might users' expectations influence AR app use?
RQ#2. How might usability characteristics of AR influence user experiences?

RQ#1 is addressed via a technical walkthrough technique (see Section 5.1), and via the examination of users' reviews and reflections, in order to identify AR app affordances and users' goals. The users' expectations, and their influence on AR app affordance use are then identified using the elements of SPT.

RQ#2 is addressed by developing a conceptual framework consisting of affordance and the SPT elements of meanings, materials, and competency that aid in exploring the three usability characteristics of AR apps, namely interactivity, compatibility, and credibility. These, in turn, provide a basis for examining the motives that may drive users' behaviour in adopting and using AR app affordances.

1.5 Thesis Structure

In order to address the research questions presented in the previous section, this thesis is organised across seven chapters, as summarised by Figure 1.1.

Chapter 1 introduces the study, while Chapter 2 presents a literature review that summarises AR technology and specific AR usability characteristics in the context of users' expectations and experiences, and the role they play in driving users' behaviour. Chapter 3 justifies the selection of affordance and SPT to inform the theoretical framework of the research. Chapter 4 discusses the research methodology, the research approach and design, along with the data collection methods and analysis. Chapter 5 presents the findings of the study, with a walkthrough process employed to identify the affordances of AR apps and then assess these affordances through the lens of the SPT elements. Chapter 6 discusses the application of affordance and SPT to understand the usability characteristics of AR apps in the context of users' expectations and experiences. The chapter also presents a revised theoretical AR adoption framework and discusses the theoretical and practical contributions of the study. Finally, Chapter 7 summarises the research, and discusses its challenges and limitations, along with potential future research directions.

1.6 Chapter Outcomes

This chapter discussed the background, motivation, and context of this study. It presented the current issues regarding AR adoption, as well as the importance of understanding user experiences and expectations in adopting AR technology. The chapter also outlined the concept of usability and usability factors, in the form of interactivity, compatibility, and creditability, before presenting the study's two research questions, alongside a brief summary of how these questions are addressed by the study. Finally, Figure 1.1 provided a graphic representation of how the thesis is organised. The next chapter provides an in-depth literature review to support the research objective and development of the research questions.

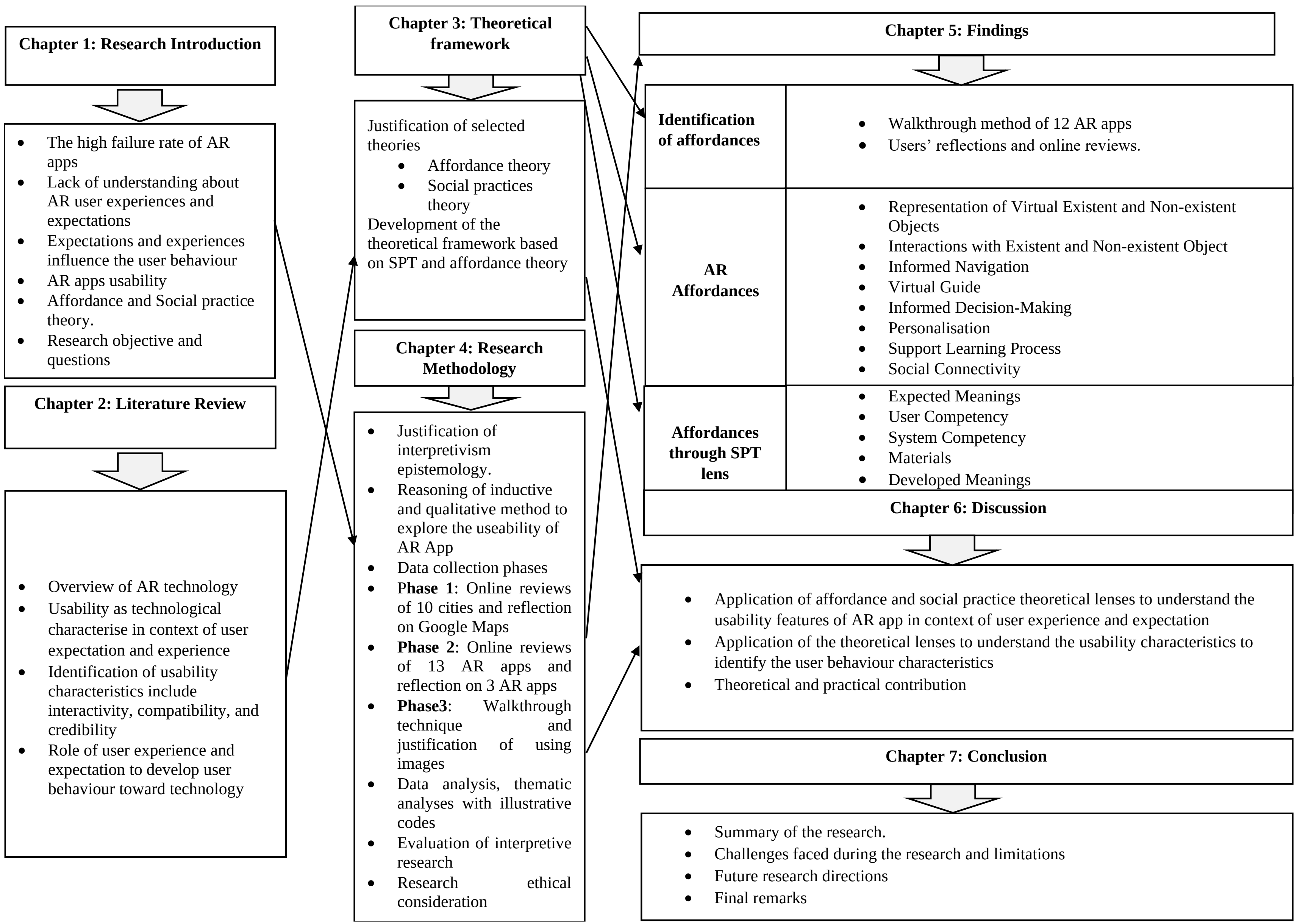

Figure 1.1: Thesis Structure.

Literature Review

Chapter 2

The previous chapter outlined the primary focus of this research, namely the exploration of how the usability of Augmented Reality (AR) might be impacted by user experiences and expectations. This chapter reviews the current state of AR, and discusses its usability characteristics to provide an understanding of current AR technology from the perspective of user expectations and experiences. The chapter is divided into three main sections: the first (Section 2.1) provides an overview of AR technology and its definitions, supported by select examples. The second section (2.2) critically reviews the current literature concerning the usability of apps to identify the most significant factors. Finally, the third section (2.3) focuses on users' expectations and experiences, and considers user behaviour.

2.1 Augmented Reality (AR) Overview

The use of the term 'augmented reality' (AR) first appeared in the literature in the 1940s, but only became widespread in the 1980s (Caboni and Hagberg, 2019). Tom Caudell at Boeing first used the term "augmented reality" in 1990 to describe a digital display used by aircraft electricians to blend computer graphics onto a physical reality. The technology itself was introduced in the engineering domain as an innovation that could improve human workers' performance by augmenting their visual field with relevant information (Caudell, 1995). This technology enabled Boeing workers to view wiring schematics over a plywood layup board so they could create aircraft wiring looms more efficiently (Lee et al., 2012). Mobile computing and mobile devices made AR technology possible in the 1990s and 2000s (ibid). Many of the technological advancements were developed to aid the military, mostly to increase virtual job fulfilment (Pope, 2018). For example, in the late 1990s, a large AR project named "ARVIKA" was launched in Germany which focused on reducing the risk of military equipment maintenance and improving the reliability and efficiency of maintenance and repairs (Wang et al., 2020). As a follow-up to ARVIKA, ARTESAS is expanding AR applications in automotive and aerospace maintenance (Van Krevelen and Poelman, 2010).

A popular definition of AR is that first proposed by Azuma (1997), who described it as a system that includes three main elements: 1) it combines real and virtual content, 2) is interactive in real-time, and 3) is registered and aligned with virtual as well as real objects in three dimensions. However, Steffen et al. (2019) highlighted that this definition excluded any systems that add non-interactive virtual objects, or that display 2D virtual effects on top of live video, including virtual effects that are not registered in 3D. Furthermore, while the idea of augmented reality (AR) and virtual reality (VR) are closely related, VR is based on a virtual world rather than a real one. The main difference between the two is that AR offers users real-time interactions with virtual information and objects (Höllerer and Feiner, 2004).

Over time, other authors have sought to refine the definition of AR. For example, Olsson et al. (2013) defined AR as a technology that integrates real and computer-generated digital information into the user's view of the actual physical world, so that they appear as one environment. Meanwhile, Raskar et al. (1999) defined AR as the real-time integration of digital information with live video in the user’s environment, and others focused not only on the technical aspects of AR, but also on its ability to enhance users’ experience (Caboni and Hagberg, 2019). For example, Rese et al. (2017) noted that AR enables real-time interactions by integrating computer-generated objects with the user’s real surroundings. In addition, AR has also been defined as an interactive technology that modifies physical environments by superimposing virtual elements, such as textual information, images, videos, or other virtual items (Javornik, 2016). For instance, AR can enhance its user’s perception of their surroundings through visual, auditory and haptics feedback in virtual environments (Viglialoro et al., 2019). While various definitions have evolved, the main function of AR continues to be to enhance the real world by combining sensory digital/virtual contents, such as information, video, graphics, and images, and the generation of an augmented real environment (Caboni and Hagberg, 2019).

In the early 2000s, AR emerged as a revolutionary approach in media-user interaction, and quickly attracted attention across a wide range of industries, including gaming, tourism, commerce and manufacturing, education, and entertainment and leisure (Chen et al., 2019). AR reached the mainstream by becoming incorporated into entertainment and gaming venues (Pope, 2018). For example, the use of AR in gaming can be seen in Pokémon Go. This is a location-based application designed by Niantic that allows the user to collect Pokémon in real surroundings, using the global positioning system (GPS) and camera on their mobile device to determine their exact location and catch Pokémon. Snapchat is another example of an AR application that employs image recognition in addition to AR (Parekh et al., 2020). In the retail and fashion industry, mobile AR applications are expected to enhance the user experience (McLean and Wilson, 2019). Consequently, many companies have introduced AR apps to enable users to test products by trying on clothes virtually, or viewing objects in particular spaces at home, or in the workplace. For example, the Ikea AR app shows users 3D modelling of furniture in their own home via an AR overlay, to help them visualise how a particular piece of furniture would fit in their space (Scholz and Smith, 2016). Meanwhile, AR virtual try-on apps, such as Sephora, Gucci, and Ray-Ban, enable users to try on makeup, products, clothes, jewellery, and glasses virtually, using their phones. These kinds of apps increase user interaction with the brand and can enhance user satisfaction (Plotkina et al., 2022).

Although some successes and advancements in AR systems have occurred (Garrett et al., 2018), none have been in widespread use, and many are still not commercially available. A very famous example is the failure of Google Glass, introduced in April 2012. According to Google, with Glass, users are able to access information and connect without shifting their attention away from real-life activities (Klein et al., 2020). However, many of the unique features of Google Glass proved to be problematic (Wagner, 2013). Klein et al. (2020) summarised some issues that damaged the product's reputation and caused the failure of Google Glass. They indicated that the main issue with Google Glass was privacy because it was not clear when users were recording or taking pictures of other people around them via Glass. Other issues were regarding safety and health risks. For example, driving with Google Glass could potentially be distracting and the cause of many accidents (Zuraikat, 2020).

Some elements and potential points could be identified and learned from the Google Glass experience that allows the AR developers to avoid or manage them with flexibility. In their study, Herz and Rauschnabel (2019) indicated that the functional and utilitarian benefits of new and emerging technologies are not sufficient to explain users' reactions to them. For example, although many users noticed that Google Glass was an impressive piece of engineering that did some interesting things, many were frustrated when interacting with Glass and experienced usability issues e.g., the voice recognition caused frustration amongst users (McNaney et al., 2014). Hence, instead of putting a lot of effort into making the technologies operate in the first place, AR developers must pay extra attention to the product usability issues. Wang et al. (2020) noted AR technology can have significant implications and support for many services such as military maintenance, but that current AR systems have many usability issues e.g., rarely recording real-time data on maintenance processes.

Indeed, despite extensive research into AR since the early 2000s, the technology has yet to overcome challenges. For example, it has not yet been fully integrated into everyday activities, such as retail, due to concerns over matters such as its usability, social acceptance, and technology security (Parekh et al., 2020). Therefore there is a need for further research to enhance awareness of the field to fully realise its benefits and usability issues in the context of the service sector (Cipresso et al., 2018, Rauschnabel and Ro, 2016). The next section explores these challenges by reviewing the usability characteristics of AR apps.

2.2 Overview of the Concept of Usability

Usability is a critical feature used to assess smartphone applications and related technology. According to Arghashi and Yuksel (2022), usability dictates the adoption of smartphone applications and determines their success. The concept of usability has been defined in various ways by researchers in the field of human-computer interactions (Thielsch et al., 2015). The term ‘usability’ was coined in the 1980s as an alternative to ‘ease of use’ and ‘user friendliness’ (Sarodnick and Brau, 2006). Since then, various researchers have proposed different definitions of the term. However, the definition of usability employed by International Organisation for Standards (ISO) 9241 is often cited, and defines usability as the “extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (ISO, 1998). This definition suggests that the interaction between the user, the service, and the context of the usage are the key dimensions of usability. This means that the usability of a product changes according to context (Abran et al., 2003). The present thesis utilises this definition and its usability dimensions, for research purposes, because consideration of both the user and technological aspects, such as usability dimensions, can support the exploration of user experiences and expectations with AR apps, to achieve goals and objectives.

As indicated above, ISO standards approach the concept of usability according to the ability to enable the user to effectively, efficiently, and satisfactorily achieve the purpose for which they use a device, such as a mobile application (Venkatesh and Ramesh, 2006). A mobile phone application represents a form of information technology (IT) artefact developed primarily to run on Smartphones or Tablets, to enable users to achieve particular goals (Wells et al., 2011). Such applications are either pre-installed, or may be installed from specific online mobile stores, such as the App store (for Apple) or Google

Play (for Android). However, Adipat et al. (2011) suggested differentiating between the usability of mobile phones and mobile applications, explaining they should not be confused, or used interchangeably. According to Faqih and Jaradat (2021), the information systems (IS) literature currently lacks the necessary research to investigate AR technology adoption through the lens of mobile-based technologies, such as smartphones and tablets, rather than computer-based technologies. Therefore, the present research focuses on the usability of AR apps, and not the smartphone itself.

The usability of mobile applications has been studied in different situations and fields, and various researchers have proposed different dimensions, models, and elements supporting the efficient and effective usage of such systems. For example, Hertzum (2010) identified the following six facets: universal, situational, perceived, hedonic, cultural, and organisational. Universal usability concerns the challenge of making systems that are suitable for everyone; situational usability is defined as a system's quality of use in a specific user situation, task, and the wider context of use; perceived usability is the user's subjective experience of a system through their interaction with it (Guo, 2014); hedonic usability denotes the enjoyment of service, encompassing its ease of use, task completion, and freedom from discomfort; cultural usability includes different meanings, depending on users' cultural background (Guo, 2014); and organisational usability concerns groups of people collaborating in an organisational setting. According to Hertzum (2010), all these facets are interlinked, and combine to determine a system's usability. This echoed the view of (Hvannberg et al., 2006), who suggested that such factors are blended to determine whether or not a system is usable.

More recent studies highlighted three prominent challenges in determining the universal usability of a system. These include user diversity, in terms of users' individual characteristics (Mator et al., 2021); technology variety and features (Ramler, 2021); and gaps in the knowledge of use (Lewis, 2014). These three challenges to the usability of mobile technologies influence the use of smartphones and related applications (Lewis, 2014, Ramler, 2021, Mator et al., 2021). While different users have different skills, potential, knowledge, and information levels, they seek to achieve the same level of advantages from objects (Borsci et al., 2019). Another prominent challenge is generational, namely referring to differences in the habits of older smartphone users compared with those of versus younger smartphone users. For example, while digital native users prefer to buy new smartphones, others prefer to retain older versions, finding them easier to use due to familiarity (Tamas et al., 2021). Moreover, a number of previous researchers have highlighted that users have different usability goals. For example, Lee and Chen (2011) argued that usability implies the absence of frustration, namely the user is not frustrated when employing the service. This means the user can use the system as intended to meet their goals, without encountering obstacles (Zaharias and Poylymenakou, 2009). Hence, users' characteristics influence understanding of a system's usability when achieving the required objectives or fulfilling their needs (Lewis, 2018).

Furthermore, Zahabi et al. (2015) indicated that variety in technology has made it difficult to approach the concept of usability based solely on the number of users. This is because there are different systems available that fulfil the same needs of users. The authors suggested including the different software and mobile applications intended for the same objective when studying the matter. For instance, there are different mobile applications for alarm clocks, calculators, and daily reminders, and the usability of these IT tools improves with software modifications to fulfil the exact needs of the user. Meanwhile Finstad (2010) suggested that the knowledge gap in terms of the use of such tools continues to affect many users, as not all users are technology literate, and are thus unaware of all the functions of their smartphone. Indeed, Kortum and Sorber (2015) explained that the knowledge gap highlights the differences between what users know and what they should know to operate their mobile phones effectively and efficiently. Users who lack sufficient knowledge can be regarded as structurally uninformed about the working of their smartphone, since application developers no longer provide instruction manuals in a physical form (Tremoulet et al., 2021). Therefore, people learn by experimenting with their smartphones, while using the smartphone and its applications. Another essential aspect involved in bridging this knowledge gap is the role played by friends and family in disseminating understanding (Tamas et al., 2021). This gap can be reduced further by using all-inclusive designs for systems or mobile applications, making them more user-friendly for a wider range of users (Hertzum, 2010).

Previous studies conducted in the domain of information and communications technology have highlighted the importance of usability (Nayebi et al., 2012) and the emotional components involved in the user experience (Cyr et al., 2009, Stangl et al., 2020). According to Nayebi et al. (2012), usability refers to the physical features of a technological product that make it easier to use; it is, for example, measured by effectiveness, enjoyment, learnability, memorability, and errors. The study by Nielsen (1994) established several measurements for this purpose, as follows: application design and efficiency, user interface input, user interface output, and user interface structure. Stangl et al. (2020) noted that although these physical features of mobile applications are essential, an application's success is also determined by the user's emotional perceptions such as enjoyment, pleasure and fun involved in using it. For example, McLean et al. (2018) demonstrated a positive relationship between mobile app usability and emotional aspects, such as the enjoyment involved in using mobile apps. Meanwhile, Lu et al. (2017) suggested that to ensure users' continued use of mobile apps, developers should strive to make the user experience enjoyable. Therefore, the present research explores the physical and emotional usability characteristics of AR apps' that can facilitate their adoption by users.

2.2.1 Usability Characteristics of AR Technology

The use of AR in apps is not only a means of displaying information to users; it can also provide users with real-life experiences of products and services in a virtual environment to enable them to determine their suitability for use in the physical environment (Brannon Barhorst et al., 2021). Various previous researchers have highlighted the specific importance of AR apps. They have observed that using 3D visualisation, can enable users to determine the suitability of a product in the absence of its physical presence (Pantano and Servidio, 2012, Algharabat and Dennis, 2010, Papagiannidis et al., 2017). This allows users to see different colours, sizes, and angles of the product in question, and sometimes even to try on a product such as sunglasses by uploading a picture of themselves.

Meanwhile, in the context of services, AR apps enable users to collect information about events, places, and objects (Javornik, 2016), and provide users with virtual information about products (Van Esch et al., 2019). Therefore, by using AR, users do not have to rely on their imaginations alone, as AR technology provides a life-like representation of the product (McLean and Wilson, 2019). Moreover, users' sensory perceptions and visualisations are amplified when they use AR apps, as these apps enhance the vividness of virtual images (Yim et al., 2017). This then influences the user's confidence in the product positively by enabling them to use it in a virtual environment (Lee et al., 2012). This use of mental imagery and the subsequent provision of an understanding of how something would look in the physical world by viewing it in the virtual world can assist the users to reach a more informed choice (Scaife and Rogers, 1996).

Despite the emergence of AR technology, the use of it in apps in consumer marketing has been obstructed by the need for large, cumbersome devices (Rese et al., 2017). However, McLean and Wilson (2019) and Dacko (2017) indicated that with the continuous growth and adoption of smartphone technology, brands are increasingly investing in developing AR technology to offer AR apps for shopping purposes. Furthermore, Porter and Heppelmann (2017) highlighted the increased presence of brands in the virtual world, such as Nike, Mini, Adidas, L'Oreal, TopShop, Sephora, IKEA, and Amazon, via the use of AR technology. They explained that these major brands offer personalised and interactive buying via AR apps that provide users with a visual experience that is close to reality. All of these brands currently utilise AR technology to enhance their customers' shopping experience. Significantly, Brannon Barhorst et al. (2021) found that learning and enjoyment can be enhanced via the use of AR technology, and reported that both enjoyment and information utility are influenced positively by 'flow' in the context of AR-facilitated shopping, compared with a traditional shopping experience. This demonstrated that the use of AR increased the overall learning of the users in question, enhancing their shopping experience. Moreover, Brannon Barhorst et al. (2021) reported that the satisfaction level of users is influenced positively when they realise the information they receive using AR apps benefits their shopping experience.

Furthermore, the ability of AR to overlay a physical environment with virtual factors, such as images, sounds, videos, and text, enhances the user experience in a virtual world. For example, Gatter et al. (2022) observed that users who have a high need for a touch experience were dissatisfied when they could not touch products, particularly when shopping online. To address this, AR features compensate for this lack, not by making material touch possible, but by invoking other hedonic and sensory qualities. This echoed the observations of Rauschnabel et al. (2019) that AR has hedonic and utilitarian benefits from the users' perspective that can provide a highly satisfactory shopping experience. Additionally, AR apps have the potential to change experiential activities, such as information searches, product trials, product try-ons, and acquisitions (Javornik, 2016). The impact of this realistic product experience, through providing an individual with an enhanced world, is helpful for enabling the user to develop a closer relationship with a brand than traditional media types (Yim and Park, 2019, Dacko, 2017). However, the quality of such apps, and the extent of the control they give to users, are key determinants in their success (Jung et al., 2015). Therefore, it is essential to explore the usability features of AR that fulfil the users' needs.

According to Yim and Park (2019), although AR apps are becoming more popular, as various smart devices are now powered by AR technology, they have not yet realised their full potential, and are not used widely. Moreover, Jiang et al. (2021) suggested that while AR apps support innovative technologies, potential adopters still express concerns about their use. For example, most AR app users should be considered to be novices (Labrie and Cheng, 2020). Thus, Shih and Schau (2011) stated that certain aspects should be considered when designing apps, and Alba and Williams (2013) explained that designers should consider the majority of users' lack of familiarity with AR technology, and consider their technological limitations when designing mobile AR apps. For example, AR users may find it difficult to understand some actions, such as surface detection or object manipulation, namely interaction with virtual 3D objects in a 2D space, can be confusing (Labrie and Cheng, 2020). Nevertheless, Ponzoa et al. (2021) reported that many users are interested in learning about AR, and use it because it is new and attractive to them. Hence, to avoid confusing interactions, developers might employ guidance for first time users (Scholz and Duffy, 2018); for instance, there might be video tutorials to guide users in using the app.

Moreover, Wixom and Todd (2005) observed that the usability of an app can be ascertained from its potential to meet users' requests, its ease of access, and its responsiveness. In addition, Labrie and Cheng (2020) indicated that existing limitations of AR technology are responsible for a number of usability concerns in AR home design apps. The inaccuracy or inability of these apps to detect surfaces, for instance, is one of their most problematic aspects. Other researchers reported additional usability problems, such as digital fatigue, installation difficulties, slow response speed, and privacy security (Feng and Xie, 2018, Yim and Park, 2019). Additionally, Arghashi and Yuksel (2022) highlighted the technological limitations of the latest innovative technologies, such as difficulties with installation, the malfunctioning of computer programmes, and lack of users' computer literacy. For example, some newer apps use cartoon-like images of products, and have a slow response speed compared to conventional apps or websites (Bouhamri et al., 2019). Since these technological limitations can affect usability (Lee et al., 2021), determining technology limits and taking them into account during the design process is therefore crucial when designing an AR mobile app (Kowalczuk et al., 2021). For example, the quality of an AR app is compromised when it fails to deliver content virtually at a location that suits the user (Yim et al., 2017).

According to Tuli and Mantri (2021), usability guidelines must be defined. While leading software and mobile phone development companies, such as Microsoft, Google, and Apple, offer practical guidance for maintaining the usability of mobile applications, these guidelines are insufficient (Nielsen, 2012). For example, according to Apple's mobile user experience guidelines, attractive artwork is critical for obtaining user satisfaction with an application (Hoehle and Venkatesh, 2015). This means that Apple often suggests developers improve an application's visual appearance, however, the visual appearance of a mobile app only attracts a user to begin using it (Riegler and Holzmann, 2018).

In their work, Holden and Rada (2011) observed that usability has evolved as a concept over time. It commenced as a representation of a smart device's capability or potential to address different users' needs. The term 'usability' currently lacks a universal definition, as it remains ever-evolving. According to Tan et al. (2021), usability guidelines might be explored through the lens of user expectations and experiences, as this may increase understanding of the usability of apps for the purpose of improving their adoption among users. Therefore, the present research explored usability from three different perspectives: product-oriented, user-oriented, and performance-oriented (Bevana et al., 1991). As the product-oriented perspective encompasses the fact that usability is an inherent attribute of a product for aligning with users' circumstances (Sarodnick and Brau, 2006), compatibility was addressed in this research. Meanwhile, the user-oriented perspective denotes that usability is related to the user's mental efforts and perception of an app's credibility (Jung et al., 2021). According to Huang (2021), AR research to date has focused mainly on the factors that influence the acceptance of emerging technologies. This is currently limited to assessing the effect of users' current use and future adoption of AR technology (Chung et al., 2015). User behaviour regarding apps is based on their experience and their perception of an app's credibility (Cipresso et al., 2018), therefore credibility is another important usability feature of AR apps. Thirdly, the performance-oriented perspective of mobile apps includes the performance of the app when interacting with users to achieve the required objective (Kowalczuk et al., 2021). This suggests that the interactivity feature of AR apps represents the interaction between the user and the AR app itself (Park and Yoo, 2020, Arghashi and Yuksel, 2022, Yim et al., 2017). Based on these definitions, the present study considered the features of interactivity, compatibility, and credibility to be the primary usability attributes of AR apps (Figure 2.1).

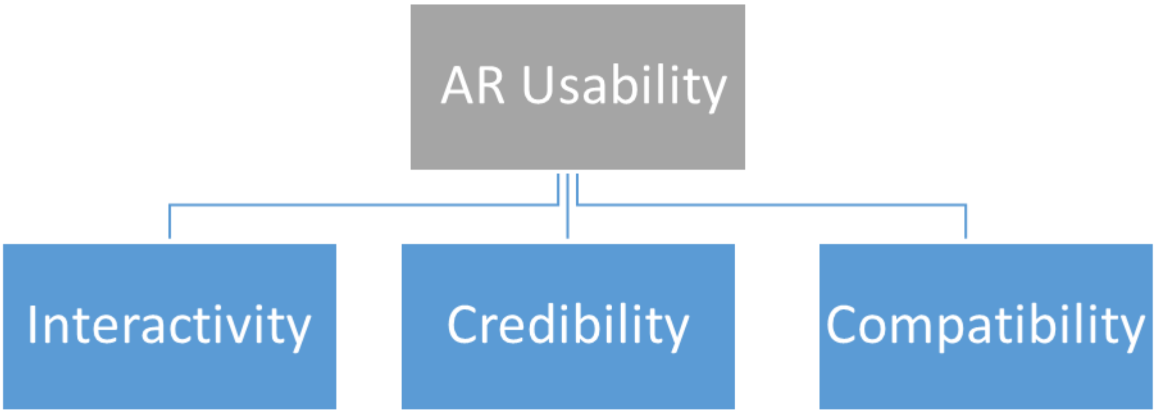

Figure 2.1: AR usability characteristics (Source: author).

2.2.1.1 AR Interactivity

The interactivity of AR has been studied widely. As Azuma (1997) explained, since AR technology combines virtual and real worlds, it has created a unique user experience, and Fiore et al. (2005) added that such apps' interactivity both interests and engages users, thus prompting a positive emotional response. The highly interactive nature of AR means that many users are enthusiastic to experience its 3D utilities that offer a vivid and clear representation of objects. Indeed, Poushneh (2018) suggested that the use of AR, for instance for producing 3D content in various styles, directions, and colours, would be futile in the absence of interactivity.

Interactivity can include various elements, such as operational and functional features, communication, and user perceptions (Bucy, 2003). Regarding the operational and functional features, the existing literature demonstrated that there is a difference between user interactivity in AR and that in the context of traditional GUIs (graphical user interfaces), such as personal computers (PC) or laptops (Bujak et al., 2013). Meanwhile, (Yim et al., 2017) tested a model that depicted the usability of AR versus the traditional internet and found that users evaluated AR technology positively, due to its vividness and interactive affordances. Indeed, a rich, vivid, or personalised presentation is an essential characteristic of AR technology (Parise et al., 2016, Yim et al., 2017). For example, AR enables interactivity by connecting users with a product in real-time, in an immersive environment (Parise et al., 2016). This suggests that AR benefits more from the interactivity feature of media than the traditional internet. However, due to the technological complexities of AR, such as its combination of virtual and augmented features, the technology may continue to encounter interactivity issues. For example, due to the complexity of real-time experience, AR apps may lose their innovativeness, newness, and uniqueness (Carrozzi et al., 2019). Indeed, Wedel et al. (2020) recommended reducing the complexity of AR apps to achieve a higher level of AR interactivity. Users often abandon apps because they are frustrated with their design complexities (Tan et al., 2019), suggesting that AR apps must perform reliably, running smoothly, quickly, stably, and efficiently, without errors (Hasbi et al., 2020). Hence, developers must determine the extent to which the system can achieve users' goals, in terms of the reaction process, system response speed, and loading time (Kucirkova, 2017, Delagi, 2010).

Meanwhile, Sohn (2011) suggested that interactivity is a behavioural factor, since users are able to control and manipulate the environment before them. Moreover, Bevan and Macleod (1994) stated that the feature of efficiency is related to the resources of the system, and is also related to the time required to achieve the user's desired objectives. Thus, a bad user experience with a system involves a negative interaction, usually due to the hurdles the user must overcome in order to achieve their objectives (Ceccacci et al., 2016). This can affect a user's satisfaction with the consumption of a service (Kivijärvi and Pärnänen, 2021).

There can be various reasons for a poor mobile app user experience or usability. For example it may lack essential features, the content may not be presented effectively, the app may not be user-friendly, or it may not respond appropriately to user interaction (Youens, 2011). Meanwhile, Poushneh and Vasquez-Parraga (2017) highlighted that the entertaining experience of using AR is based on the availability of essential utilities, such as a quick response time, touch, narration, search features, an elevated level of interactivity and informativeness, and high augmentation quality, such as a telepresence and realistic view, all of which are key AR features. The increased interaction of users with these AR features ultimately improves satisfaction levels, and vice versa (Carrozzi et al., 2019). Additionally, Adipat et al. (2011) observed that when a mobile application is inundated with content, its usability is affected negatively, as the content overload consumes a mobile phone's memory, thereby slowing both the app and the mobile phone. Meanwhile, Molich and Dumas (2008) reported that the features identified by their participants as supporting usability were multi-language support, quality of design, system accuracy, quality of navigation, and the capability of segmenting according to their interests. These features were also highlighted by (Kounavis et al., 2012, Yovcheva et al., 2012), who found that a multi-language support system was one of the usability features most preferred by their participants, as they were only able to use the app in their studies in English. Indeed, Han et al. (2018) highlighted that if an AR app is intended to be launched internationally, it should be available in different languages.

The interactivity of a technological object informs two-way communication between the user and the device, and is also termed the device or system's 'responsiveness' (Song and Zinkhan, 2008). As Pantano et al. (2017) explained, the main dimension of users' interaction with technology is its interactivity, such as the quality of its aesthetics, its response time, and the quality of information provided. Meanwhile Tadrous et al. (2019) suggested that interactivity implies the presence of flexibility in the timing of messages provided during communication between a system and its users. Meanwhile, McLean and Wilson (2019) argued that AR interactivity is the ability to manipulate what the user sees by combining the real and virtual worlds. This then enables users to modify their actions in the real world and receive feedback (Flavián et al., 2019). For example, through the use of AR, users can interact with an environment in a virtual world, due to the digitally enhanced sensory, auditory, and visual information provided (Hilken et al., 2018, Yim et al., 2017, Carrozzi et al., 2019, Dwivedi et al., 2020). Since interactivity concerns the communication between a technological system and a user, interaction with AR apps more requires attention, spatial cognition, and motor skills on the part of the user than other systems (Cheng and Tsai, 2013). In other words, its successful use is dependent on the user's skills, and requires different skills for a user to achieve their goals (Sundar et al., 2014). For example, the interface of mobile AR apps provides a unique set of challenges in terms of usability, such as the use of gestures, visualisation issues, 3D issues, smaller displays than other devices, and context dependencies, all of which are also directly linked with users' skills. Consequently, absence of the requisite skills can impede two-way communication between AR apps and their users (Carrozzi et al., 2019).

According to Tan et al. (2019), certain factors of app interactive usability influence the intention of users to continue using an app significantly. These factors include the user's perception of an app's functionality, such as how well the app does its job. Meanwhile, Faqih and Jaradat (2021) reported that there remains a lack of awareness of AR technology and its components; this may explain why AR and its features are unpopular. Unique efforts are therefore required to heed the demands and views of prospective users, in order to understand their expectations of the technology (Daassi and Debbabi, 2021). For instance, there is a need for more users to employ AR apps to provide valid feedback regarding its operation. Hence, the present study explored the interactivity features of apps, in terms of user experiences and expectations.

Finally, interactivity also influences users' perception of the usefulness of the technology, and is subjective in nature (Rahmi et al., 2018). A user's perception of a form of technology is developed according to their expectations (Ischen et al., 2020), thus interactivity in the context of AR can generate different levels of experience for different users. This is because the actual experience is the overall outcome of the use of the system, which is linked to the user's skills and previous experience (Pantano et al., 2017). The existing literature indicated that a high level of interactivity influences the users' experience positively. For example, Lee et al. (2010) studied AR app users' perception of interactivity through the use of an app that provided an appropriate lens for analysing user behaviour. Although different studies sought to evaluate the elements associated with user experience of smartphone interactions (Kim et al., 2012, Kim and Sundar, 2014), there remains a dearth of research concerning interactivity in mobile apps (Xu and Gupta, 2009). Indeed, Nikhashemi et al. (2021) claimed that little is known about how AR characteristics and features such as vividness, novelty, interactivity, or augmentation influence users' behaviour. Consequently, McLean and Wilson (2019) recommended further investigation should identify the causal relationships between the characteristics of AR and AR app engagement. Therefore, this thesis considers the interactivity of AR apps to be one of the essential usability characteristics that AR app users expect to experience.

2.2.1.2 Compatibility

According to Rogers (2003), compatibility is another characteristic of innovation that influences adoption behaviour. Compatibility denotes the degree to which a user perceives a service to be consistent with their existing sociocultural values and beliefs, past and present experiences, and needs (Rogers, 2003). However, Karahanna et al. (2006) argued that Rogers' (2003) definition does not include operational compatibility explicitly, which Tornatzky and Klein (1982) claimed is an essential aspect of compatibility. Additionally, Karahanna et al. (2006) proposed separating operational compatibility into three dimensions: compatibility with prior experience, existing work practices, and compatibility with preferred work style. Hence, in previous empirical studies of IS, compatibility was seen as a two-dimensional construct, involving both practical and value compatibility (Harrington and Ruppel, 1999). Value compatibility describes the suitability of new technology or innovation with potential users' values or norms, while practical compatibility is the suitability of an innovation to support people's activities (Tornatzky and Klein, 1982). The present research considers value and practical compatibility to be the two dimensions of compatibility.

To elaborate upon these definitions, value compatibility is the degree to which innovativeness is consistent with potential adopters' previous experience, existing values, and needs (Costa et al., 2014). When the compatibility of any idea is high, the level of uncertainty amongst potential adopters is low (Dufaux et al., 2013). Users' past experiences of adopting a new technology, whether negative or positive, strongly impacts the adoption of any newly developed technology (Marwick, 2013). For example, past negative experiences with technology may influence the adoption of other technologies adversely, due to low expectations (Venkatesh and Goyal, 2010). According to Sherry et al. (2017), a failed adoption of an expensive technology is likely if the value assumptions embedded within the IS mismatch users' personal values. Additionally, Thanakijsombat et al. (2022) indicated that incompatibility of innovation with the values and beliefs of potential adopters, can determine the outcome of an adoption process. For example, Jiang et al. (2021) indicated that during the COVID-19 pandemic, users who had once preferred to experience products on-site, viewing physical shopping as a form of enjoyment and a social activity, adopted AR apps to meet their lifestyle and shopping needs, influencing their attitude towards AR apps positively.

Value compatibility also includes compatibility with economic value (Kim et al., 2009). For example, Huang and Benyoucef (2014) highlighted compatibility, cost, and usefulness as the elements of usability. The cost of technology can either positively or negatively influence its adoption (Barnes and Meyers, 2011, Yoon and Youn, 2016), and the cost of an AR app is one of the key factors influencing its continued use (Yoon and Youn, 2016, Venkatesh et al., 2012, Van Rijnsoever and Castaldi, 2011). Therefore, technology users' expectations regarding the cost of a particular form of technology must be known. In this context, the compatibility of the price value is related to a user's experience, with trade-offs between cost and value for money (Venkatesh et al., 2012). Although most previous IS researchers acknowledged that price is highly important in innovation diffusion, few explored its impact on adoption decisions, such as the way in which price establishes user expectation of the economic value of a form of technology (Kim, 2015, Albert and Tullis, 2022). Therefore, the price plan, packages, and incentives of a form of technology, or free trials, are also considered to be an aspect of technology compatibility (Barnes and Meyers, 2011, Yoon and Youn, 2016). A focus on these factors facilitates the examination of user expectation regarding the cost of AR app use.

The second dimension of compatibility is practical compatibility, which Tornatzky and Klein (1982) referred to as aligning an innovative system with users' requirements. This encompasses the following factors: hardware/software suitability, social values, lifestyle harmony, and matching users' needs (Kocheilas, 2018). Compatibility is the capacity of two systems or people to work jointly (Karahanna et al., 2006), but it is also referred to as the interoperability between two products, such as software and hardware, and different varieties of the same product or products of different/same types (Serano et al., 2015, Barnes and Meyers, 2011). The compatibility of apps in the context of mobile devices involves determining their suitability with mobile phone devices through mobile compatibility testing (Zhang et al., 2015). For example, mobile devices may have different software and hardware requirements, and dissimilar operating systems. An app passes the testing stage successfully if they are suitable in terms of both the hardware and the software (Adamczyk, 2017). Compatibility testing in this regard involves the level of compatibility of AR applications with various devices with different characteristics (Hasbi et al., 2020). For example, AR apps are designed for all users, which means that an app should run without any problems, regardless of the platform. The existing literature concerning apps also indicated that a lack of uniqueness in-app, poor design of an app, and lack of knowledge of users' needs are some of the common causes that increase the chances of failure of emerging technologies (Jigyasu, 2018, Blair, 2018). Moreover, Labrecque (2012) and Jetter et al. (2018) noted that users prefer user-friendly systems that match their current skills, and Stowell et al. (2018) noted that system design including ease of use, can determine whether different users with different skills can use it.

As Kim et al. (2009) observed, the compatibility of any innovation should be aligned with users' needs, preferred lifestyle, and also their social norms. This then enhances the acceptance and trust of the innovation by users (Owen, 2008). According to Karahanna et al. (2006), compatibility with the desired work style and lifestyle of a user in this context involves a person's self-concept, in terms of how they like to work. In addition, Chiu et al. (2013) explained that technologies compatible with different aspects of an individual's experiences and work styles are likely to create positive and comfortable feelings (Agarwal and Karahanna, 2000). Hence, a technology that is inconsistent with users' attitudes, and requires them to adjust their current behaviour, is less likely to be adopted by users (Chow and Bucknall, 2011). Meanwhile, a service that is compatible with users' lifestyles is more likely to be adopted (Greenberg et al., 2011). For example, since mobile phones are more personal than personal computers and wired devices, lifestyle is a significant predictor of an individual's intention to adopt a mobile app (Greenberg et al., 2011). Also, smartphone users generally use one hand to interact via smartphone apps (Lai and Zhang, 2014), allowing users to access information and make calls when they are unable to use their other hand, a multitasking feature of apps that enhances their compatibility. Moreover, this single-hand compatibility lends an impression of freedom to users when using apps, who might otherwise feel physically and mentally bound to, or occupied with, a specific app or technology (Zhang and Yeoh, 2016). Since mobile communications usually occur when a person is 'on the go', the compatibility features of apps, and the speed of their communication, are central to the practical compatibility that facilitates the multi-tasking expectations of users (Gao et al., 2010).

In contrast, the incompatibility of an innovation with the social values of potential adopters will potentially hinder the adoption process, since the more compatible an innovation, the lower the uncertainty amongst potential adopters (Rogers, 2003). Therefore, Kim et al. (2009) argued that technology providers should heed potential users' cultural orientation and lifestyle when developing new technologies. In addition, Jiang et al. (2021) suggested that AR apps should be designed and marketed to be compatible with users' lifestyles, values, shopping styles, and individual needs. Their study further indicated that perceived compatibility has a significant positive impact on users' attitudes towards AR app use (Jiang et al., 2021). Hence, developers and retailers should focus on improving the compatibility of AR apps, so they are consistent and appropriate with the social and cultural norms that might impact the adoption of the technology.

Since compatibility is one of the factors of the usability of the app (Noble, 2009), the present research considered it a characteristic of AR apps that they should operate satisfactorily with current users' values and needs, and by using their existing systems. Therefore, primary data collection from multiple sources of AR app users would either confirm or further enhance understanding of the characteristics of compatibility factors that either create expectations or improve understanding of AR users' experiences.

2.2.1.3 AR Credibility

According to Flanagin and Metzger (2008), the traditional definition of credibility concerns the believability of a source or message, comprising two primary elements: trustworthiness and expertise, both of which include objective and subjective components. Trustworthiness is a subjective judgement made by the receiver, while expertise can be perceived subjectively in the same way, but also includes the source's or message's essentially objective characteristics, such as the quality of the information. A number of previous studies that explored the credibility of technology-based information have relied on the traditional distinctions of source, message, and medium credibility in some form or another (Northcraft and Earley, 1989, Meinert and Krämer, 2022, Walten and Wiedmann, 2022). However, the core dimensions of trustworthiness, such as reputation, reliability, and trust, and those of expertise, such as information quality, accuracy, and authority, require closer examination.

According to Tan et al. (2019), trust is the perception of credibility achieved through the content in question that develops when an app provides quality and relevant information. The quality of the information included in an AR app determines the extent to which sufficient and relevant virtual content is provided by AR to the user (Feng and Xie, 2018). In terms of AR specifically, technology is expected to reduce users' uncertainty about decision-making, while concurrently delivering experiential benefits. Such apps enable users to see the features of a product in detail, and to view examples in a virtual environment, before using it in the physical world (Dacko, 2017). The existing literature in this field indicated that these value-added features can influence an app's long-term use (Buellingen and Woerter, 2004, Wang and Liao, 2007, Dantas et al., 2009, Karahasanović et al., 2009, Dinh et al., 2013). This is because, for example, it is related to the reliability of the system in question, and thus must accord with the expectations and needs of users (Mishra et al., 2021). Thus, if the information available through AR apps is incorrect, this will cause dissatisfaction among users and affect the credibility of the app negatively. The comfort with decision-making facilitated by AR app use when shopping online, and the perception of users' values, shapes behavioural intentions (Cowan et al., 2021), therefore the designers of such apps must develop applications that display products according to the desires and needs of users.

As Fill (2009) explained, an app's credibility also concerns the system's trustworthiness, including the risk perception, privacy, reliability, and security related to the system.

Hence, the present research highlighted trust, expected risks, and the security-related concerns of users as constructs relevant to the discussion under the umbrella of credibility. These were therefore the main dimensions of this study. Previous researchers discussed the concept of 'trust' in terms of communication, IT, psychology, management, political science, and marketing (Cho et al., 2018). These studies revealed that trust is the main factor of credibility, and can determine whether a system's users have positive or negative experiences (Chinomona and Sandada, 2013). For example, Dimitriadis and Kyrezis (2011) discussed the concept of fulfilled expectations in the online environment as a component of trust, highlighting it as a state that determines the willingness of users to provide personal and financial information to fulfil their obligations. In an AR context, the extant literature noted that one of the most significant challenges faced by AR developers is the extent of control users have over their information. For example, Poushneh (2018) indicated that the ability of users to control access to their personal information affects their satisfaction with AR apps significantly, as they are concerned with data privacy. Similarly, Huang et al. (2019) found that users of AR apps are concerned with the ability to control their personal information. Consequently, privacy concerns regarding the use of an AR app's face filters affect users' future behavioural intentions indirectly (Cowan et al., 2021).

Moreover, Olsson et al. (2013) reported that users' privacy concerns represent the chief drawbacks of AR app use. This is because AR is primarily predicted to be used for industry segmentation and particular device types, rather than for online users' specific requirements, such as visualising online offerings (Smink et al., 2020, Sung, 2021). In this regard, Yavuz et al. (2021) explored the elements that influenced AR app use in Turkey, and found that privacy and security were the two main factors influencing participants' decision to use AR apps. Other studies also recognised the risks concerning the protection of users' privacy (Wolfinbarger and Gilly, 2003, Miyazaki, 2008, Featherman et al., 2010). The likelihood of misuse of information and the loss of private information in e-commerce can deter users from using such platforms (Antoniou and Batten, 2011).

The perceived risks involved in using AR apps can be psychological or functional, and are associated with either expected uncertainty or chances of loss when the system's user commences use (Dowling, 1986). Perceived risk depends on the extent of the subjective uncertainty surrounding the outcome (Jayashankar et al., 2018). There is strong evidence that when system users perceive a risk, their intention and motivation to use a certain form of technology are influenced negatively (Alhudaithy and Kitchen, 2009, Lee et al., 2012, Kesharwani and Singh Bisht, 2012). Moreover, Danielson and Rieh (2007) highlighted the traditional approach to expected risk as comprising uncertainty and unfavourable results following the users' expectations that would attach risk. This highlights users' expectations or perception of uncertain results after searching for and selecting products or service information, before arriving at the final purchase decision. This expected risk plays a pivotal role in online financial transactions (Cobb Payton and Zahay, 2005), since, according to the theory of reasoned action, users generally conduct online transactions only when their risk perception is low (Ojeniyi et al., 2019, Estrella-Ramon et al., 2016). Moreover, positive and low-risk perceptions are attached to the credibility of the security offered by the company in question to their users/customers (Wei et al., 2013). For example, Ojeniyi et al. (2019) indicated that the use of a secure transaction system improves an organisation's credibility. This then increases the adoption of the online service by users (Wang et al., 2016). Therefore, businesses in the e-commerce sector must be mindful of the privacy and security concerns of both users and regulators.

In terms of the fact that an app's security and reliability influences users' evaluation of the app, and decisions about online purchases (Bomil and Ingoo, 2003, Miyazaki and Fernandez, 2001, Wolfinbarger and Gilly, 2003), Litan (2005) found that 42% of the respondents they surveyed claimed that their online shopping behaviour was affected by security concerns, due to the widespread nature of online scams. When a security breach occurs in the e-commerce sector, it gives access to users' confidential data, such as their name, address, credit card information, and social security details (Milne et al., 2004), putting them at risk of losing their personal and private data, and inclining them to avoid online services in future (Alhudaithy and Kitchen, 2009, Kesharwani and Singh Bisht, 2012). Therefore, the value of any online service relies on ensuring transactions are protected from online security threats. This also concerns the reliability of e-services, and determines the extent to which users regard their providers to be employing reliable tools to provide services, and whether the service can be depended on to perform specific tasks (Damghanian et al., 2016, Tan et al., 2020). These concerns are typically based on subjective experience, news reports, and word-of-mouth, which are imperfect subjective evaluations (Alalwan et al., 2016).

Continued trust and mitigation of risk, and assurance of security are key expectations of users of AR apps. For example, users must always be in control of their information, and able to delete or modify it, a matter that has prompted data privacy concerns among users (Gruschka et al., 2018). It is also essential that the concerns of users are addressed in terms of the safety, reliability, and security of transactions occurring online, and of the privacy of their data; for example, when users must pay to use certain functions of AR apps. Therefore, the present study focused on users' experiences regarding privacy, expected risk, security, and reliability in the context of different industries and various expectations of AR users. Table 2.1 summarises the key usability characteristics and dimensions reported in the extant literature that informed this study and the way in which its research questions were addressed.

Table 2.1: Summary of usability characteristics reported in the extant literature.

Usability characteristics	Dimensions	Summary
Interactivity	Operational and functional features	• AR technological and design complexity, e.g. for creating life-like experiences with an object (Carrozzi et al., 2019, Tan et al., 2019). • System efficiency, e.g. the time required to achieve the objectives desired (Bevan and Macleod, 1994). • Multi-language support system (Kounavis et al., 2012, Yovcheva et al., 2012), i.e. an AR app should be available in different languages to improve its usefulness (Han et al., 2018).
	Two-way communication (technological system and user)	• Flexibility, e.g. in the timing of messages during communication between systems and users (Tadrous et al., 2019). • Ability to control the system, e.g. users able to modify their actions in the real world and receive feedback from it (Flavián et al., 2019). • AR interface challenges, e.g. the use of gestures, visualisation issues, 3D issues (Cheng and Tsai, 2013).
	Users' perception of an app's functionality	• How well the app does its job (Tan et al., 2019). • Perception is subjective in nature (Rahmi et al., 2018), e.g. depends on a user's skills and previous experience (Pantano et al., 2017). • Lack of awareness of AR and its features (Faqih and Jaradat, 2021).

Compatibility	Value compatibility	• System is consistent with potential adopters' previous experience, existing values, and needs (Costa et al., 2014). • Also includes economic value (Kim et al., 2009), e.g. cost.
	Practical compatibility	• The system aligns with what users like to do (Tornatzky and Klein, 1982). • Hardware/software suitability, e.g. the suitability of AR apps with mobile phone devices' systems, e.g. iOS, Android (Zhang et al., 2015). • Social values and norms, e.g. heeding users' cultural orientation (Kim et al., 2009) and lifestyle. • Lifestyle harmony, e.g. multitasking compatibility of apps, and single-hand compatibility (Zhang and Yeoh, 2016). • Suits users' needs and skills, e.g. user-friendly systems that suit users' current skills (Labrecque, 2012).
Credibility	Trustworthiness	• Includes trust, expected risks, and security-related concerns (Fill, 2009). • Trust, e.g. quality and relevant information (Tan et al., 2019). • Privacy, e.g. the ability of users to control access to their personal information (Poushneh, 2018). • Risk and security, e.g. expected uncertainty or chance of loss (Dowling, 1986; Chang, 2010), and security breaches (Milne et al., 2004). • Reliability, e.g. whether a user can depend on AR's system for performing specific tasks (Damghanian et al., 2016).
	Expertise	• Includes source's or message's characteristics, such as the quality of the information (Flanagin and Metzger, 2008).

2.3 Users' Expectations and Experiences

User expectations can be defined as 'pre-exposure beliefs', and can vary among technology users (Venkatesh and Goyal, 2010). According to McLean and Wilson (2016), user expectations are linked to past experiences; word-of-mouth, such as positive and negative feedback; company promises; personal opinions; personal needs; and the ranking by other users. The majority of the previous studies in this field have failed to address the emotional aspects and expectations of systems, because these are not related directly to measuring the performance of interactive systems (Mahlke and Thüring, 2007). However, Olsson et al. (2013) argued that user expectations, values, requirements, and needs related to interactive systems are associated closely with their experiences, which, in turn, inform behaviour. Meeting such requirements can enhance the adoption of AR apps among users. According to the extant literature, user experience encompasses a broad field of technology-user interaction that is connected to their expectations of emerging technologies.

According to Immonen et al. (2018), user values concern the expected usability of a system. Since user expectations are vital, in terms of the characteristics that are expected to be present, and how the user conceptualises human interactive technology (Olsson and Salo, 2012, Kujala et al., 2017), it is generally argued that newly-introduced services should be based on the realistic expectations and the requirements of the prospective end-user groups of mobile apps (Baek and Yoo, 2018). For example, Thong et al. (2006) indicated that users' expected enjoyment affects their intention to continue using a service significantly, and McLean and Wilson (2016) reported that user expectations include users' experiences, opinions, norms, attitudes, values, intentions, and trust factors. Furthermore, Abbott (1955) noted that users not only want the product in question, they also require a satisfactory experience that meets their expectations. This observation was validated by other researchers who explored different aspects of user experience, such as products and consumption (Holbrook and Hirschman, 1982). User expectations strongly influence the nature of the actual user experience with a product (Jung et al., 2021), and also impact how users perceive a product/service, in terms of its quality and capabilities, and direct users' focus in interactional situations. If a product's performance exceeds users' expectations, satisfaction results; if it does not, dissatisfaction is the outcome (Shin, 2021). For the purpose of the present study, users' expectations were deemed to be represented by users' anticipations of AR apps that, in turn, determine their behaviour regarding AR adoption.

User experience can be defined as, “All the aspects of how people use an interactive product: how well they understand how it works, how they feel about it while they are using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it” (Alben, 1996, p. 12). According to Poushneh and Vasquez-Parraga (2017), user experience is a broad concept that includes a user's emotional state, a product's features, and the context in which they use a product (Hassenzahl and Monk, 2010). Indeed, Poushneh (2018) suggested that product characteristics are the main reason for the diverse nature of experiences; further adding that stimulation, identification, and evocation are the three key groups of qualities of a product that can generate a positive user experience. Stimulation is the quality of a product that enables it to provide users with insights, impressions, and opportunities (Carrozzi et al., 2019), while identification is the product’s capacity to facilitate users’ determination of how they can use it to express themselves to others, and how they can interact with others through its utilisation. Finally, evocation is the product’s quality, and has the potential to enable the user to recall positive memories of the product (Dutta and Omolayole, 2016). In terms of mobile-based applications, Ahn and Lee (2016) highlighted the fact that user experience concerns the usefulness and exciting features of an app, and the potential difficulties that influence its use. When designing AR interactive systems, these three characteristics should be considered, in order to ensure a rich and enjoyable user experience.

The user experience, which includes the stages of awareness, consideration, purchase, service, and advocacy, has also been examined in previous studies (Parise et al., 2016). The findings have suggested that retailers should possess the knowledge appropriate for serving users properly at any of these multiple touchpoints. The extant research in this field identified that the AR user experience is influenced by four concepts: flow, immersion, cognitive fit, and emotional fit. The ‘flow’ of experience denotes the holistic sensation experienced by people when they are involved in something that yields hedonic and cognitive benefits, as they feel that they are ‘flowing’ in their experience to achieve something (Seligman and Csikszentmihalyi, 2014). This ‘flow’ is defined in a technology-mediated environment as the degree to which a user navigates across different interfaces successfully. A high degree of flow in an environment indicates that the user's interactions, including sharing of information, are smooth and integrated, resulting in an enjoyable user experience (Parise et al., 2016). Several previous studies investigated how the ability to generate flow, or the involvement of users with interactive qualities in a highly absorbed state, develops an experiential value (Javornik, 2016). For instance, AR technology creates a sense of flow for users when they feel immersed in a virtual world when using the technology.

The concept of the flow of experience was employed by previous researchers in different contexts in relation to user expectation and experience (Lee et al., 2019). For example, Brannon Barhorst et al. (2021) explored flow in traditional versus AR shopping experiences to determine whether investment in the adoption of AR was appropriate, and whether AR technology can create a state of flow that is conducive to the various desired outcomes from the user shopping experience. They observed that a high state of flow positively influenced a user's learning, enjoyment, and information utility expectation of AR apps, and was a prominent predictor of overall satisfaction with the shopping experience. In other words, a positive AR experience not only requires an intense state of flow, but this also enhances enjoyment.

User experience is also influenced by immersion, which is described as the perception of being physically present in a non-physical world, for instance the mental sensation of engagement and interaction with the surrounding environment in meaningful ways (Shin, 2019). The use of AR renders interactivity between the user and the brand relatively easy, as it helps to create a highly immersive and personalised environment by revealing additional product information, engendering a higher user experience at the time of purchase (Poushneh and Vasquez-Parraga, 2017). Previous research has also demonstrated the presence of a positive relationship between immersion and users' future intentions (Suh and Lee, 2005, Suh and Chang, 2006). The extant literature in the field of AR technology focused primarily on the overall features of AR technology that facilitate immersion, such as vividness and novelty. The 'vividness' of AR technology denotes the provision of a clear and detailed representation of the real world in the virtual world (Hilken et al., 2018), while the 'novelty' of AR denotes the provision of real-time sensory information to the user, in order to achieve their goals (Petit et al., 2019). Hence, immersion, vividness, and the novelty of AR can motivate users to continue performing activities, by conveying a sense of enjoyment (Seligman and Csikszentmihalyi, 2014).

Meanwhile, the emotional aspects involved in this context denote a technology's ability to offer an aesthetically pleasing experience for specific purchasing behaviours (Parise et al., 2016). Previous studies have reported that AR can effectively foster this form of engagement (Scholz and Smith, 2016). For example, images, interactive features, and gaming features offered in AR apps create excitement and increase user satisfaction (Stangl et al., 2020). Moreover, Kourouthanassis et al. (2015) examined AR apps' physical and interactive features and found that there is a positive association between the physical properties of an app and users' emotions, such as their feelings of pleasure, control, and arousal. Meanwhile, Marinova et al. (2017) viewed AR technology in the context of service augmentation, describing it as a core and innovative technology, as it seeks to improve the online service experience, for instance via a context-sensitive and more intuitive interface than traditional technologies that align with the natural ways in which users process information. This type of frontline interface is far more advanced than that of traditional technologies, and can enhance service quality and offer a more enjoyable and effective user experience (Olsson and Salo, 2011). As Javornik (2016) noted, an AR app's augmentation feature enables the creation of immersive experiences. Additionally, AR provides the user with a mentally stimulating, enjoyable, and exciting experience (Olsson et al., 2013); for example by generating a highly immersive flow, by transforming or augmenting realistic visual representations, and ultimately boosting users' responses (Javornik, 2016). Meanwhile, Poushneh and Vasquez-Parraga (2017) found that AR augmentation promotes playfulness, excitement, and immersion, which can increase experiential value for users encouraging the adoption of the AR app in question.

Meanwhile, cognitive fit concerns a digital technology solution's ability to provide relevant information and expertise to users, when required (Parise et al., 2016). The use of AR technology helps retailers to enable users to view a product in the way they prefer, for instance via a virtual equivalent of trying a product (Chen et al., 2021). For example, image interactivity is utilised widely in fashion retailing to create a virtual equivalent of a real-life product experience (Flavián et al., 2019). Moreover, interactive AR apps give buyers a sense of control over their purchase choice (Smink et al., 2020, Sung, 2021). This means that image recognition accuracy is a vital interactivity feature of AR apps (Yang et al., 2020), as users expect such apps to recognise the objects they are made for. They also expect these apps to enable them to try these objects in different situations, in the same way they might in a physical environment (Nikhashemi et al., 2021). For example, an AR app developed for testing sunglasses that does not enable the user to try the sunglasses on their face in the virtual world would be less likely to generate user satisfaction than one that does. Therefore, AR app display technology should project high-quality, high-resolution images, so the user can view the product in a virtual environment from different angles. In other words, poor-quality images impact users' buying decisions negatively (Plotkina et al., 2022). In contrast, high-quality interactivity encourages users to respond favourably towards the product in question, and this can facilitate enjoyable experiences for the user when buying products via the AR app (Smink et al., 2020).

Moreover, Olsson et al. (2013) noted that AR represents particular and highly immersive facets that can change the means of observing surroundings, expressing what information the user can experience, and identifying the corresponding values. As modern users have become increasingly demanding, they tend to expect that products and/or services meet their specific needs. According to Dacko (2017), a system developed with the aid of AR can provide personalised pre-purchasing assessments. This can enhance the user experience, hence the promising interactive characteristics of AR technology are appealing for retailers, encouraging them to introduce them to their online stores (Lee et al., 2010). However, there remains only limited research concerning the ability of AR technology to enhance user experience, in order to realise positive user outcomes, such as enjoyment, information utility, satisfaction, and learning (Brannon Barhorst et al., 2021).

Much of the extant related marketing literature focused on the usefulness of AR apps for a customer's buying process, with less focus on their actual usability in the context of users. Usability concerns the usefulness, or relevance, of a particular service for the needs and expectations of the user; for example, whether it fulfils the needs of the user, or addresses what they are seeking (Bruun and Stage, 2014). A basic scale that can be employed to determine the usability of an application or service is the returnability of the user, namely the probability of repeated use (Kortum and Sorber, 2015). According to Wang and Liao (2007), usability concerns the difference between user expectations and real experience, based on a system's effectiveness and efficiency, that can develop users' behavioural intention to use AR technology.

The expectations of end-users play an essential role in understanding user behaviour through the real experiences of the users with the system concerned (Poushneh and Vasquez-Parraga, 2017). Therefore, it is necessary to understand the types of experience or characteristics that are deemed desirable for a particular kind of service in a specific area of application or context. Many previous studies have employed the technology acceptance model (TAM) for this purpose, by simply replacing 'technology acceptance' with 'continued system usage' (Tan et al., 2020). For example, as Jiang et al. (2021)

explained, a number of researchers examined the factors that influence users' behaviour, such as their adoption of AR technology and AR apps, using the TAM variables of perceived ease of use and perceived usefulness (Pantano et al., 2017, Rese et al., 2017, Huang and Liao, 2015, Plotkina and Saurel, 2019, Holdack et al., 2022, Hinsch et al., 2020, Qin et al., 2021); expanded entertainment, fun, aesthetics, visual imagery, and multifaceted quality attributes (Park and Yoo, 2020, Jung et al., 2021, Li and Fang, 2020, Chiu et al., 2021); and technical anxiety, privacy security, and perceived risk (Bonnin, 2020, Kim and Forsythe, 2009, Zhang et al., 2019, Yoo, 2020). In addition, Faqih and Jaradat (2021) reported the positive influence of performance expectancy, technology fit, social influence, effort expectancy, and hedonic motivation, in facilitating users' behavioural intention to adopt AR technology. However, Tan et al. (2020) indicated that the intention to continue using AR apps differs from technology acceptance, for example acceptance-discontinuance occurrences are common, whereby users abandon apps quickly after initial their download.

Meanwhile, Bhattacherjee (2001) studied the expectations of interactive products using the 'expectation-confirmation' theory to differentiate the initial decision to use a system from continued system usage. Their study developed a model that was based on the assumption that expectation confirmation could be assessed through post-use responses to the question of whether actual performance was higher than expected (performance informs both perceived usefulness and satisfaction). In their study, in addition to predicting perceived usefulness, expectation confirmation also appeared to be a good predictor of user satisfaction. According to the existing body of IS of research, disconfirmation influences attitudes negatively, and it was suggested that expectations be analysed separately from ease of use and usefulness (Venkatesh and Goyal, 2010). However, there is currently limited research concerning continued system usage, particularly in the context of mobile technology (Nascimento et al., 2018). The traditional user-centred design approach (Xu and Gupta, 2009) suggests the need to develop new services based on the expectations and needs of a potential end-user group. User expectations represent expected behaviour, and therefore play an essential role in shaping actual users' experience with a product (Hunecke et al., 2017). Expectation influences user perceptions regarding a product's qualities and capabilities, and direct user intentions in interaction situations (Kirs and Bagchi, 2012, Lee and Chen, 2011). When a product outperforms expectations, this causes post-use satisfaction, while if it performs less effectively than expected, there is a greater possibility that the user will be dissatisfied

(Coursaris and Kripintris, 2012). Previous studies have suggested that differences in expectation and experience shape user behaviour regarding AR apps (Steffen et al., 2019), hence there is a theoretical need to understand how expectations influence user experience (Michalco et al., 2015). Moreover, there is an empirical need to understand what types of experiences are most desirable, in terms of a specific kind of technology or service, in a particular application arena or context. For this purpose, the gathering of data concerning expectations and the real experience of end-users is vital for understanding their influence on services and technologies, a field in which it can be challenging to determine how users' behaviour concerning specific technology, such as AR, develops.

Meanwhile, the factor of satisfaction, which is based on user diversity (Fisher et al., 2008), does not determine the overall usability of an application, and thus fails to adequately advise the developer regarding the overall usability guidelines of an application (Nielsen and Budiu, 2013). This means that user experience not only concerns the system itself, but also includes the information provided to guide the user in using the system, a tool that can improve their experience and help them to achieve their objectives (Lee et al., 2015). Hence, it is also necessary to understand the user characteristics that can influence AR app usage. For example, according to previous studies, experienced users behave differently from those who are less experienced, or inexperienced users (Celik, 2016, Sun, 2013, Desurvire and Wiberg, 2015). A lack of familiarity with mobile apps can cause users not to trust them. Moreover, Bakhsh et al. (2017) reported that both experienced and non-experienced users of technology differ in their expectations. For example, experienced users have more evaluation power in certain cases than inexperienced users. However, studies of this matter in the context of mobile apps usage are scarce (Zhang et al., 2017). For example, Tan et al. (2020) and Pranam (2018) recommended that an app should be simple, and. deliver its intended purpose to users as quickly as possible. In addition, Zapata et al. (2015) suggest that there should be a tutorial at the beginning of the application to guide users in their use, as, for instance, some features of a touch-screen operation are understood by users only after a few attempts.

Furthermore, while Wang et al. (2016) highlighted that user enjoyment is linked directly to the usability of an app, and to risk-free features of the online experience, Taylor and Todd (1995) reported that the various levels of experience among users impacts their view of the expected enjoyment and usefulness of technology adoption. They noted that the various perceptions obtained from either direct or indirect experience produce different intentions to adopt technology. According to Karahanna et al. (1999), when derived from direct experience, clear knowledge and understanding engenders users' ability of to assess the technology in question clearly, and subsequently supports the formation of favourable attitudes.

Meanwhile, other researchers explored the influence of enjoyment on users' attitudes, intentions, and loyalty towards AR technology and its applications. According to Parise et al. (2016), emotional satisfaction with AR technology is essential for increasing the number of follow-up visits of shoppers to a particular online store. Therefore, AR technology plays a vital role in brand loyalty through the personal experience of its users. For example, Cyr et al. (2009) observed that there is a significant relationship between e-loyalty and enjoyment. This is a form of hedonic motivation that denotes the fact that a person who wants to enjoy something as a real experience exhibits behaviour regarding the perception of enjoyment (Childers et al., 2001, Babin et al., 1994). Later versions of technology acceptance theories best illustrate the level of enjoyment in user experiences (Venkatesh et al., 2012), and Hsiao et al. (2016) highlighted that it is essential for producing real experience satisfaction. Enjoyment also relates to the activities involved in using a particular system, aside from the performance-oriented results of system usage, that are inherently enjoyable (Venkatesh and Ramesh, 2006). For example, Gupta and Dogra (2017) reported that customisation, ease of use, and convenience engender a higher level of enjoyment, while other studies in the field of the online environment indicated that when users do not experience enjoyment while shopping online with a specific service provider, they tend to complete their shopping with a different service provider (Lee and Chen, 2011, Faiola et al., 2013).

Furthermore, Rese et al. (2017) noted that users engage better with an app if they have a positive impression of usability. For example, the study found that the influence of image interactivity is the most important factor of user engagement when using mobile touch screens with AR apps. Moreover, Sung (2021) suggested that the objective of an AR experience can be achieved if users have a positive experience of the usability of AR technology. Nevertheless, Tan et al. (2020) indicated that there remains a challenge to user engagement, because of usability issues. There is currently a dearth of literature that seeks to understand the role of usability through the lenses of the user experience and expectations of AR apps that might improve their adoption. Since previous studies have suggested that user expectations are complicated (Olsson and Salo, 2012, Kujala et al., 2017), and virtual experiences are different for different users, depending on their knowledge and previous understanding (Söderman, 2005), its exploration might provide unique insights into AR apps. For example, there is a need for qualitative research that explores the underlying motives that drive user behaviour in adopting AR (Steffen et al., 2019). Figure 2.2 summarises the outcomes of the literature review.

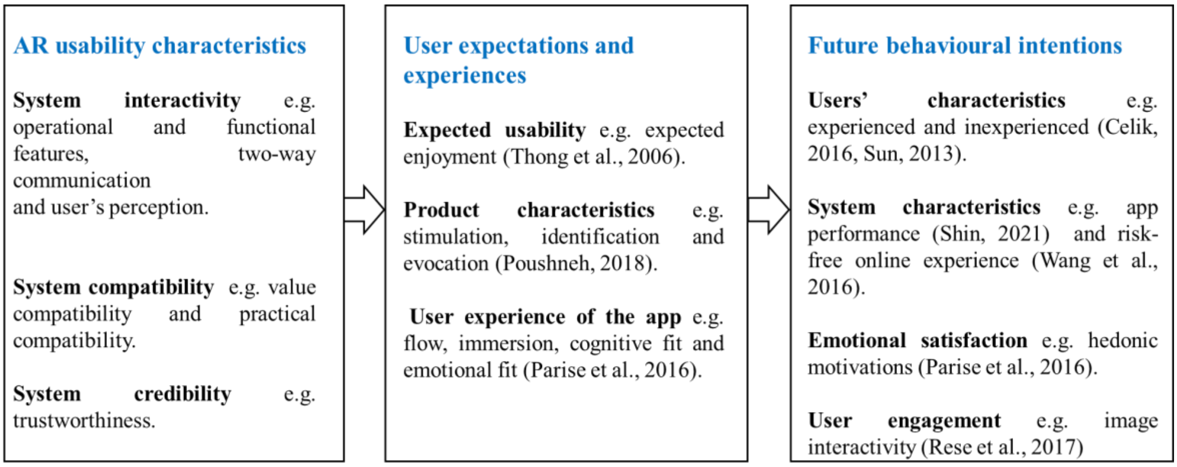

Figure 2.2: Usability of AR technology (Source: author).

Previous studies have highlighted the inadequacy of website or software-oriented usability models for mobile apps and other mobile technologies, especially AR apps (Carrozzi et al., 2019, Hilken et al., 2018, Dacko, 2017), because their usability features differ, according to users' goals regarding AR apps. Consequently, Nielsen (2011) recommended that comprehensive surveys should be conducted with the users of mobile applications, to develop understanding of their needs and expectations, so that applications can be designed accordingly. Additionally, Shackel (2009) advised that the views of users when using the entire system should be sought. While it would be challenging to determine the precise usability needs of such users, it is possible for developers to identify user expectations of such systems. Many previous studies have argued that user expectations of technology impact satisfaction levels, as an outcome of real user experience (Rosenberg, 2018, Finstad, 2013, Lewis, 2013, Bosley, 2013, Bolle et al., 2016, Lewis, 2021, Boyd et al., 2019). Therefore, the present research employed experiences and expectations as integral factors for understanding user behaviour, in terms of the usability of AR apps. Since the major objective of this study is to explore how the usability of AR is impacted by user experience and expectations, it uses AR apps from different industries to develop a rich understanding of the data generated from their exploration. This includes reflections on the use of Google Maps and other, different AR apps, combined with online reviews of different apps. Further details of the methodology employed are provided in Chapter 4.

2.4 Chapter Outcomes

This chapter reviewed the existing literature in the field of AR and its usability characteristics to provide a clear understanding of the technology and its usability characteristics, from the perspective of user expectations and experience. Section 2.1 provided an overview of AR technology, including definitions, and was supported by select examples. Section 2.2 critically reviewed the current literature concerning the usability of AR apps to identify key features. Finally, Section 2.3 addressed user expectations and experiences, and considered user behaviour in this context.

Building on this literature review, Chapter 3 discusses two theories, that of affordances, and social practice theory, which are employed herein to gain a better understanding of user expectations and real experiences. These two theories facilitate the provision of information regarding users' goals, the expected usability features of AR technology, and the usability issues associated currently with AR apps.

Theoretical Understanding

Chapter 3

This chapter justifies the use of affordance theory and social practice theory in the context of technology use, describing both theories in sections 3.1 and 3.2 respectively. The discussion then moves on to the appropriateness of each theory in relation to technology use. Next, the affordances of technology are viewed through the lens of social practice theories to develop a conceptual theoretical framework for this research. The development of a conceptual framework merges affordance and social practice concepts in the context of technology use.

3.1 Theory of Affordance

3.1.1 Concept of affordance

Affordance is a concept that originated in ecological psychology (Gibson, 1977), where it denoted interactions between animals and their environment. According to Gibson, humans and animals first perceive the physical features of objects, substances, and surfaces within their environment, and then determine what interactions are possible. Alternatively speaking, upon observing their surroundings, humans and animals directly perceive "what it offers (...), what it provides or furnishes, either for good or ill" (Gibson, 1979, p. 197). Contrary to similar demand character concepts, affordances are "there forever to be perceived independently of the needs of the observer" (Gibson, 1979, p. 139). Turvey (1992) observed that an affordance is a feature of the environment that an actor can utilise in some way. An understanding emerged from discussions with ecological psychologists suggesting that perceiving affordances before actualising them is vital (Chemero, 2018). Stoffregen (2003) argued that affordances are relational, and as such cannot be found in isolation from either object or environment. Chemero and Turvey (2007) opposed the suggestion that affordances be merely cognitively represented, and argued that such views contrast with the original position of Gibson. They asserted that affordance is emergent, involving relational properties linking the actor and the environment.

Researchers debating in other fields subsequently started to adopt the concept of affordance; notably in the information systems field, where it was used to understand the utilities of technology. For example, Norman (1999) spoke of the affordances of technology artefacts in terms of design, development, and service. According to Borgo et al. (2014) a technical artefact is a physical object created through an intentional production process by one or more agents with the goal of producing an object able to realise an intended behaviour in a given generic technical situation. Norman (1999) explained that the concept of affordance focused on the immediate and practical usability of an 'artefact', acknowledging that he was deviating from the original concept propagated by Gibson (1979), by disregarding the relational arrangement between actor and object. One helpful difference in Norman's view of affordance concerns an object's usability, while the original view of Gibson related to its usefulness (McGrenere and Ho, 2000). The usability aspect of the theory also increased its importance as a tool for exploring expectation and experience in the usability of AR Apps according to user opinion, which is the primary focus of this research.

Norman (1999) also believed that the designer of an artefact plays a pivotal role in characterising its affordance (McGrenere and Ho, 2000). The design-oriented advantage of an artefact lies in determining its usability by simply looking at it. Jung et al. (2010) argued that the concept of affordance propagated by Norman (1999) relates to the socio-materiality of the artefact, as also reiterated by Robey et al. (2013).

Hutchby (2001) considered the relational and functional aspects of affordances as probabilities of activity, believing the approach could be utilised to study the complex relationship between actors and technologies. Hutchby's (2001) claims were challenged by Rappert (2003) as not advancing understanding of the implications and social aspects of technology. However, according to Hutchby (2003), Rappert's (2003) study only focused on sociological claims about technology, ignoring critical issues such as the complexity of interplay. For example, Rappert (2003, p.570) study predicted technology "*as a stable, predictable and functioning part of the practices of everyday life*". Nevertheless, the reality differs, as users' expectations, values, requirements and needs have influenced the adoption rate of new technologies, with the result that the probability of failure is also increased (Olsson et al., 2013). Therefore, this study has adopted Hutchby (2003) version of affordance theory to comprehend and explore user experience and expectations with regard to technology.

With the adoption of the affordance concept in IS, a series of very informative reviews emerged in the IS literature around Affordance Theory (Majchrzak and Markus, 2012, Fayard and Weeks, 2014, Robey et al., 2013, Markus and Silver, 2008, Zhang and Yeoh, 2016). Instead of narrating all materials on the subject here, a short explanation is provided here to refer to significant elements relating to affordance theory in IS research, thereby, giving rise to different and often contradictory definitions.

Some dominant themes have emerged over time. One theme that prominently appears in technology-related research is akin to Chemero and Turvey (2007) observation that affordance is based on the relationship between the technology and the user, and not on the technology only. Another emerging theme is that affordance is related to possibilities of actions for goal-oriented actors, rather than actual actions or objects. The latter view is not entirely explicit in IS literature, and will be discussed later in section 3.1.2. Prior to commencing a discussion of issues identified in the utility of affordance theory, this thesis first explores the alternate use of the concept in technology-related literature; i.e., its application to everyday objects and its usage in studies concerning the interactions between humans and computers, as highlighted by Norman (1988).

3.1.2 Affordance of technology

McGrenere and Ho (2000) reported that affordance reveals an inseparable mutuality between actor and environment. However, in the context of technology, the focus of affordance is typically on the human – artefact relationship rather than on animal - environment interactions (Zheng and Yu, 2016). This means that it influences probability when using an IT artefact (Majchrzak and Markus, 2012, Volkoff and Strong, 2013). The literature concerning IT describes affordances as possibilities arising from goal-oriented action due to the relationship between organisational systems and IT artefacts (Zammuto et al., 2007). Some researchers have also argued that since affordance represents ‘action’ potential, it must first be triggered for action to take place. Once triggered, the goal-focused actor then undertakes the activity to achieve a particular outcome (Strong et al., 2014, Volkoff and Strong, 2013). The literature on this subject shows that different terms can be used interchangeably to indicate the role of an actor, such as user, agent, individual, and person (Markus and Silver, 2008, Majchrzak and Markus, 2012). This thesis uses the term ‘user’ to emphasise the human element, whereby actors (technology user) make use of an IT artefact.

Sundar et al. (2014) highlighted interactivity as a set of system affordances whereby users can alter the medium, source, and message of communications using a system associated with the most critical factors facilitating information transmission in traditional communication. Studies by McGrenere and Ho (2000) and Hartson (2003) also highlighted that affordance is not only influenced by an actor’s ability, but also includes information concerning whether the action taken proved helpful to the actor or not. A study by Hutchby (2001) applied the concept of affordance to technologies such as IT artefacts, also lending importance to the technology itself. Some researchers provided comprehensive descriptions of the characteristics of the IT artefact being studied in addition to the actors' goals (Karlsen et al., 2019, Burton-Jones and Volkoff, 2017, Du et al., 2019), whereas others consider the affordance concept in terms of its relational nature, because it can map particular IT characteristics in the environment where IT is being used (McKenna, 2020, Leonardi et al., 2019, Leidner et al., 2020, Lehrer et al., 2018, Krancher et al., 2018, Claggett and Karahanna, 2018). Previous studies in IS and affordances highlighted how particular user types perceive affordances of the same technology differently (McKenna, 2020, Leidner et al., 2020). While the affordances of technology have been widely explored in the literature (Cai et al., 2020, Canhoto, 2021, Waizenegger et al., 2020), this research also explores the affordance literature to investigate the usability characteristics of technology through an affordance lens, considering users' expectations and experience.

Although there are multiple interpretations of the affordances concept, affordances are situated and relational and contingent not only on human agency purposes, but also upon socio-institutional and historical settings (Zheng and Yu, 2016). In the case of the affordances of technology, considering the characteristics of a user's likeability and technology as an artefact presents the possibility for one to use such technology. Thus, according to the affordance concept, a person may use a technology without identifying its specificities (Leidner et al., 2020). This highlights the importance of exploring the use of expected outcomes and the 'genuine' experiences of users when using an App, which is the central thrust of this thesis.

A definition of affordance that Strong et al. (2014, p., 53) proposed that is widely accepted considers where affordances "*arise from the relation between an artifact and a goal-oriented actor or actors*". According to Volkoff and Strong (2017), affordances relate to the prospect of action for goal-directed actors, not to actual actions, objects or states. Therefore, they provided *six* critical *principles* for researchers to adhere to when using Affordance Theory in IS Research, as are also applied to this research. In summary:

- *Principle 1:* Affordances arise from the relationship between the technology and the actor. It is imperative to distinguish between a technology's affordances and its features as they are not the same (Volkoff and Strong, 2017). This principle is supported by Fromm et al. (2020), who recommended separating technology affordances from their features, use, and usage outcomes. Therefore, this study employs the walkthrough method (Light et al., 2018) to identify the affordances of AR apps (see Chapter 5 for findings).

- *Principle 2:* It is incumbent upon researchers to understand and elucidate the difference between affordance and its actualisation (Volkoff and Strong, 2017). As per their understanding, while affordance is the potential for achieving a goal, actualisation concerns a specific actor and information pertaining to the exact activities that actor will take or has already taken. In this study, the researcher does not intend to provide guidelines for actualising affordances, rather the aims is to deliver a better understanding of the usability issues associated with AR apps. Specifically, it seeks to underline the motives that might drive a user's behaviour, so as to adopt them as routine practice, by identifying the apps' affordances first, and then viewing them through the lens of the second theory social practice theory (see Chapter 5 section 5.1-5.6 for further details).
- *Principle 3:* To focus on the action, and not the condition reached after taking action (Volkoff and Strong, 2017) as per Valbø (2021). Although Volkoff and Strong (2013) and Strong et al. (2014) suggest that an outcome is usually immediate and concrete, Du et al. (2019) point out that it can be challenging to differentiate concrete outcomes from non-concrete ones, and that not all outcomes occur immediately following actualisation of affordances. Thus, following this principle, the researcher adopts Valbø's definition of affordances in this study, whereby affordances describe the possibilities of actions that emerge when actors use technology to achieve a particular goal. Actors can be either individuals, or groups of people, such as organisations, while the technology is typically an IT artefact. In this research, the IT artefact are "AR apps", and the actors are the "AR apps' users".
- *Principle 4:* It is essential to select appropriate level(s) of granularity to assist with affordances. This helps to pinpoint the actors involved and the potential actions they might take (Volkoff and Strong, 2017). As previous studies on IS and affordances highlight, particular user types perceive affordances of the same technology differently (McKenna, 2020, Leidner et al., 2020). This study identifies different affordances that could emerge when using AR apps, based on personal experience and empirical study to capture users' views and engagement with AR technology.

- *Principle 5:* It is essential to identify the bundles of affordances that arise from the many potential uses of an IT artefact, including how they interact instead of focusing on a single affordance (Volkoff and Strong, 2017). Therefore, this research identified ten different affordances that emerged when using AR apps (see Chapter 5 section 5.1 for findings).
- *Principle 6*: Consider the social factors affecting the actualisation of affordances. Volkoff and Strong (2017) acknowledge that affordances do not actualise in a vacuum, but rather proceed from a social context. Therefore, the social forces that arise from the groups to which the actors belong, also influence whether an affordance is actualised or not. Moreover, Fromm et al. (2020) indicated in their research that several authors have identified the contextual factors inhibiting or enabling affordance actualisation, such as work environment characteristics, individual competencies, skills, and attitudes, as well as IT features and infrastructure (Jung and Lyytinen, 2014, Strong et al., 2014, Bygstad et al., 2016, Burton-Jones and Volkoff, 2017, Krancher et al., 2018, Karlsen et al., 2019, Leonardi et al., 2019, Thapa and Sein, 2018, Du et al., 2019). Therefore, this research identified some of the social factors known to affect actualisation of the affordances of AR apps. For example, when reviewing the literature and research data, the researcher identified that many users are still not familiar with the benefits of AR. Consequently, they may not know how to use their affordances.

Based on the above principles, the researcher considered the affordance of IT artefacts (AR apps) as the possibilities of actions that actors (AR app users) can take when they have the appropriate skills (users' ability) to achieve their goal (users' goal). Therefore, AR apps, users' goals, and abilities are three factors of affordance theory. However, affordance theory ignores the usability of the artefact features (AR app) which explains the importance of SPT. In other words, to answer the research questions - by exploring the usability issues of AR apps through understanding users' expectations and experiences and what motives might drive AR apps' users to adopt them - there is a need to look at the elements that facilitate the usage of these apps affordances for users which justifies the adoption of SPT for this research.

3.2 Social Practice Theory

3.2.1 Origin of social practice theory

Social practice theory was developed by Reckwitz (2002) and links back to Structuration Theory (Giddens, 1984). Reckwitz (2002) argued that many interconnected elements shape or configure the practices and comprise the circumstances for existing social practice. These elements are forms of both mental and bodily activities, background knowledge in terms of know-how and understanding of things and their usage, motivational knowledge, and state of emotions (Reckwitz, 2002). This idea was later translated by Shove et al. (2012) into a theoretical framework composed of three components that together form and shape social practice during the interactions between social actors, in everyday life, namely: Meanings, Materials and Competency.

According to Jin and Cai (2022), a wide range of social practices have been assessed using this framework, including mobile shopping (Fuentes and Svingstedt, 2017) and cruise tourism (Lamers and Pashkevich, 2018). As Shove et al. (2012) have argued, for a practice to be successful, the components involved must be coherent. For example, to actualise AR app affordances, SPT helps to show how the materials (AR apps) are linked to the meaning-making of user expectations and experiences and their competencies. Holtz (2013) argued that possibility practice is one of the main features of practice frameworks, in which routine behaviours are, in essence, practices. Hence, a successful practice must involve factors that facilitate the smooth adoption of routine practices or behaviour (Røpke, 2009).

3.2.2 Elements of social practices

This section provides a brief definition of the three elements of SPT: meanings, materials, and competency.

- **Meanings**

Meanings as essential components of social practice represent "*symbolic or shared meanings*", social norms, and "*ideas and collective aspirations*" (Shove et al., 2012, p., 14). Meanings in this research are considered users' expectations encompassing their previous experiences and perceptions.

- **Materials**

As a second key element of SPT, materials include "*things, technologies, tangible physical entities, and the stuff of which objects are made*" (Shove et al., 2012). The materials in this research are considered to also include the AR app itself, the content of the app, and its features.

- **Competency**

Competency is a key component of SPT that includes knowledge about the practice and the skills required to perform the practice. This component represents the knowledge and skills needed for executing social practices (Røpke, 2009, Shove and Pantzar, 2005, Reckwitz, 2002, Shove et al., 2012). As per SPT theory, this research considers users' skills and knowledge as essential elements when using AR affordances. Therefore, the impact of required skills is extensively explored in the context of the skill level of those individuals wishing to adopt technology that would further develop their behaviour when using the technology (Barbosa and Faria, 2008, Heller, 2012).

3.2.3 Social practices and behaviours

Social practices are comprised of everyday life practices performed on a daily or habitual basis by members of a society (Reckwitz, 2002). Technology has become a part of social and practical life, as we utilise it in the workplace, home, and when socialising (Heller, 2012). Using different apps on mobile phones is now a central daily practice in people's lives; therefore, from the point of view of this research, technology use has also become as much a social practice as working, socialising, and shopping.

Both Reckwitz (2002) and Schatzki (2002) have offered relevant insights into social practice to fulfil this study's remit. Reckwitz (2002) argued that practice represents the routine behaviour of an individual, which is composed of different interrelated factors. Jackson (2005) further observed that there continues to be limited understanding of the dynamics and evolution of social practice. Therefore, the 'meaning' factor of this theory is considered to explore expected and developed meanings deriving from the use of technology. Additionally, Schatzki (2002) states that material could be used to explore a system's material compatibility, which includes the system material and user infrastructure when performing a social practice. Reckwitz (2002) and Schatzki (2002), indicated that materials include both the social actor and the objects to perform the social practices. Thus, this research considers social actors and object (app features) characteristics to understand the use of AR in social practices.

The social context also depends on individuals, i.e., the collective behaviour of individuals constitutes the social context (Røpke, 2009). Thus, both the individual and their social context are mutually dependent on performing something as a social practice, which is itself subjective (Shove et al., 2012). However, a longstanding debate exists concerning whether to assess individual to social or social to individual behaviour, based on the coherence between meaning, materials, and competencies. Therefore, there is a need to understand the harmony or coherence of social practices as a means to better understand behaviour (Kasavin, 2017).

Coherence of certain practices measures to what extent its three elements fit (competency, meaning and material), and indicates how smoothly a particular routine or behaviour emerges (Becker et al., 2005). Holtz (2013) has elaborated on the coherence of any practice as central to its conception as a social practice. Thus, it has its roots embedded in the concept that practice is a routine behaviour when there is harmony between material and competencies, which suggests a possibility for social practices to be routine (Røpke, 2009). Schatzki (2002) explained that a "working" routine means that people do not necessarily experience inconvenience when carrying out a particular activity. That would be possible once there is coherence between material, meaning and competencies. In other words, all respective requisite complementarities of involved elements are encapsulated by coherence, and create possibilities of social practices in a routine life that has become a behaviour. For example, in the case of a practice with a high coherence level, people do not necessarily experience a push to change anything, nor do they in all the habitually possible acts and procedures they practice over time (Hargreaves, 2011). Consequently, if we consider the fitness and coherence of a concept in the context of using new technologies such as AR, that may better explain the importance of the compatibility of a system with user skills (competency), meaning (expectations) and materials, which include the system itself and the required infrastructure. Therefore, exploring the coherence of meaning, material and competency involving users can help us to better understand user behaviour in terms of using technology routinely in life without experiencing any inconvenience.

3.3 Development of The Theoretical Framework

The theoretical framework developed in this study uses affordance theory and SPT to explore the usability of AR apps by attaining an understanding of users' experiences and expectations. AR affordance describes the relationship between the users' abilities, and the features of AR apps that help them to achieve their goals. AR users frequently have different expectations, and how they perceive technology significantly influences how they experience it. Additionally, each AR user has different abilities and accesses different materials. Figure 3.1 illustrates the proposed linkages between AR apps and the three elements of SPT theory by identifying the affordances of AR apps.

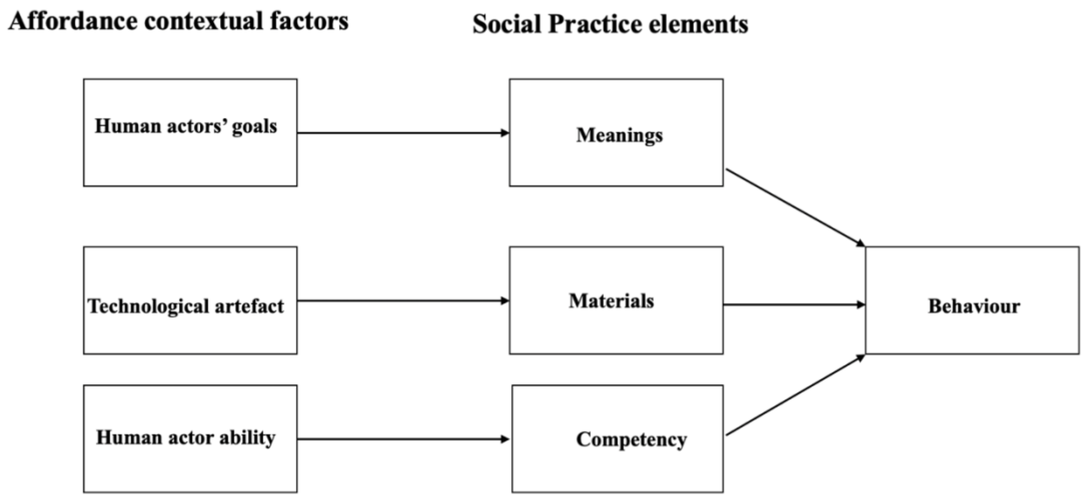

Figure 3.1: Context factors of affordance through the lens of SPT.

Considering the coherence of the SPT elements in AR affordances can help researchers to better understand the contextual factors associated with affordance (outlined in figure 3.1. as human actors' goals, technological artefact, and human actor's ability), which are explored through the lens of meanings, competency, and material. Consequently, this raises the importance of a technology's features to increase the possibilities of users using AR technology as a social practice, which is currently neglected in affordance theory. Social Practice theory, with its three elements, serves to identify why AR App affordances might still not be used at a high rate, i.e., by determining what kind of meanings, features (materials) e.g., enable or constrain the affordances, and the competencies required to use those affordances. Hence, the arrows in Figure 3.1 determine the link between the affordance factors and SPT elements that might drive users' behaviour towards using AR apps.

Affordance relates to potential actions that enable users to achieve their goals through interaction with AR apps. For example, Google Maps has a live view feature that informs navigation (affordance) that helps users obtain accurate directions (user's goal). This is an affordance of Google Maps; however, there must be a person 'on the other side' who creates meaning, and has the proper materials, and the appropriate skills to actualise this affordance: in other words, to achieve the goal of getting accurate directions.

This relationship between technology and humans informs how behaviour toward AR technology is expressed (Lavoye et al., 2021). For example, based on a conceptual framework, one might say, "*This AR app is supposed to give me the opportunity to try-on products virtually, but I struggled to find out how to use this feature, so I lost interest in using this app*". By applying the framework in figure 3.1, this can be better understood in the following way: "AR app is supposed to give me the opportunity to try-on products virtually *(affordance),* but I struggled to find out how to use this feature *(user competency),* so I lost interest in using the app *(behaviour)".* In this simple example, users acknowledge the AR app's affordances; however, they lost interest in using it and so wrote a negative review due to their lack of skills (*user competency*).

3.4 Chapter outcomes

Affordance theory and social practice theory are introduced in the context of technology use and are summarised briefly in sections 3.1 and 3.2 respectively. The three elements of SPT e.g.., meanings, materials and competency, are also outlined. Figure 3.1 illustrates associations between the contextual factors of affordance, three elements of SPT theory and behaviour. This conceptual framework allows the affordances of technology to be viewed through the lens of SPT. The next chapter will introduce the approach to the methodology, design, data collection method and analysis to answer the research questions posed.

Research Methodology

Chapter 4

This chapter presents the research methodology employed for this study. The research used a qualitative design to explore the usability of AR technology from the perspective of users' expectations and actual experiences when using different kinds of AR apps. This chapter explains the epistemological position adopted for this study, and the steps involved in the data analysis. A combination of research methods, including the use of online reviews, as well as that of reflections, and the walkthrough method, were employed to determine the expectations and experiences of AR users. The data analysis was undertaken in NVivo, in order to determine the major themes present, using the conceptual framework described in Chapter 3 as guidance. The ethical considerations of this study are also discussed.

4.1 Interpretive Principles of The Study

A qualitative interpretivist epistemological position was adopted for this study, as it aided the understanding and interpretation of the users' use factors, such as their expectations, real experiences, motivations, and satisfaction, in the context of AR quality characteristics. This approach was appropriate for analysing the overall user adoption context of AR apps. As Orlikowski and Baroudi (1991, p.15) stated, "it is [used] to understand the existing meaning systems shared by the actors and thereby interprets their actions", a fact that encouraged the researcher to explore the interpretation of user's expectations of AR apps, along with their experiences of using such apps.

According to Klein and Myers (1999), interpretive researchers believe that the knowledge of multiple realities can be achieved by understanding the consciousness, along with shared meanings, individual social perceptions, artefacts, tools, language, and documents. Interpretive researchers often employ qualitative methods for information systems (IS) research, because they are helpful for determining the answers to the questions of what, how, and why (Cornford and Smithson, 2005). For example, this study explored AR usability by focusing on the following questions: how might users' expectations influence AR app use, and how might usability characteristics of AR influence user experiences? Hence, in explaining the research's philosophical assumptions, the researcher's focus has been mostly subjective and qualitative in nature, with the experiences and expectations of AR app users serving as the core focus. Within the interpretive approach that has guided this research, the researcher designed her research questions based on the principle of the hermeneutic circle (Klein and Myers, 1999). The concept of the hermeneutic circle suggests our understanding of parts pivots on our general understanding of the whole and vice-versa. This suggested that, in the context of IS, looking at an isolated phenomenon, the failure of the AR app's experience, for example, makes it difficult to get a meaningful understanding of it. Specifically, the hermeneutic circle is used in critical IS studies to understand a technological phenomenon from multiple perspectives. Hence, the research participants' perspectives play a central role in the study which positions this research under an interpretivist paradigm. Working within this paradigm, the researcher was able to connect with the research participants (AR apps users) in order to capture their experiences and expectations about the usability of those apps. In addition, an interpretivist epistemological position was taken since each user experience and expectation is unique and provides multiple realities about the same phenomenon. For example, the researcher was also able to examine the users' diverse experiences and expectations that depended on their different characteristics such as existent knowledge of AR apps, skills and preferences.

Moreover, in general, individuals tend to discuss and communicate their beliefs and values with other individuals. They also tend to be broadly similar in terms of their habits and the meanings they ascribe to the different social practices of technology use in their life. For example, people tend to communicate openly and freely, in order to develop their competencies and grasp of meaning, in order to use a certain technology (material) in a social setting (McPherson et al., 2001). Therefore, the implications of employing technology, along with users' competencies, develop through users' social interactions in their everyday lives, interactions that are subjective in nature. Communication among individuals suggests a higher alignment of meaning subjectively, as they develop these meanings through their interactions in their everyday life (Crilly et al., 2004). Therefore, the present study sought to understand users' behaviour by exploring the usability of AR app affordances through users' experience and expectations. In order to do so, the study considered the three elements of social practice theory (SPT), namely meaning (purpose for using), expected technological features (materials), and competency (users' skills), to inform an understanding of users' actual experience through subjective interpretation.

4.1.1 Role of the researcher

According to Kaplan and Maxwell (2005), interpretive studies are not concerned with defining independent and dependent variables, rather their focus is on understanding the individual meanings of sense-making in a particular situation. Therefore, the role of the researcher in this context is significant, hence it is essential to understand the role of the researcher in producing quality outputs and uniqueness in interpretive studies. In the context of the present study, the researcher's role was to understand the various individual motivational factors influencing technology use in the participants' everyday lives (Hevner and Chatterjee, 2010). Specifically, the researcher sought to comprehend the expectations and experiences of using AR apps in the service context. A pilot study was conducted to collect the participants' reflections regarding the use of a particular AR app (Google Maps reflections). The reflections gathered at this stage provided a basis of understanding of users' perspectives concerning the use of AR technology, and a direction in terms of interpreting the context of users' perceptions.

When employing a qualitative methodology, the researcher's roles should be straightforward, in order to ensure the credibility of the research (Lewis and Ritchie, 2003). Researchers who conduct qualitative studies can adopt various roles in the research setting, from being outside observers to involved researchers, or 'insiders' (Walsham, 1995b). Although there are several extant definitions of 'insider' researchers, they are generally part of the group within which they are conducting research. In contrast, 'outsider' researchers are considered to be situated outside of the group they are studying (Hellawell, 2006). As a qualitative researcher, the researcher adopted both outsider and insider roles. Firstly, they were an outsider at the first two phases of data collection, as this study sought to obtain primary data using online reviews and reflections, both at the pilot stage and the later in-depth stage of the study, using Heedzy software and Microsoft forms that were circulated via Twitter and WhatsApp. According to Walsham (2006), the close involvement of the researcher aids the understanding of social and cultural realities, and their influence on system users' behaviour and perceptions. He also noted that researchers can lose the opportunity to obtain fresh and unbiased participants' views if they are too closely involved. Therefore, as an outsider for this study, the interests and experiences of the researcher did not form part of the first two phases of data collection.

However, the authors also indicated that adopting the role of both insider and outsider can increase the quality of data collection, interpretation, and analysis (Walsham, 1995b, Walsham, 2006). Therefore, the role of researcher was an insider at the third stage of data collection (walkthrough technique) that include a personal account experience. Furthermore, Walsham (2006) explained that we all are biased when interpreting things meaningfully, due to our background, prejudice, experiences, and knowledge. While the researcher took an outsider position for the first two phases of data collection, their role at the data interpretation stage was as an insider. This enabled the approach to the data analysis to be one that explored the usability experiences and expectations of app users, in order to comprehend their behaviour when employing AR technology.

4.2 Research Methods

In contrast to quantitative research, which overlooks people's opinions, words, and documents in favour of their numerical relevance, the focus of qualitative research is on understanding a phenomenon by looking at people's actions, experiences, words and documents (Trauth, 2001). Qualitative research methods are commonly used to understand the different opinions, motivations, and explanations that exist for the same phenomenon, and therefore align with subjectivism and interpretivism (Ritchie et al., 2003). According to Lee and Liebenau (1997), qualitative researchers within the field of IS can provide comprehensive and satisfying accounts of success, failure, effectiveness, and efficiency that occur within different versions of technology.

In this study, the researcher focuses on exploring AR usability issues by understanding users' expectations and experiences of multiple AR apps and the meanings they developed after using these apps. These meanings that are produced by the users refer to multiple perspectives on a topic and diverse views and therefore cannot be quantitatively analysed or measured (Creswell, 2014). Hence, the qualitative research method was appropriate for this exploratory research design. Specifically, by using entirely qualitative methods including multiple data sources (858 users' online reviews, 62 users' reflections and walkthrough methods of 12 AR apps), the researcher was able to explore AR app users' expectations and experiences concerning different usability characteristics and provide novel insights to aid understanding of the AR app adoption behaviour of users. Further explanation of the data collection methods is provided in the next sub-sections.

4.2.1 Data Collection

In qualitative research, common data collection tools include individual open discussion, group discussion, and unstructured or semi-structured interviews (Walliman, 2015). In a qualitative study, rich data can be gathered using transcripts from semi-structured interviews, narratives, participation observations, diaries, and stories (Waring and Wainwright, 2008, Myers and Newman, 2007). In addition, Kaplan and Maxwell (2005) explained that pictures, documents, texts, and photographs are some of the most valuable sources for generating qualitative data, along with rich data insights (McKenna et al., 2015, Andrade et al., 2015). As Myers and Avison (2002) explained, qualitative data collection methods include researcher reactions and impressions, texts and documents, questionnaires and interviews, and observations. Data collection from multiple sources can help the researcher to provide multiple and rich interpretations of specific phenomena that allow them to explore the topic from different angles (Klein and Myers, 1999). For example, in their IS-based study, McKenna and Chughtai (2020) employed multiple data collection sources, including participant observation, chat logs, screenshots, discussion forum posts, and social network websites. Meanwhile, Cai et al. (2020) used multiple primary data collection sources, such as diary and semi-structured interview methods, in a study conducted in the tourism industry context.

The data collection for the present study employed primary sources, including online reviews of AR apps, pilot study reflections, and in-depth reflections of users. The data was collected in three different phases, as summarised in Figure 4.1. Initially, online reviews of 10 top tourist cities worldwide were collected using Gibbs' (1988) reflective model, along with the reflections of users of the Google Maps AR app. The preliminary findings from these online reviews and the Google Maps reflections informed the subsequent questions employed for the subsequent in-depth reflections. This approach enabled the collection of rich data concerning the usability of AR apps by promoting understanding of user experiences and expectations. Moreover, it guided the researcher's selection of the AR apps used for the study, as shown in Figure 4.1 and Table 4.1. Further details of the data collection phases are provided in sub-sections 4.2.1.2, 4.2.1.3 and 4.2.1.4.

4.2.1.1 Usefulness of and Justification for Using Online Reviews Data

There is currently an abundance of information concerning system usability that highlights the value of online reviews (Nielsen and Budiu, 2013). As Genc-Nayebi and Abran (2017) explained, online user reviews of apps can be a major resource for understanding a user's real experience and actual expectations, which can provide valuable direction for the future improvement of mobile apps. Many previous researchers explored mobile app development by using online reviews as the data source of their study (Stoyanov et al., 2015, Ouzzani et al., 2016, Tavakoli et al., 2018). For instance, Tavakoli et al. (2018) employed online reviews of applications as a source of information for software development, and Stoyanov et al. (2015) used mobile rating scales and reviews to assess the quality of certain mobile apps.

According to Jain et al. (2021), there is a wealth of information available in the form of online reviews on numerous websites, and therefore, doing customer surveys, opinion polls, and focus groups is not necessary for any service provider organisations in order to gather client experiences. Moreover, they indicated that online reviews that post publicly on social media have aided and changed the direction of business growth. For example, system developers who utilise online reviews data can achieve better decisions that are based on evidence, rather than on intuition. However, as Harrison-Walker and Jiang (2023), indicate that not all the reviews available on online platforms are regarded as credible as some are fake, the researcher follows Klein and Myers (1999) principles to evaluate the use of online reviews as one of the main data sources of this research. (See section 4.4.7 for further details)

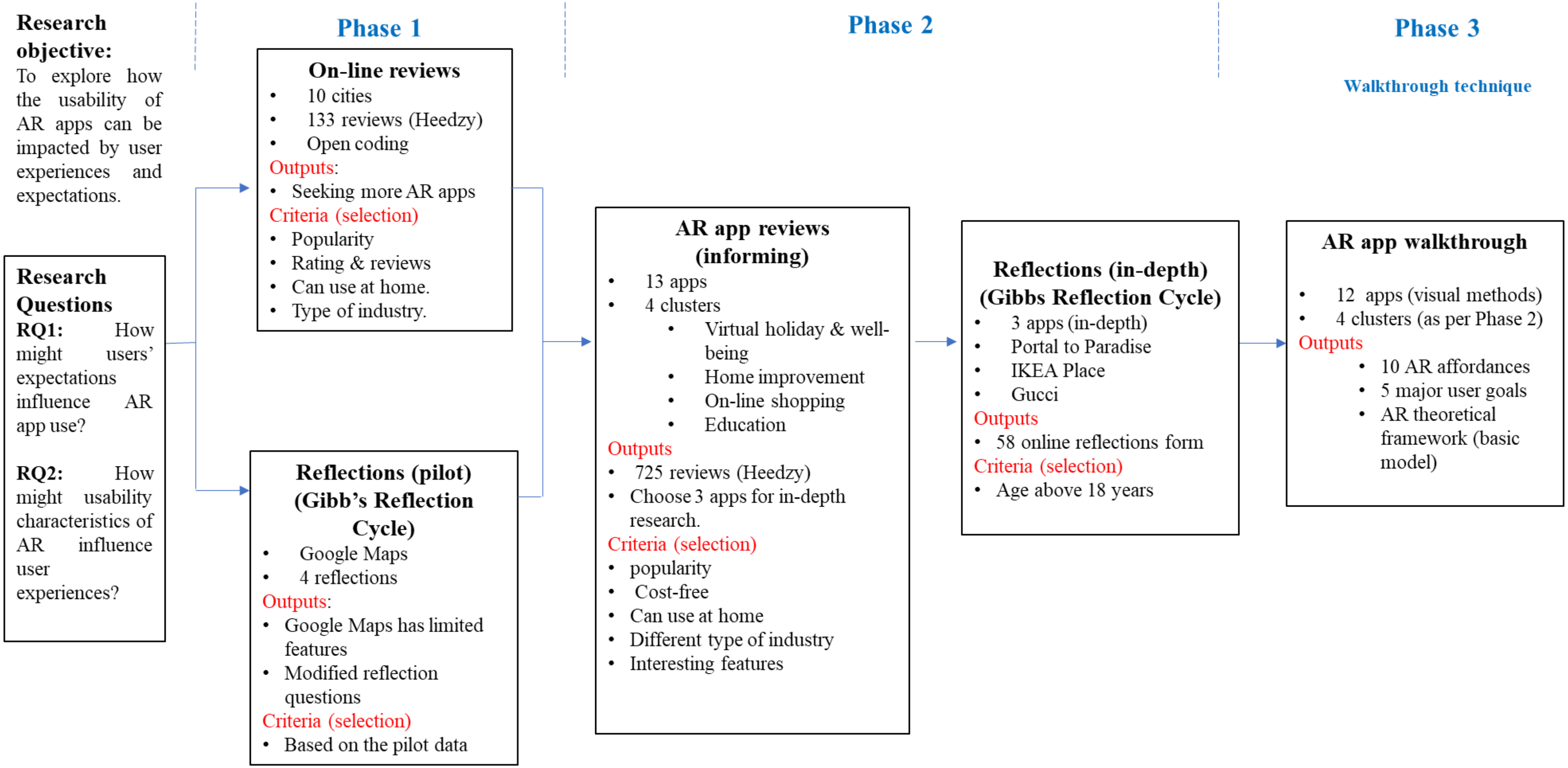

Figure 4.1: Data collection phases and walkthrough method.

This study therefore employed online reviews of AR apps as a means of understanding their perceived usability by exploring the experiences and expectations of users that might inform AR users' behaviour. This was because it was deemed that the use of online reviews for exploring user experiences and expectations would be helpful for understanding user behaviour concerning AR apps.

4.2.1.2 Phase 1

- **Online User Reviews**

According to Myers (2019), there is a current trend for people to share their experiences of brands and technology use online. These experiences are influential in engaging other users via the word-of-mouth exchange about brands and technologies. Therefore, online experiences can be viewed as an optimal method for capturing users expectations, experiences, perceptions, and needs (Myers, 2019). However, according to McKenna et al. (2017), there are many challenges for the data collection phase when using online platforms as the data source. These challenges must be considered and addressed by the researcher, in order to maintain data collection and analysis validity. First, the size of online reviews is very large and cannot be filtered without the use of an online data filter tool (Hu et al., 2017). Although qualitative data management tools, such as NVivo software, can facilitate storage and manage data, they are not helpful for cleaning and filtering data in a specific context (McKenna et al., 2017). Therefore, for the purpose of the present study, specific criteria were developed, such as including only the reviews most relevant to the usability of the app in question, and those written in the English language, in order to reduce the amount of data gathered (see Figure 4.1 and Table 4.1).

According to McKenna et al. (2017), researchers must possess a particular set of skills to access and make best use of online platforms, which may be protected by a firewall, or may require permission from an administrator or gatekeeper to use. In order to overcome these challenges, this study focused on AR apps for which reviews are available publicly. Therefore, no special permission was required from an administrator, nor were specific skills necessary to collect data from a firewall-protected online platform. In order to collect the online reviews, the researcher used Heedzy software, an online tool that facilitated the selection, filtering, review, and storage of ratings and reviews of AR apps from the Apple App Store. These user reviews and ratings were helpful for determining users' expectations, experiences, and behaviour regarding the use of the AR apps in question. The instructions and guidance for using the Heedzy software was provided in the form of tutorial videos offered by Heedzy.com at the time of purchase. These instructions explained the storage, management, and export of data for interpretation purposes.

It is essential to discuss the selection criteria employed for the online reviews. Recently, Morton (2019) provided details of the 10 most popular cities in the world, namely those with the maximum number of visitors and visitor spend, based on a single night, month, and a number of years. In total, 143 online reviews were downloaded for these 10 cities from the Cntraveler website. The Cntraveler website also includes links to top tourist locations, along with related maps. Certain well-known AR apps were then selected and the 10 most popular cities searched on them. Out of the 143 reviews, 10 were excluded, because they were not relevant to the context of the study. Other reviews were also excluded, because the language they employed was not easily readable or understandable. This left 133 for use in the study. However, in order to avoid repetitions, the study reported only those that were relevant, unique, and comprehensible. For example, of the 133 online reviews, the majority, namely more than 50%, concerned value in terms of price, including comments such as ‘waste of time and money, so do not use this app’, and the level of satisfaction/dissatisfaction with the app. Further details of these reviews are provided in Chapter 5 (Sections 5.1- 5.6).

- **Google maps reflections**

The first stage of reflections for this research was conducted as a pilot study, in order to understand the users and usability of a particular AR app. The Google Maps app was selected for this purpose for two reasons. First, Google Maps’ developers launched a live view (AR) feature in August 2019 that presented an excellent opportunity for the researcher to ascertain whether there were any usability issues with the app. The second reason was accessibility, since it is a popular app that many people have on their smartphones, and is free to use.

The main purpose of the pilot study was to capture any usability issues from users’ perspectives that might help to develop appropriate questions for the users’ reflections in the second phase of the research. As Schon (1992) explained, reflection is the ability to continue learning from the self-experiences and others’ experiences. The Gibbs Reflective Cycle (Gibbs, 1988) was adapted by the researcher of the present study to ensure that it suited the purpose of collecting users’ reflections concerning the use of AR apps. This tool is commonly used for reflection and learning from any event in life, and includes the future direction after the event in question. The Cycle has six stages:

description, feelings, evaluation, analysis, conclusion, and action plan. For this study, the four stages relevant for addressing the research objectives concerning usability factors were selected. Specifically, the evaluation and analysis stages were merged, and the conclusion was merged with the action plan stage, as they provided the same meanings in the context of this research. Figure 4.2 summarises the four stages used for this study.

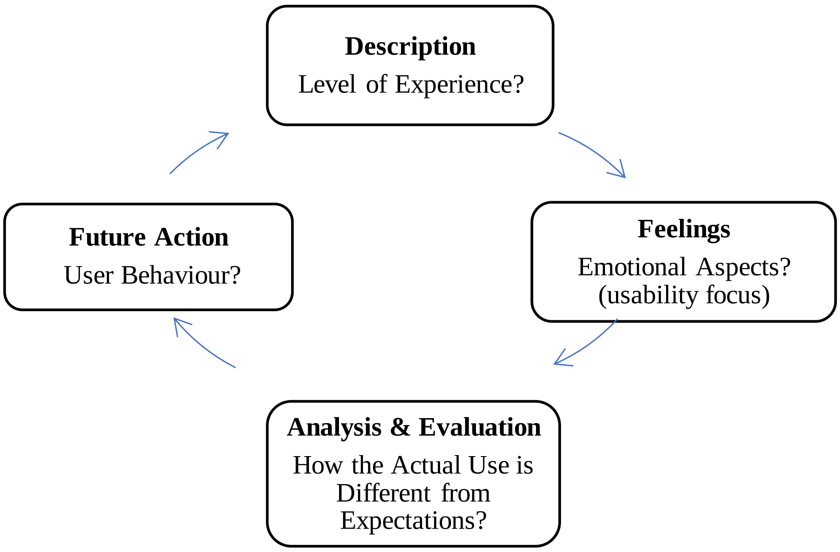

Figure 4.2: The four stages of the Gibbs' Reflective Cycle employed for the study (Source: adapted from Gibbs, 1988)

The description stage of the Gibbs Reflective Cycle identified the existing knowledge and expectations of AR users before using a certain AR app, while the feelings stage captured their actual emotions regarding the ease of use and usefulness the AR app. The analysis and evaluation stage reflected the user experience, which was either positive or negative, based on their expectations. The final stage, future action, reflected whether the AR user would use the app again, and/or the improvements or suggestions proposed by the AR app user after using the app.

The pilot study targeted participants from the UK, and guided them in downloading and using the Google Maps app. The researcher asked certain questions of the participants before they used the app, during their use of the app, and after their app use (see Appendix A). In total, reflections were collected from four participants. Since the Google Maps app does not have a wide variety of AR features, thus limiting the reflection opportunities for users and the opportunities to collect further insights, for the next phase of data collection, the researcher sought alternative AR apps that had online user reviews, along with a wider range of features to experience.

4.2.1.3 Phase 2

- **Online Reviews of AR Apps**

After collecting reviews of the 10 most popular cities on AR apps, along with four users' reflections concerning the Google Maps app, it was clear that focusing on one type of AR app, or one industry, could limit the opportunities to collect rich data concerning the different features of AR apps. As noted in the previous section, the Google Maps app has limited AR features (navigation only), which limited the extent of the in-depth reviews of the participants and their reflections concerning the app. Therefore, other AR apps were sought in the Apple App Store, encompassing a range of different industries. In total, 13 AR apps were identified from various industries, including virtual holiday and well-being apps, home improvement apps, online shopping apps, and education apps (see Table 4.1).

The number of reviews and the cost of downloading or using the app (whether it was free or required purchases in-app), were the criteria examined when selecting the apps used for the data collection. The review data for 10 out of the 13 AR apps was downloaded; three of the apps did not have online reviews (see Table 4.1). These 10 AR apps were used to collect 4,745 related online reviews. In order to serve the research aim of this study, a filtering approach was utilised to remove unnecessary or irrelevant data. For example, after reviewing all of the reviews, some were found to have been released before the AR feature was implemented in some of the apps. Hence, the reviews were selected according to different characteristics that might meet users' core requirements criteria of the AR app in particular. This selection method aligned with the collection of the data required for the context-specific objectives of this research. Therefore, the selection of the reviews from a number of similar features was based on the richness of the reviews, rather than the frequency of occurrence of the same features. The expected features were those that the AR users would like to see, but that the app did not support.

In summary, the reviews were filtered by extracting only those provided after the AR features were released for the app, those written in the English language, and those that were most relevant to the context of this research. This produced a final total of 725 reviews for Phase 2 of the study, as shown in Table 4.2. These complemented the 133 on-line review from Phase 1 of the data collection.

Table 4.1: AR apps clustering.

Cluster	App	Description	Platform	Pricing	Existing reviews	Number of reviews
Virtual holiday, health, and wellbeing	Portal to Paradise	8 resorts; 48 scenes	iOS	Free	No	-
	Relax-Meditation	Virtual instructors appear directly in users' environment	iOS; Android	Free	Yes	2
	Dance Reality	Six scenarios	iOS	Free	No	-
Home	Ikea Place	Virtual placing of true-to-scale 3D models in users' own space. Combines AR technology and IKEA's smart home solutions	iOS; Android	Free	Yes	137
	Dulux Visualizer	Enables users' to see paint colours on their wall using AR technology to explore different colours; X colours; paint calculator option	iOS; Android	Free	Yes	119
Online shopping	Gucci	Uses AR to decorate spaces and to try-on eyewear, sneakers, masks, lipsticks, and hats virtually.	iOS; Android	Free	Yes	7
	Asos	AR shopping experience	iOS; Android	Free	Yes	363
	Wanna Kicks	Trainers try on app	iOS	Free	Yes	33
Education	Mondly	Learning languages using AR	iOS; Android	Free to download, offers in-app purchases	Yes	52
	Skin & Bones	10 augmented reality experiences with 3-D tracking; two games and two interactives; 32 videos	iOS	Free, requires a printer	No	-
	Pocket Universe Express - Sky Map	Provides a detailed, annotated window into the night sky	iOS	Version1: free; offers in-app purchases. Version 2: paid	Yes	10
	CopyArt	Learn drawing with AR	iOS; Android	Paid	Yes	1
	Google	Watch Google 3D animals at home	iOS; Android	Free	Yes	1

- **In-depth Reflections Concerning Three AR Apps**

The data collection activities for this stage coincided with the COVID-19 pandemic, therefore AR apps that could be used at home during lockdown were selected for the study. Since engaging users' interest in an app and its features enhanced the opportunities to obtain users' views of the app, three particular AR apps out of the total 13 apps were selected for an in-depth investigation, due to their potential appeal. These were from different industries, and there were specific criteria for their selection, including the need for them to be free of cost, namely the app was freely available for the users. The same four stages of Gibbs' Reflective Cycle (description, feeling, analysis and evaluation, and action plan) used for the pilot study were employed for the data collection in this stage, for the users' reflections on the three apps selected. These were *Portal to Paradise, IKEA Place*, and *Gucci*. As described under the pilot study, the description stage identified the existing knowledge and the expectations of the AR users before they used the AR app. The feelings stage identified the actual emotions of the users regarding the ease of use and usefulness of the apps when using them. The analysis and evaluation stage reflected the users' experience, either positive or negative, according to the AR users' expectations. The final stage was future action, which reflected whether the AR user was likely to use the app again, or if they had suggestions for improvements in its design and usability, post-use. The participants were asked a series of questions before using the three apps, during their use, and after their use (see Appendix B for further details of the questions that informed users' reflections at the various stages).

According to Steinberg and Steinberg (2015), researchers should not use technical terms or phrases in questionnaires, because their participants have limited opportunities to ask additional questions if they don't understand any terms or concepts. This is especially the case when using online forms. Therefore, the present study employed simple wording to obtain the participants' responses. Meanwhile, Taylor (2017) explained that the language, quality, and quantity of the questions in a questionnaire matter in IS research, because researchers seek to collect common users' views of the system concerned. However, since they may not understand the technical terms regarding a system fully, it is important to pose a set of simple and short questions that keep the participants interested in answering the questions. Due to these recommendations, a pilot study of the questionnaire employed for the present research was conducted with three close friends of the researcher, in order to obtain their view of the quality, quantity, and language of the reflective questions, and the style of the questionnaire. All three participants suggested reducing the number of questions, and using simpler language for a number of the original questions. Consequently, the total number of questions was reduced from 20 to 13.

Additionally, Myers and Avison (2002) noted that when seeking a user's view of a system's usefulness, it is necessary to ask both closed- and open-ended questions. Therefore, the present study used a combination of both types, reducing the length of time required and increasing the participants' interest level. Specifically, the closed-ended questions helped to identify the most important features of AR apps under investigation, while the open-ended questions explored the reasons behind the importance of specific AR app characteristics.

Furthermore, the study employed certain simple usability terms, with details of each characteristic, to facilitate the participants' understanding. While the selection of these usability characteristics was based on the previous literature, the nomenclature of some of the characteristics, in terms of the terminology used, was simplified for this study. The participants reflected on their expected or experienced usability characteristics in their responses. Open-ended questions were also posed, in order to obtain an understanding of the usability expectations and experiences of the users of the AR apps. To ensure the quality of the data collected, detailed instructions were provided to the participants, including the researcher's email address, and the participants were encouraged to contact the researcher if they had any queries (see Appendix C).

In order to ensure that social distancing was maintained, due to the COVID-19 pandemic, web-based communities were employed to recruit the participants (Beldad, 2021). Specifically, the research aim and online questionnaire, in the form of a Microsoft form, was advertised on WhatsApp and Twitter. Links to the three apps chosen for exploration were provided on the reflection forms, so that the participants could select one of their choosing, download it, use it, and reflect on it. According to Saunders et al. (2018), the researcher can cease the data collection process when the saturation point is reached, namely the point at which the thoughts and experiences reported begin to be repeated. In total, 58 responses were collected at this stage of the data collection, over a 10-day period, before saturation point was reached (see Table 4.1).

4.2.1.4 Phase 3

- **Walkthrough Technique Employed to Identify Affordances**

The walkthrough method is a direct interaction mode with a digital interface (Cavagnuolo et al., 2022). It is a kind of user interface inspection method (Sears, 1997) that gives researchers an understanding of how the intended user is expected to integrate an app into their everyday practices (MacLean and Hatcher, 2019). The method was developed by Light et al. (2018) in the form of a step-by-step exploration of apps that allows researchers to put themselves in users' shoes and to visualise the range of options available to them. According to Cavagnuolo et al. (2022), the walkthrough method can help to address research questions about digital technologies, especially concerning socio-cultural representations and such technologies' technological aspects. Although walkthroughs can also be conducted alongside users, the standard application of the approach involves a researcher reviewing how an app's interface contributes to its interactions. Its purpose is not to check whether users react to the interface as its designers intend, rather to illuminate the material elements of those intentions, and by doing so to critically examine the app's functioning as a socio-technical artefact. By examining its operating model, governance, and vision, it is possible to obtain insights into how app designers, developers, publishers, and owners expect users to interact with, receive, and use an app (Light et al., 2018). Hence, the present study employed the walkthrough technique for Phase 3 of its data collection.

In technical walkthroughs, the researcher engages with the app interface, explores the screens, and examines the menus involved. Employing a walkthrough of an app requires the researcher to put themselves in the position of users, and to apply their analytical skills to the acquisition process, specifically registering, accessing features and functionalities, and discontinuing use, by generating detailed field notes and recordings, such as by capturing 'live' screenshots whilst conducting the walkthrough. This involves a focus on an app's materiality, including the actions it requires and guides users to conduct, and imagining how users might perceive these as affordances (Light et al., 2018). For example, this study included screenshots (images), in order to provide visual support to the identification of AR apps affordances, via the walkthrough method. A series of screenshots from 12 AR apps were taken (as shown in Chapter 5), in order to illustrate some of these apps' affordances.

The walkthrough technique groups the uses of apps into three common stages: registration and entry, everyday use and suspension, and closure and leaving (Light et al., 2018). The purpose is to identify AR apps' potential affordances, and the first two stages provide detailed information on this matter. Hence, the present study employed only the first and second stages, registration and entry, and daily use, as detailed below:

1) The first step, registration and entry, involves analysing how a user creates a user account for a particular app. The expected uses of apps are often communicated clearly during registration, which might state the app's vision on the welcome screens. In addition, the app's operating models may be mentioned in their price list in app stores or in-app purchase menus. Additionally, registration is generally the point at which an app communicates its governance, including 'terms of use' screens on which the user must click 'I agree'.
2) The second step, everyday use, is a walkthrough of daily use that addresses the activities regularly engaged in by registered users. This stage records the app's functionality, options, and affordances. This may necessitate the creation of various profiles, in order to interact with algorithms that are customised to specific user groups. It is essential to heed the app's features and the flow of activity, namely the order of the screens and functions. Not all the functions of the apps selected for this study were easily accessible, as some AR features were only available if the user paid a fee. Nevertheless, walking through the app's fundamental functionality, gave an indication of the activities it allows, limits, and directs users towards.

The walkthrough method developed by Light et al. (2018) has been used in a number of previous studies. For example, MacLean and Hatcher (2019) applied it to the BEACON Rx health platform to address research questions relevant to critical health communication studies. Similarly, Duguay et al. (2020) used the walkthrough method to investigate the governance approaches of Tinder, Instagram, and Vine via detailed analyses of each platform. Moreover, Bivens and Haimson (2016) examined how gender is represented among the current top 10 social media sites, including Facebook, Twitter, and Instagram, using the walkthrough method. The present study contributed to the extant literature by applying the technical walkthrough method to AR apps, 'walking through' them with the purpose of identifying their affordances.

According to Light et al. (2018), combining methods or data sources can address the walkthrough method's limitations. While walking through an app can provide a sense of user engagement, it does not collect and analyse user content, activity, or attitudes directly. Therefore, for the purpose of the present study, app reviews and user reflections were collected as supplementary data to identify the particular AR app affordances. In the walkthrough stories discussed in Chapter 5, the researcher put herself 'in the shoes' of a regular app user. Table 4.2 presents the data sources and filtering criteria employed by this study to capture, in total:

- 858 online reviews;
- 62 reflection forms;
- 10 AR app affordances;
- 5 user goals.

Table 4.2: Data sources and filtering criteria.

<table>
<tr><th>Phase</th><th>Source of data</th><th>Nature of data collected</th><th>Quantity collected</th><th>Filtering criteria</th><th>Type of data</th></tr>
<tr><td rowspan="2">Phase 1</td><td>Online reviews of 10 cities (top tourist destinations)</td><td>Used Heedzy to download app reviews available at app stores (Excel format)</td><td>133 out of 143 reviews</td><td>Most relevant reviews, e.g. usability issues and emotional expressions

English language</td><td>Text</td></tr>
<tr><td>Gibbs' Reflective Cycle (pilot study used Google Maps app)</td><td>Written</td><td>4 reflection forms</td><td>-</td><td>Text</td></tr>
<tr><td rowspan="2">Phase 2</td><td>Online reviews of 13 apps (based on availability of reviews)</td><td>Used Heedzy to download app reviews available at app stores (Excel format)</td><td>725 reviews out of 4745.</td><td>The date of launching the AR feature

Most relevant reviews

English language</td><td>Text</td></tr>
<tr><td>In-depth reflections of 3 apps (most popular apps from four different industries)</td><td>On-line Microsoft forms</td><td>58 reflection forms.</td><td>-</td><td>Text</td></tr>
<tr><td>Phase 3</td><td>Walkthrough of 12 apps</td><td>Screenshots;
online reviews;
62 user reflections</td><td>10 affordances;
5 user goals</td><td>Four clusters:

• Holiday and wellbeing (travel guide apps, Portal to Paradise, Google Maps, Dance Reality, Relax & Meditations)
• Online shopping (Gucci)
• Education (CopyArt, Skin & Bones, Google, Pocket Universe Express)
• Home (Ikea Place, Dulux Visualizer)</td><td>Images</td></tr>
</table>

4.3 Data Analysis

4.3.1 Thematic Analysis

As Maguire and Delahunt (2017) explained, the use of thematic analysis is fundamental in a qualitative analysis, because it promotes the skills essential for conducting other kinds of qualitative analysis. According to Fink (2019), as numerous qualitative methods use thematic analyses, it cannot be considered a different method, rather an approach that researchers use to assist their analysis. In essence, thematic analysis is a process in which the themes in a data set are identified, analysed, organised, described, and reported. In the context of the present study, after identifying the apps' affordances via the walkthrough method, a thematic analysis was used to analyse the data, since it allowed the categorising of the data, based on similarity (Joffe, 2011), which was helpful for understanding and organising the data to address the research objectives.

Thematic analyses involve six main steps: familiarisation with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report (Clarke and Braun, 2013). This study employed these steps to generate, firstly, descriptive and NVivo codes (open coding). Although the researcher was familiar with the data after downloading the online reviews during the data collection, this stage began officially with the identification of the apps' affordance, as researcher began viewing the data through the lens of SPT at this point. The use of NVivo aided in analysing, managing, and shaping the data, and in generating certain codes (nodes). The data was coded, organised, and categorised according to the affordances identified and the SPT themes. The categories and themes were then considered in relation to the research questions and theories. These categories helped to create an analytical framework to guide the study and to maintain a focus on its aims. The themes were reviewed several times to ensure they stood alone and did not need to be subdivided or combined with other themes, and were all connected rationally tied to the codes (Boyatzis, 1998). This was followed by the writing-up stage of the study, in which the narrative of the data was expressed by organising and synthesising the themes to allow the meanings to emerge (Clarke and Braun, 2013). To ensure rigour in the analysis, the process commenced with open coding, and proceeded to the theoretical themes, using a sample of the data analysis and the emerging themes (Table 4.3 and Figure 4.3).

4.3.2 Unit of Analysis

The primary emphasis of a research study is often termed as the unit of analysis (Gronn, 2002). It is also recommended that, in order to interpret research data properly, researchers should try to find a unit of analysis that retains the research context that is necessary (Elo and Kyngäs, 2008). Therefore, the unit of analysis in this study is the individual rather than collective. To clarify, the researcher in this study explores the usability of AR apps and how usability is impacted by user expectations and experience – at the level of the individual or user. That is, individual expectations and experience of multiple AR apps were collected from different data sources (users' online reviews, individual reflections, and walkthrough method). Hence, user expectations and experience – in a service context – is the unit of analysis in this research. According to Chenail (2012), in order to gain insight from qualitative data and ensure the reliability of the results, qualitative researchers must use these units consistently through the analysis process (from coding to developing categories and themes to interpreting the data). Therefore, when processing texts for the purpose of conducting qualitative data analysis, the researcher concentrated on this meaningful unit of analysis: user expectations and experience. Table 4.3 and Figure 4.3 provide examples of research data, codes and the emerging themes.

Table 4.3: Illustrative quotations and data analysis of emerging themes.

Quotations	Analysis
"To support decision-making during the pre-purchase stage **(affordance)** *and to save the time of returns when buying IKEA products* **(user goal)**; *I will recommend it to my friends* **(user behaviour)***".*	**User goals:** saves time, offering a convenient experience **Affordance(s):** provides users with information that helps in decision making process (informed decision-making affordance) **User behaviour:** developed after experience with the app, i.e. recommend the app to friends.
"Perhaps I **(person)** *would use it* **(user behaviour)**, *especially if you get lost and do not know which direction to head* **(user goal)**, *AR* **(materials)** *can help you to solve the issue by orienting your phone to the buildings* **(user goal)**, *which then can accurately show you the way* **(affordance)***".*	**Person:** AR app user **Materials:** AR app **User goals:** use AR app to obtain accurate location **Affordance(s):** Informed navigation affordance **User behaviour:** developed after experience with the app, i.e. intention for future use.
"I **(person)** *first downloaded the online shopping app. The design looks great* **(materials)**, *and it seems to be free of error, for now,* **(meanings)**, *and they have a contact option in case of problems* **(materials)**, *which is good for online shopping activity* **(meanings)***".*	**Person:** AR app user **Materials:** AR app user's first impression of the AR app materials e.g. app's design and content, such as customer service options **Meanings:** pre-use expectations, e.g. app is free of errors **Meanings:** developed after user noticed the contact options, i.e. good app for shopping activity.
"I like **(person characteristics)** *to identify the benefits and how well it will operate. The advantages are extremely important, because the [more] efficient the app, the higher success it will have in the market* **(meanings)**. *The settings must be accurate, and the app should [include] clear policies and guidelines* **(materials)**. *I certainly feel an app should be high in quality. For instance, the quality of a camera should be high in quality, so that the images look professional* **(competency)***".*	**Person characteristics:** AR user characteristics, e.g. different users' preferences **Meanings:** pre-use expectations, e.g. AR users' values and beliefs **Materials:** quality of app's content, e.g. AR app settings, policies, and guidelines for use **Competency:** AR system competency, e.g. high quality functionality.

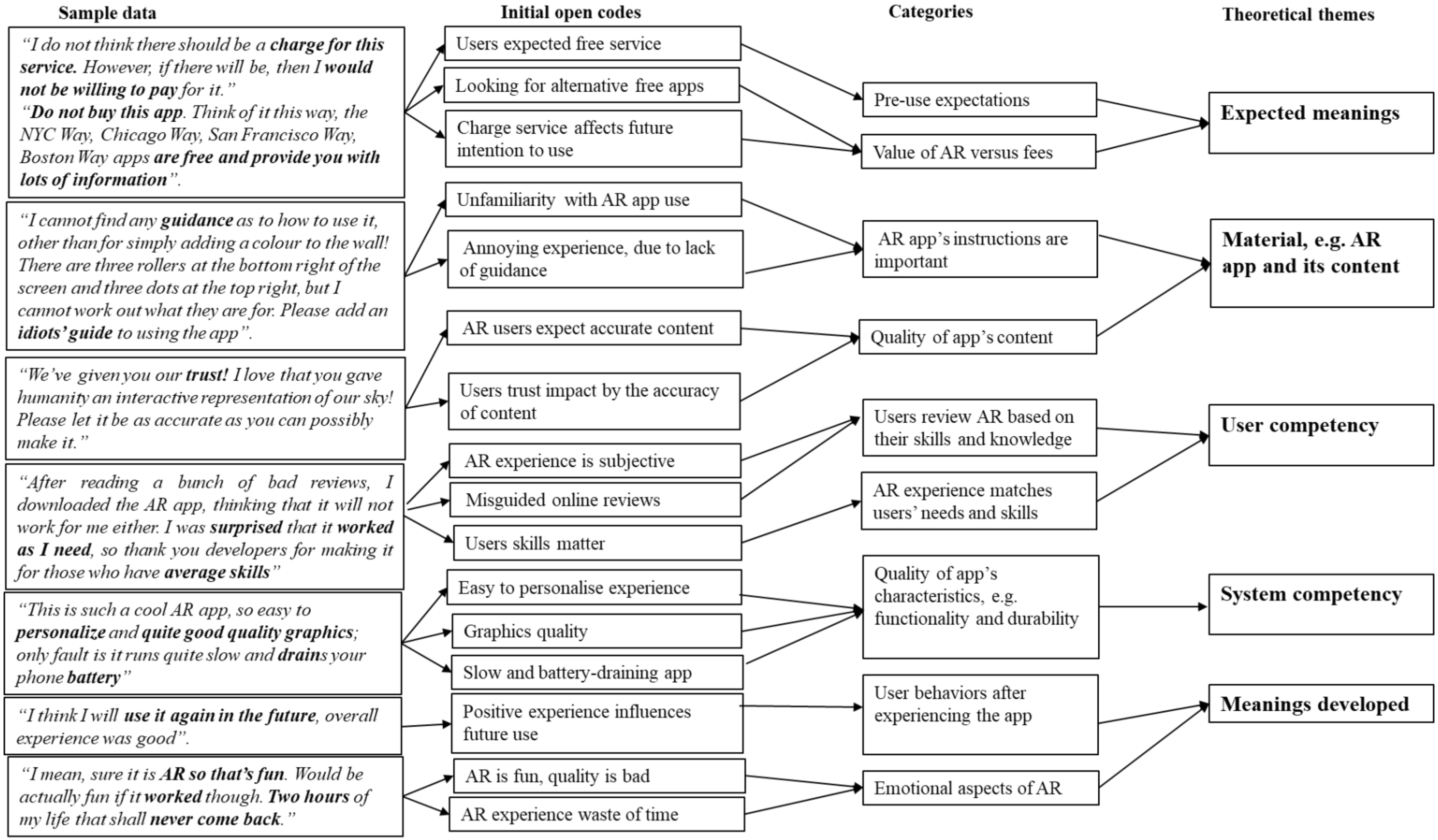

Figure 4.3: Illustrative codes process.

4.4 Evaluation of Interpretive Research

In their work, Klein and Myers (1999) offered the following principles for using an interpretative method in IS studies, explaining that they must be followed to ensure the rigour and uniqueness of a study: hermeneutic circle, contextualisation, generalisation and abstraction, the interaction between subjects and researcher, multiple interpretations, dialogical reasoning, and suspicion. These principles are discussed in relation to this study in the following sub-sections.

4.4.1 The Fundamental Principle of the Hermeneutic Circle

The concept behind this principle is that all human understanding is achieved by considering the interdependence of the parts and the whole that they form together. This principle of human understanding is fundamental to all the other principles (Klein and Myers, 1999). In this study, the primary objective of hermeneutics was to capture an understanding of the specific context of the interaction of the social agents, namely technology users (Klein and Myers, 1999) and the sociological view of social behaviour includes the reasons and explanations for it. For example, online reviews and users' reflections represent certain individual aspects of AR apps, namely users' expectations and experiences. Without these individual parts, it may not be possible to understand the AR usability issues and findings presented in Chapter 6 fully.

In their purpose-oriented research, Città et al. (2019) claimed that individuals act in a certain way due to their interests, and that a combination of these engenders a social order. However, Parsons (1968) argued that rules drive social behaviour, thereby causing a social expectation of the individual in question. Therefore, understanding of specific characteristics of the social practice of using AR apps can be facilitated by the context of social practices and the affordances of technology. For example, the analysis of specific AR apps' usability and user characteristics presented in Chapter 6 facilitated understanding of particular examples of usability issues that influence the actualisation of AR affordances. Meanwhile, use of the SPT perspective enabled understanding of how meanings, materials, and competencies make it possible for users to use AR apps' affordances, and then steer their behaviour towards adopting them for use in a social context.

4.4.2 The Principle of Contextualisation

According to Klein and Myers (1999), a critical reflection concerning the historical and social background of the research setting is necessary to enable the intended audience to understand how the situation under investigation developed. The context should be explicit and should aid in sense-making for the story (Myers, 2019). The present study's context was related to users' experiences and expectations of AR apps, and sought to understand user behaviour in the adoption of AR apps. Chapter 1 (Section 1.3) discussed the context of the study, including a description of app's usability, users' expectations and experiences, and the selection of affordance and SPT theories for the study. This promoted an individual-centric approach to the research that was subjective and qualitative in nature. For example, individuals observe the material artefacts (AR apps) and their potential actions (affordances), and then makes sense of them in their own way (meanings), which requires an interpretation. A higher level of habituation may prevent users from choosing AR technology altogether (Hargreaves, 2011). For example, people may experience encouragement to change their current materials, such as phone devices, or any habitual acts and procedures, in order to use AR. Consequently, individuals select the material component that aligns with their competency, materials, and meanings attached to AR technology. These aspects are discussed further in Chapter 5 (Sections 5.2 - 5.6).

The hermeneutic concept supports this principle, seeking to clarify, or make sense of, the object of a study (Myers, 2004). The goal of hermeneutics is to make the interpretation of the text our own (Myers, 2019). Due to the Covid-19 restrictions in place at the time of the data collection, this study did not include interviews as a data source. Instead, the interpretation was derived solely from the data collected from the participant reflections, or via material collected from online sources, such as online reviews. Consequently, the researcher had to rely on her own interpretation of the text.

4.4.3 The Principle of Interaction between the Researcher and the Subjects

This principle requires critical reflection concerning how the research data was socially constructed through the interaction between the researcher and the participants. According to Walsham (1995a), it is difficult to understand individual meanings, interpretations, screening, and filtering in interpretive research, and to report the interpretations; it is sometimes necessary to return to the participants for further exploration. Therefore, interpretive researchers must determine their own role in this complex human process. For this study, the research data was collected in three phases, therefore the researcher's role was both as an outsider and insider (see Section 4.1.1).

4.4.4 The Principle of Abstraction and Generalisation

According to Klein and Myers (1999), field studies should be related carefully to theoretical abstractions and generalisations to enable readers to follow how the researcher gained the theoretical insights involved. The main goal of this process is either to build a theory, or to use various theories to support rich insights (Urquhart and Fernández, 2016). As Klein and Myers (1999) explained, theories in interpretive research are used as a "sensitising device" that allows the researcher to view the world in a particular way. The current study did not seek to negate any theory/theories, rather it employed affordance theory and SPT to provide a theoretical framework to facilitate understanding of users' experiences and expectations regarding AR apps, in the context of adopting new technology. Previous research concerning technology-human interaction has often neglected the emotional aspects that are constructed subjectively through the everyday life interactions of human beings in the world (Schmidt and Etches, 2012). Comprehending how people generally feel when using a particular system is important, but can be challenging, therefore this study employed multiple theoretical perspectives to provide rich insights into how users' expectations and experiences can impact AR usability.

This study's approach was inductive. An inductive research approach is one employed to develop a theory, framework, and model via the orientation and correlation of different, relevant factors (Shove and Walker, 2010). The approach is useful when there is limited information available about specific phenomena (McAbee et al., 2017), for instance users' expectations and experiences of AR apps affordances in the context of social practices. Therefore, this study explored the subjective and qualitative meaning of the social actors concerned, namely the participants who used the AR apps in question, and shared their experiences and expectations regarding them. An inductive research approach was used to develop an AR app adoption framework that aided comprehension of AR users' behaviour in facilitating AR adoption.

For example, this thesis explored the system's credibility through the meanings element of SPT. This is because the use of a system linked to meanings that users already possess, and that motivate them to use that specific system. According to SPT, meanings include aspirations, ideas, and symbolic meanings (Shove et al., 2012), namely the issues that are central to a meaning's components, such as beliefs, understanding, and emotions (Shove and Pantzar, 2005, Reckwitz, 2002, Røpke, 2009), that in turn promote understanding of users' goals. Hence, the expected meaning of an AR app influences the actual experience of it directly. In this case, the user's behaviour is influenced by the difference between the expected meanings and the actual experience of the system. This also raises the question of whether the user is wary, unsure, confident, frustrated, annoyed, or empowered, matters that are related to the emotional aspects of users' experience, explored via the SPT elements.

4.4.5 The Principle of Dialogical Reasoning

This principle requires the researcher to conduct consecutive cycles of revision to ensure that there are no contradictions between the theoretical preconceptions guiding the research design and the actual findings (Klein and Myers, 1999). In order to address this principle, the research data for this study was collected in three phases. The first phase involved collecting online AR reviews of the top 10 tourist cities worldwide, and conducting a pilot study using the Live View feature of Google Maps to gain initial insights about user experiences and expectations of using AR apps. The original intention was to study AR use in tourism, however this industry was hit the hardest by the Covid-19 pandemic (Gössling et al., 2021), as it was impossible to visit tourist destinations physically during the lockdowns. Therefore, the focus of this study shifted to an examination of AR apps from a different angle, and across different sectors, substituting the planned offline data collection (semi-structured interviews) with new online data collection methods. Recommendations for collecting online data were provided by McKenna et al. (2017), including one that formed part of the present study's analysis and action stages, namely the need to become familiar with online platforms. Therefore, the researcher spent more than one month scanning a range of the AR apps that can be used at home, reading users' online reviews, and gaining familiarity with the terminology employed by users to describe their expectations and experiences.

The outcomes of the first data collection phase informed the second phase, namely a suitable reflections form that was developed according to the lessons learned during the pilot study. As discussed in Section 4.2.1.3, in order to ensure data quality, detailed instructions were provided to the participants, who were encouraged to email the researcher if they had any queries.

4.4.6 The Principle of Multiple Interpretations

This principle requires the researcher to explore the social phenomenon in question via multiple viewpoints, involving participants. According to Klein and Myers (1999), data collection from various sources can provide various and rich interpretations of specific phenomena. Therefore, in order to attain multiple interpretations, the data for this study was collected from various primary sources, including online reviews using Heedzy software, and in-depth user reflections employing the Gibbs' reflective model. Both negative and positive user reviews of the same app were identified, highlighting the importance of using the SPT elements to understand the differences in users' interpretations, namely their expectations and experiences. Further details are provided in Chapter 5 (Sections 5.2 -5.6).

4.4.7 The Principle of Suspicion

Klein and Myers (1999) describe the principle of suspicion as the discovery of false preconceptions that require critical analysis. However, Klein and Myers (1999) also acknowledge that interpretive researchers disagree about the degree to which social research can (or should) be critical. As the researcher employed users' online reviews as one of the main data sources for this research, it was significant to follow this principle to understand the suspicion of fake online reviews. According to Harrison-Walker and Jiang (2023), it is important to note that not all online reviews are regarded as credible because some are fake. They are often provided by reviewers with little or no actual knowledge of the products or services they are reviewing, often to mislead consumers. additionally, there are several deceptive practices reported by Petrescu et al. (2022), including automatically removing negative consumer reviews, posing as consumers to write positive reviews, and offering incentives to promote positive reviews. Hence, to ensure the reliability of this research, the researcher of this study included both negative and positive app reviews with a focus on the app's usability reviews. Moreover, the researcher combined these online reviews with other data sources namely, users' reflections on four selected AR apps, and the walkthrough method of twelve AR apps. As a result, the researcher identified the common issues in AR apps usability that users faced while interacting with those apps.

4.5 Ethical Issues

Adherence to research ethics is critical for ensuring that researchers conduct their research in an ethical manner (Israel and Hay, 2006). These include ensuring that the rights of the participants in a study are protected, as well as those of the sponsoring institution, and the researcher (May, 2011). The ethical standards recommended by the University of East Anglia (UEA) in their ethics policy were followed when conducting this study. Before collecting the data, the researcher applied for, and received, ethical approval, and confirmed that the researcher would not collect any sensitive data.

In order to tackle the issue of social distancing during the COVID-19 pandemic, the researcher decided to use web-based communities to interact with, and recruit, the participants for the study. In total, three instruments were employed for the data collection: online reviews, user reflections of Google Maps, and online reflection forms. According to Crow et al. (2006), the participants in a study have the right to be informed about the research aims and its outcomes, and a researcher should obtain informed consent from the participants before conducting their research. In order to comply with this, on 20 May 2020, the researcher launched online reflections form for the participants, using Microsoft Forms, which included a consent form. The form detailed the research aim and procedures, and how the researcher would ensure that the participants were protected (Appendix C). In order to maintain the reliability of the research, the researcher consulted the Postgraduate Research Office (PGR) at her university, who advised her to use her university account to create the online reflection forms. The researcher also provided detailed instructions for the participants, included her email address, and encouraged them to contact her if they had any queries.

4.6 Chapter Outcomes

This chapter outlined the research methodology of this study, and justified its epistemological position in Section 4.1. Section 4.2 illustrated and justified the use of the three phases of data collection, namely the use of online reviews, reflections, and the walkthrough method, supported by Figure 4.1. The walkthrough method was used to identify the potential AR apps' affordances, combined with users' online reviews and reflections, in order to capture their expectations and experiences. Table 4.1 illustrated the 13 AR apps selected for the purpose of this study, from four different service industries. Meanwhile, Table 4.2 presented the data sources and the outcomes of the three phases of data collection, namely 858 online reviews, 62 reflection forms, 10 AR app affordances, and five major user goals.

Section 4.3 discussed the approach to the data analysis, supported by Table 4.3 and Figure 4.3, which explained how the researcher proceeded from the use of open coding to the theoretical themes, using a sample of the data and emerging themes. Finally, an evaluation of the interpretive research was provided according to Klein and Myers (1999) principles and the ethical issues related to the study were discussed in Sections 4.4 and 4.5, respectively. The next chapter presents the study's findings, commencing with the walkthrough method that was used to identify the AR app affordances, and proceeding to the findings produced by use of SPT.

FINDINGS

Chapter 5

Chapter 3 developed a conceptual framework based on understanding meanings, material, competency (from SPT), and affordance theory. Although some literature is available on social practice and affordance factors, the present chapter provides an in-depth analysis of the data gathered based on the current study's conceptual framework, in order to capture a series of rich insights. This chapter will first identify the affordances through the *walkthrough technique* (Light et al., 2018) for each of the 12 selected AR apps, users' pre-expectations, online reviews, reflections (Google Maps, 3 apps in-depth reflections). This process will also include an account of the researcher's experience of using AR apps through a mixture of personal experience and participants' empirical evidence. Through this process, several affordances and users' goals were identified; for example, the researcher went through the apps' online reviews and the users' reflections in order to capture their goals. Section 5.1 illustrates these goals and affordances, then section 5.2 presents the identified affordances through the lens of SPT to identify the link between SPT and the affordance theory.

5.1 Identification of Affordances

The researcher followed the technical walkthroughs process (Light et al., 2018). In this process, the researcher engaged with the app interface, put themselves in the position of users and applied analytical skills to the acquisition process, registering and accessing features and functionalities while generating detailed field notes and recordings. For example, screenshots were taken while conducting the walkthrough in order to illustrate how users would perceive these as affordances. To address the walkthrough limitations, the researcher also went through the users' reflections and online reviews to gain a sense of user engagement, and to identify the affordances they perceived and the goals they expected to achieve from using the AR apps. Sub-sections 5.1.1-5.1.12 summarise the process and reflections for the 12 apps selected.

5.1.1 Gucci app walkthrough

Gucci is a shopping app that offers an AR experience for its users. Firstly, the researcher downloaded the app from the App Store; it is available for both iOS and Android users free of charge. Then, to access the app-exclusive features, the researcher had two options: 1) to create a new profile; or 2) to sign up with Gucci.com login details.

After creating the user account, the researcher experienced the app by first selecting a product, then selecting the "try-on" feature. This is done by aiming a smartphone camera at the correct part of the body (e.g., wrist, foot); the virtual product then appears automatically, providing the user with a real-time shopping experience, as shown in the images in Figure 5.1.

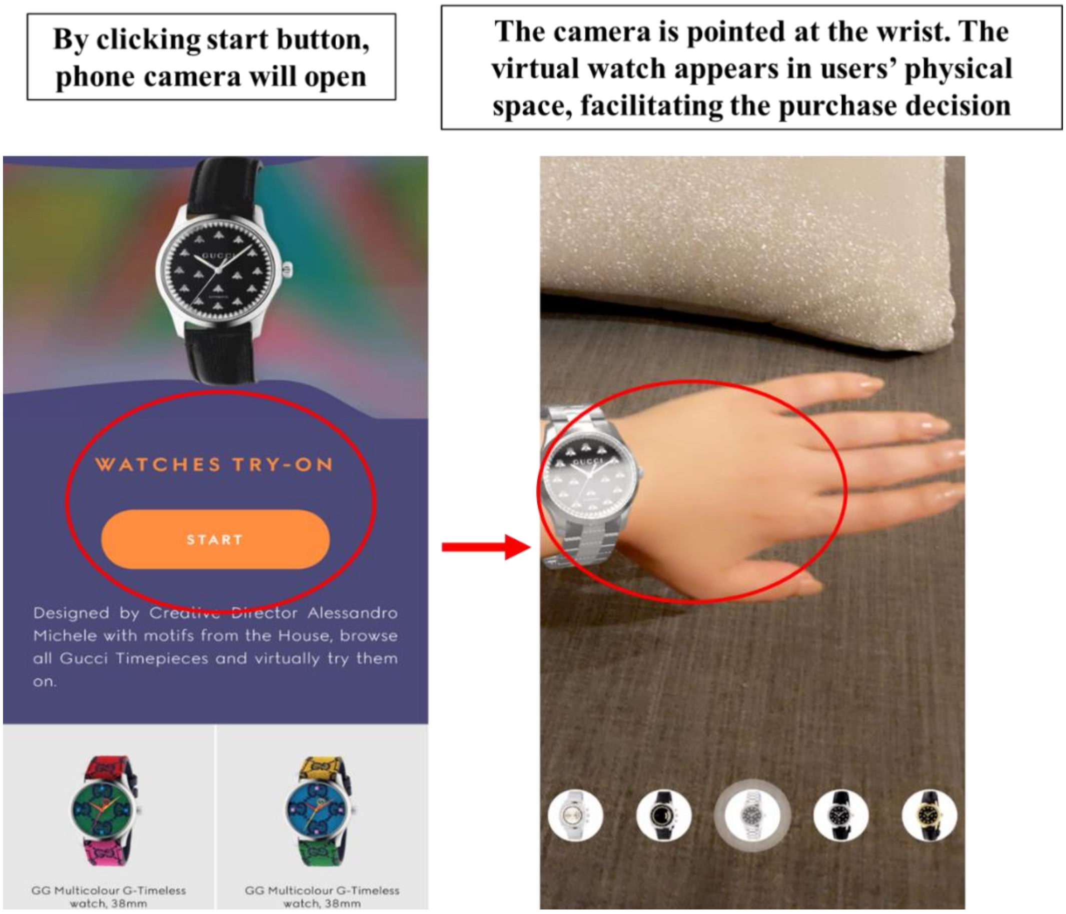

Figure 5.1: Presentation and interaction with virtual object affordance.

The Gucci AR app allows users to view their chosen product in their immediate surroundings, and they can then try and select the product or model that best suits their requirements, personality, and/or choice. It allows users to view and virtually "try on" products from the comfort of their own home, including watches, eyewear, trainers, masks, lipsticks and hats. For example, the researcher selected a watch from Gucci's watches selections (Figure 5.1). When she pointed the camera at her wrist, the watch appeared (*representation of virtual object affordance),* so she could see how the watch would look, as if she had been in the store. The app also allows the user to visualise these virtual watches in their own physical space and to try on different kinds of watches and see how they will look on the wrist (*Interaction with a virtual existent object affordance)*.

The Gucci AR app was one of three apps that the researcher selected for in-depth reflection. Gucci's pre-expectations reveal that the users' goal is to have a real-time experience:

> *"I haven't used AR-type technology apps before. I would expect them to help me visualise a design, go to places I haven't been to, visualise plastic surgery results, stuff like that."* (**User's goal: real-time experience**)

The Gucci app reflections reveal its affordances. For example, several users reflected that the app met their expectations of providing a satisfactory real-time experience:

> "*It met my expectations so far. I like the feature of trying the products on* **(Interaction with a virtual object existent affordance),** *especially the glasses. I never expected that I could buy glasses online* **(user's goal: real-time experience),** *but with AR tech, this option is possible now!."* **(Representation of virtual existent object affordance)**

> *"Looking at products virtually like you are in person is an amazing characteristic. it saves time and effort. Very brilliant step.it."* **(Representation of virtual existent object affordance)**

Moreover, this AR app allows users to interact enjoyably in real time with products in a physical space *(Interaction with a virtual existent object affordance)* via the combination of audio, video, and computer-generated images. For example, one user described their experience as *"fun and quick service",* and another said, "*I expect it to be a fun way of exploring"*.

Furthermore, one of the Gucci AR app affordances that was identified through the users' reflections is *personalisation*. For example:

> *"As we know that Gucci is well known and a high-end brand in the market, so they offer amazing features [via their AR app] to allow consumers to experience products suite to their own personality before buying anything."* **(Personalisation affordance)**

The users' reflections also confirmed that the app informed decisions over purchases for others who lived in different countries (social connectivity affordance). For example:

> *"My family in Saudi Arabia always asked me to buy some shoes and glasses from the shops in the UK* **(Social connectivity affordance).** *So, this app might help*

*them to see if these items are suitable for them or not by trying them on their own. This will be useful for me to see their decisions before I buy these items from them". **(Informed decision-making affordance)***

5.1.2 London Travel Guide app walkthrough

The London Travel Guide app is one of 10 travel guide AR apps that the researcher selected for this study. All of these apps share the same concept, i.e., giving users ideas and information about the city, such as pictures and the most famous destinations. However, for users to be able to experience the AR, they must be physically present in the city that the app was initially created for.

The researcher went through the walkthrough steps to experience this travel guide app. The app is free to download from the App Store, but it is only available for iOS users. The app gives the option of continuing with a Facebook account or Google as a compulsory step in order to access the app features.

The researcher experienced the app and identified that the London Travel Guide app helps tourists to identify landmarks. It works with GPS to show all the famous and historical places nearby and gives their exact distance and location, operating as a virtual guide for tourists (*virtual guide affordance)*. For example, the researcher used this app while visiting London and took the screenshots shown in Figure 5.2, illustrating two tourist destinations in London: Kensington Gardens and Regent's Park.

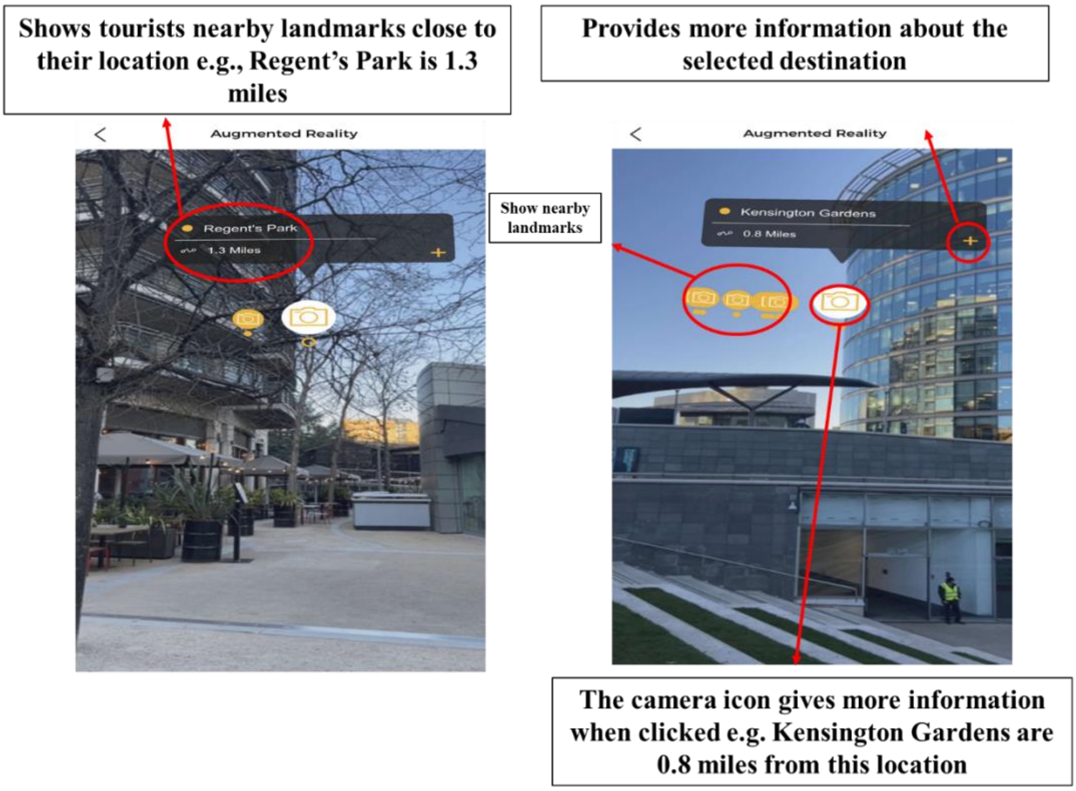

Figure 5.2: Virtual guide affordance (Famous Destinations and Distances)

The app also provides more information about the selected destinations, such as pictures and history, which acts as a virtual guide, as shown in Figure 5.3.

Figure 5.3: Virtual guide affordance (Pictures and History, source: London Travel Guide app)

A user's goal when using this app is to have a real-time experience and to see the history of certain places, as this reviewer states:

> *"There are things you might think you know, but there's a lot more that you don't know, and this app catches my eye, and my curiosity gets the better of me and makes me want to explore these areas and see the history"* **(users' goal: real-time experience)**

Moreover, the researcher also went through the app's online reviews and the reviews of ten other cities that offer the same concept. The apps' users confirmed virtual guide affordance, for example:

> *"This London travel guide app is absolutely magnificent. Not only does it give you all the street names in London, but it also gives you fantastic images. This app is a must for everyone that will be going to London. All the hot spots are right at your fingertips. Great job on this app!!!"* **(Virtual guide affordance)**

> *"The New York City Travel Guide Application is a well-designed informative resource for those who want to not know only about the attractions the famed area offers but also the history of it as well. The app allows users to navigate quickly to any section by way of the pop upside menu. The app even provides a gimmick feature such as an AR Tool which will making searching for nearby points of interest more fun".* **(Virtual guide affordance)**

> *"The Dubai travel guide and offline map are great. I've always wanted to go to Dubai and looking through all the great landmarks makes me want to go even more. Am already using this app to plan my trip".* (**Virtual guide affordance**)

In addition, other affordances were identified through the Dubai Travel Guide app online review, such as the personalisation affordance:

> *"This is the best app to travel with. It has a full Dubai travel guide and offline map. It is really helpful if you are in a poor service area. It has a great feature to show you travel locations for how many days you will be visiting".* **(Personalisation affordance)**

The *social connectivity* affordance was also identified, as this app can help users to socialise, share the plan of their journey with others, and even make their experience memorable, as described in this online review:

> *"Once we have to select products for all classmates as we are going to trip so this app really makes easy to share with everyone and select the best products that made our trip memorable"* **(Social connectivity affordance)**

5.1.3 Portal to Paradise app walkthrough

This tourism app is free to download and use for iOS users, and there is no need to create an account**.** Through the walkthrough process, the researcher identified that this AR app allows users to discover Caribbean and Mexican Resorts and live the full experience. The idea of this app is to display the company Marriott's exclusive locations and amenities as they are in real life by using AR technology. For example, users can open the portal right in their living room, step in and check out the views from Marriott hotel rooms, swimming pools and beaches *(representation of virtual existent environment affordance*), providing the users with a *virtual guide* at those resorts (affordance). Figure 5.4 shows the process of using the app affordances.

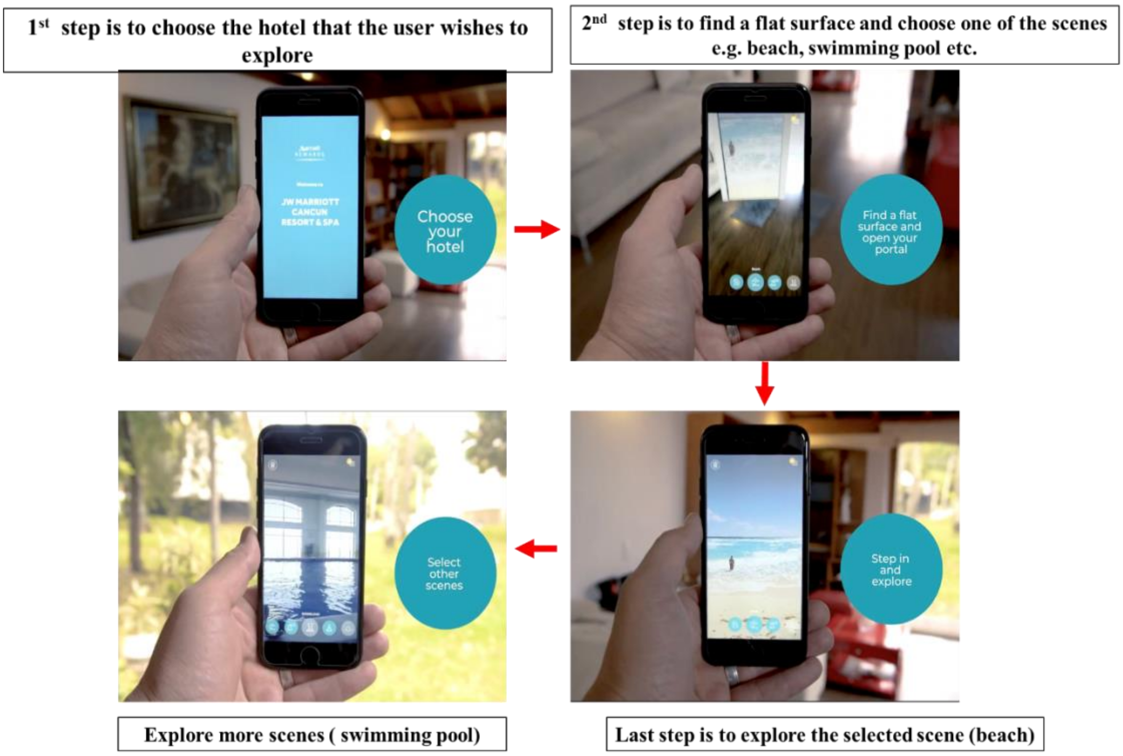

Figure 5.4: Steps to use the virtual guide's affordances (Portal to Paradise app)

The researcher selected this app for an in-depth reflection study, and the users' goal to have a real-time experience has been identified from the users' expectations.

> *"I would expect to get a fully immersed 3D experience as though I was there"* **(users' goal: real-time experience)**

> *"I'm expecting from these Apps to get a real image of something that does not exist in the place where I am"* **(users' goal: real-time experience)**

> *"I have not used an AR app. However, I believe the AR app would allow smartphones to have different elements such 3D settings to zoom images"* **(users' goal: real-time experience)**

The *representation of virtual existent environment affordance* of this app helps users to achieve their goal of having a real-time experience. For example:

> *"It looks like you are on the beach or within the room* (user goal: real-time experience) *I like the aesthetics that makes me feel like I want to travel because of the pictures and feel"* **(Representation of virtual existent environment affordance)**

Moreover, the reflections also reveal the *virtual guide* affordance of this app. For example, this user mentioned the virtual tour when they were asked what they liked about the app:

> *"Virtual tours, immersive experiences, 360 display"* **(virtual guide affordance)**

Furthermore, another affordance identified in the users' reflections is the personalisation affordance, as explained by this user:

> *"The images advertised on the Portal to paradise holiday app promote different hotels at various destinations. This is simply amazing as holiday lovers are able to choose their preferences towards visiting very wisely. It's beneficial that anyone interested in holidays are able to view and book through this app effectively. I am satisfied with the different options this app provides when selecting a specific room within a hotel"* **(personalisation affordance)**

5.1.4 IKEA Place app walkthrough

IKEA Place is a homeware app. The researcher explored the app and found that it is free to download and use for Android and iOS users. After the welcome message, the app asks the users to read and agree to their terms and conditions; this is a compulsory step before starting to use the app and allowing it to access the phone camera. Moreover, the app can be used without creating a profile.

Via the IKEA Place AR app, users can browse IKEA products in order to select the furniture or homeware they wish to view; once chosen, users simply scan the location where they wish to put the item via their smartphone camera. Then, users simply place the selected product(s) into the physical space.

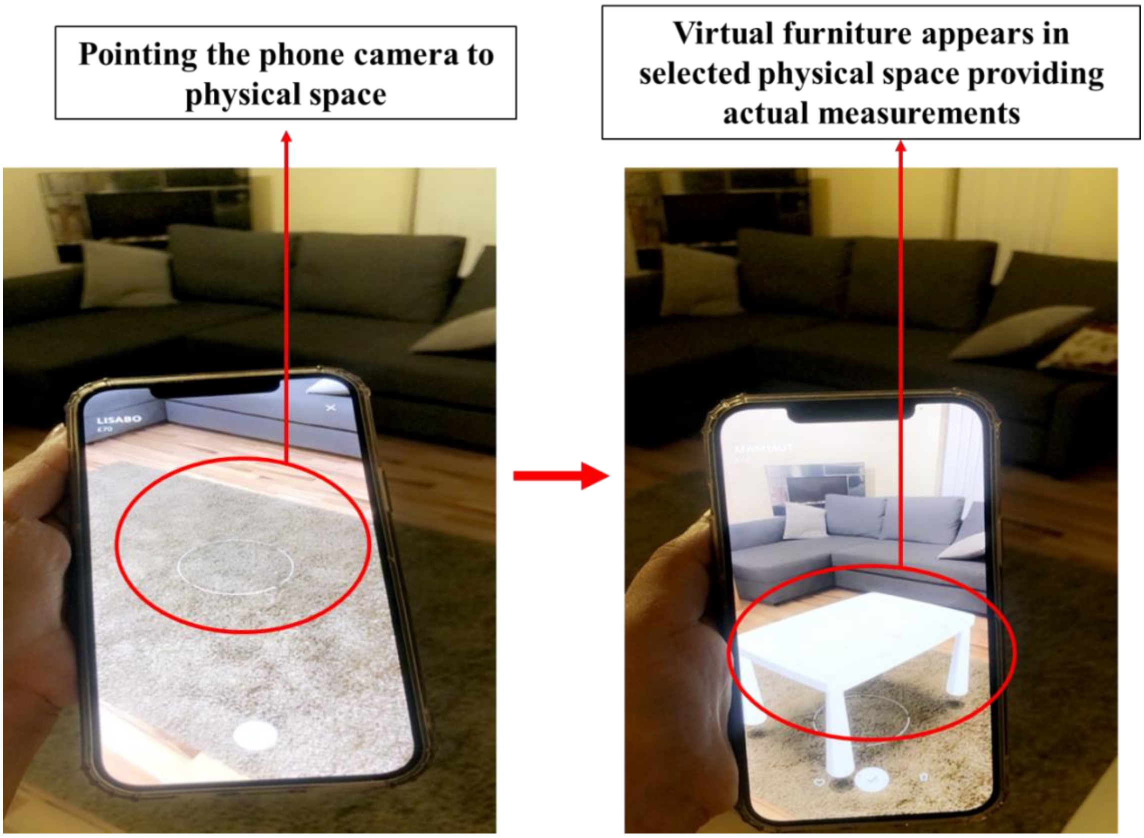

Figure 5.5: Representation and interactions with IKEA virtual product affordances

The IKEA Place app lets the user virtually place true-to-scale 3D models in their very own space (*Interaction with a virtual existent object affordance*). This provides the users with a *convenient home experience* (users' goal) by *informing decision* making (affordance). For example, as shown in Figure 5.5, the IKEA Place AR app allows users to view the company's range of furniture and homeware products in various colours and arrangements *(representation of virtual existent object affordance)* at home and in situ, which is very effective in driving *purchasing decisions* (affordance) without users ever leaving their homes (users' goal).

The researcher selected the IKEA Place app for in-depth reflections; the results show that participants rated the app highly for its effectiveness in facilitating visualisation of a range of over 2,000 IKEA products. This saves users time, *reduces unnecessary product returns*, provides *a real-world experience* (users' goal), and facilitates *purchase decisions* (affordance). For example, one user reflected on their experience of using the IKEA AR app:

> *"To support decision-making during the pre-purchase stage* **(informed decision-making affordance)** *and to save the time of returns when buying IKEA products* **(users' goal: convenient experience),** *I will recommend it to my friends."*

> *"I would expect a real-world example of what I am looking at"* **(users' goal: real-time experience)**

The representation of IKEA virtual products virtually in the users' space facilitates the selection of suitable products based on users' aesthetics. It allows the user to assess the suitability of various furniture items in their home environment *(informed decision-making affordance).* Therefore, the affordances provided by the IKEA AR app aid users in evaluating a product before making a purchase decision, which in turn reduces user uncertainty about the range of product options available. It thus makes the process of selecting and purchasing products much easier and straightforward (users' goal: convenient experience), even compared to shopping in a physical store, as the latter does not easily allow the user to visualise the suitability of the item in situ. The app's online reviews reveal these affordances, for example:

> *"The app served me well in making purchase decisions* (**informed decision-making affordance**). *I wanted to order a lamp and not sure if it would look like next to my bed. The app function allowed me to turn my expectation to a more-real visual* **(representation of virtual existent object affordance)."**

5.1.5 Dulux Visualiser app walkthrough

This home decoration AR app is free to download and use for Android and iOS users; it does not require the creation of an account. It also provides a video guide for using the app's features, as shown in Figure 5.6.

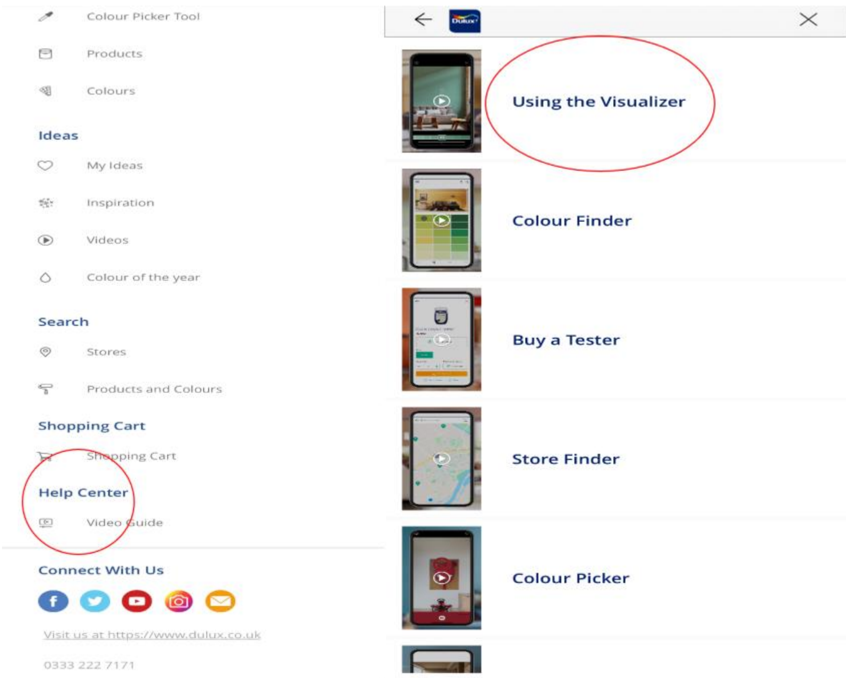

Figure 5.6: Video guide to using the app visualiser

This app allows users to view a vast selection of Dulux paint colours *(representation of virtual existent object affordance)*. Once the user chooses the colour, they simply point their phone camera at the desired wall and then the selected colour will instantly appear on their walls *(Interaction with a virtual existent object affordance)*, as shown in Figure 5.7.

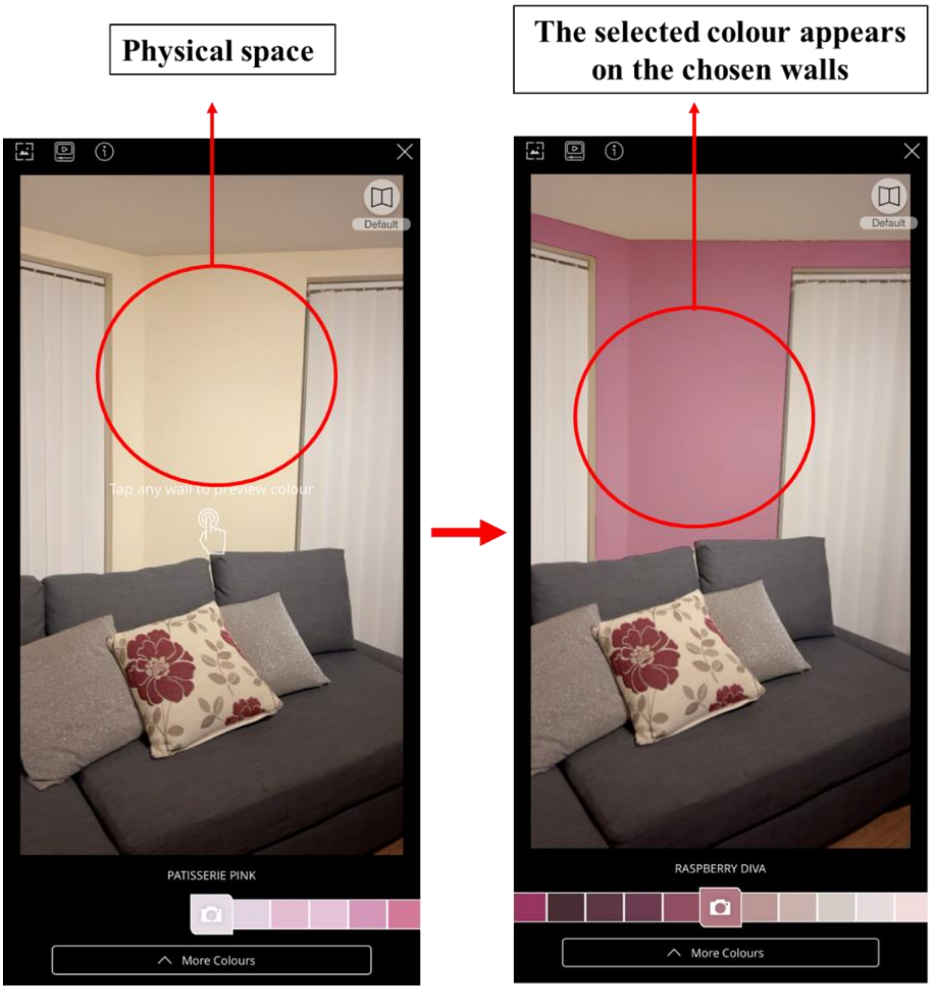

Figure 5.7: Representation and interaction with virtual colour affordance

Moreover, Figure 5.8 shows how the app allows users to match a colour from their existing furniture, create their own ideas, upload pictures from their phone and use a masking tape feature, where they can see a combination of two colours on their walls (*personalisation affordance*).

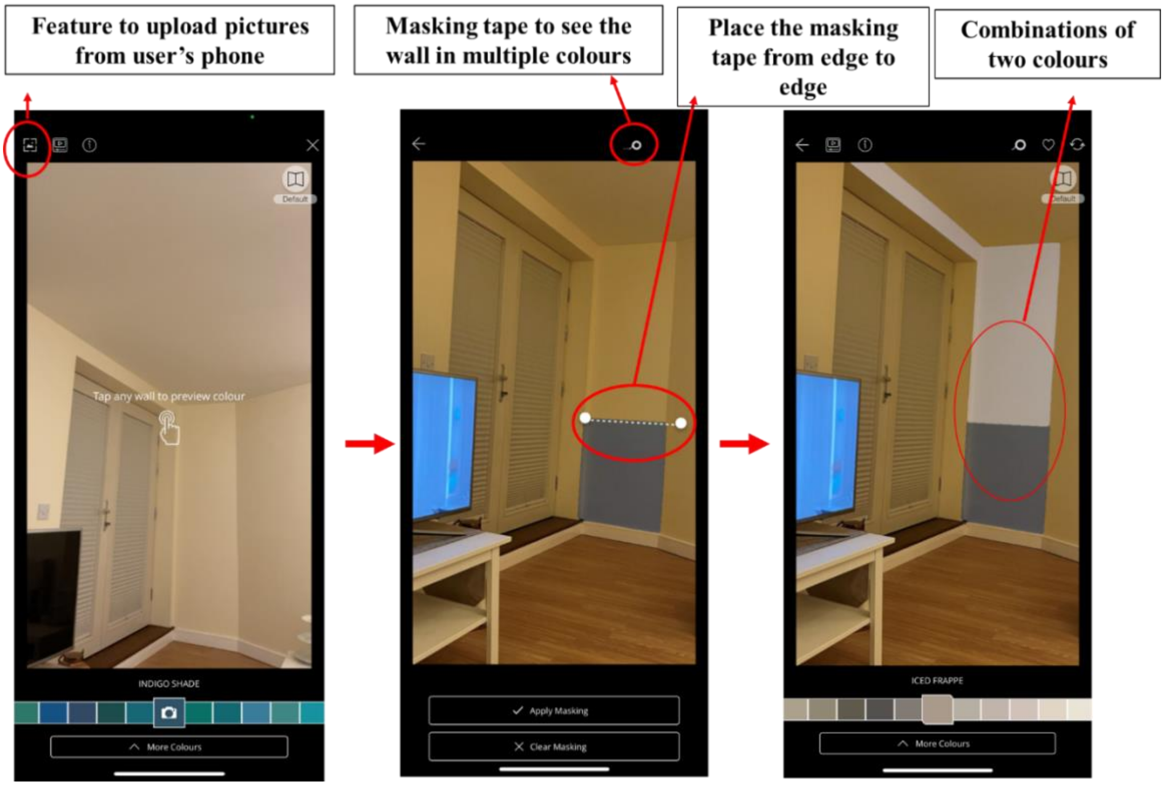

Figure 5.8: Personalisation affordance

The researcher also went through the online reviews of this app and identified that it allows users to make an informed purchase decision (informed decision-making affordance):

> *"Perfect if you're not sure what colour you want to paint your room, choose your colour, tap the wall in your photo & away you go, the colour is instantly changed!"* **(Informed decision-making affordance)**

The reason why one use utilised the *representation of virtual colours affordance* of this app is identified in this online review:

> *"Very easy to use, just select a colour hold up to the wall and tap the screen. Bright vivid colours that give a good example of what it'll be like* **(representation of virtual existent objects affordance).** *Use in well-lit rooms for best results...saved a lot of time and money"* **(users' goal: convenient experience).**

The developers of this app state that it allows the user to share personalised designs and room ideas with friends and family and to obtain instant colour feedback (social connectivity affordance). However, the researcher could not find how to use this feature. Moreover, this feature is not mentioned in the app's online review – see section 5.2 for further discussion about this point.

5.1.6 Google Map app walkthrough

Google Maps is a free app for Android and iOS users to download and use. The researcher identified the *informed navigation* affordance by experiencing the Google Maps AR app and going through 4 users' reflections. To use this affordance, users first need to search for a destination and then make sure that they have selected walking (it is not available for driving). They then need to select the live view function, hold the phone up, and point the camera at the place around them. They look for the giant arrow *(representation of virtual existent object affordance)* and then walk in the direction indicated by it (*informed navigation affordance*). This helps users to obtain accurate directions, as shown in Figure 5.9.

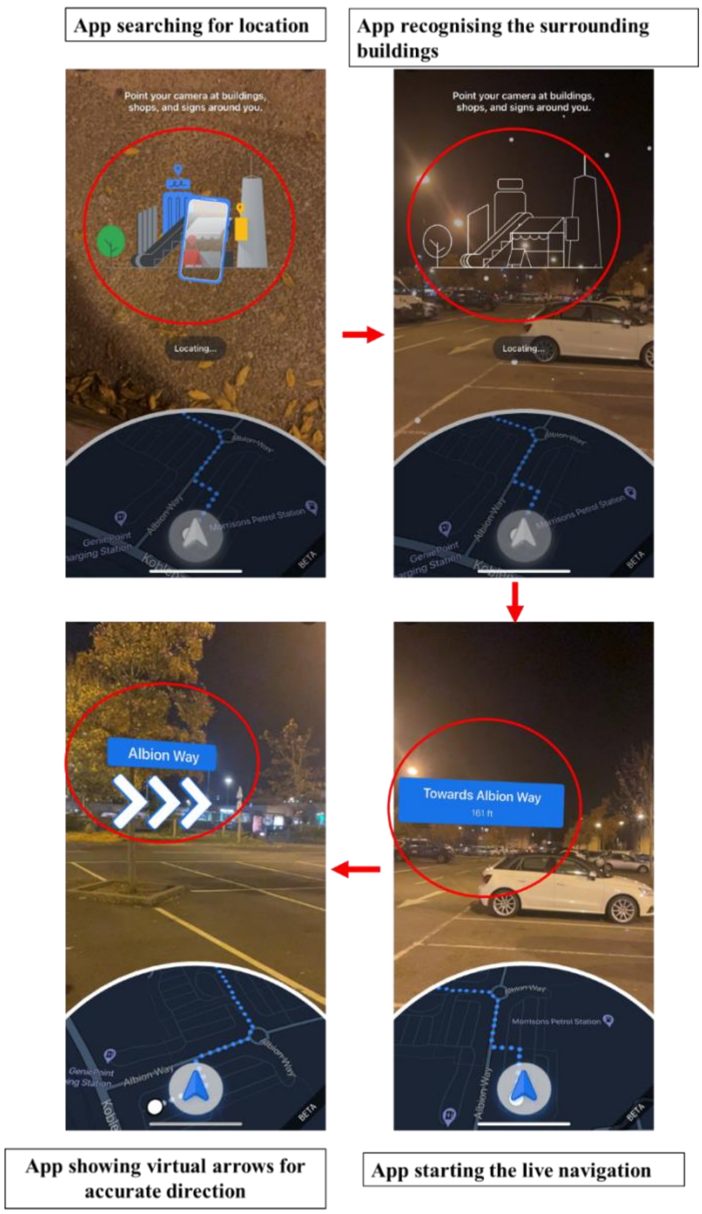

Figure 5.9: Steps to use AR navigation affordance

The *informed navigation* affordance helps users to find their accurate location and avoid getting lost (users' goal), as one user reflected when talking about their experience of using the Google Maps AR feature:

> *"Perhaps I would, especially if you get lost and do not know which direction to head, AR can help you to solve the issue by orienting your phone to the buildings* **(user's goal: obtain accurate location)** *which then can accurately show you the way* **(informed navigation affordance)".**

5.1.7 CopyArt app walkthrough

This AR app is a painting tool for learning to draw; however, it is not free to download as users must buy it from the App Store or Google Play. After purchase, the app provides a free tutorial; then, the user is asked whether they are right-handed or left-handed. The app also gives the users the option to either create an account or continue with different platforms, such as Facebook and Snapchat.

The app provides instructions for the users to start drawing with AR (Figure 5.10), such as finding a paper and pencil and something to rest the paper on. Through the camera of the user's device, the user can see an AR sketch on the surface in front of them *(representation of virtual object existent affordance).* Then they can take a pencil and follow the virtual lines on the paper step by step *(Interaction with a virtual existent object affordance).*

By experiencing this app, the researcher identified that it supports the users to draw by using AR, allowing them to become artists! (*Support learning affordance).* This app is a combination of art, technology, education, and *enjoyment* (users' goal).

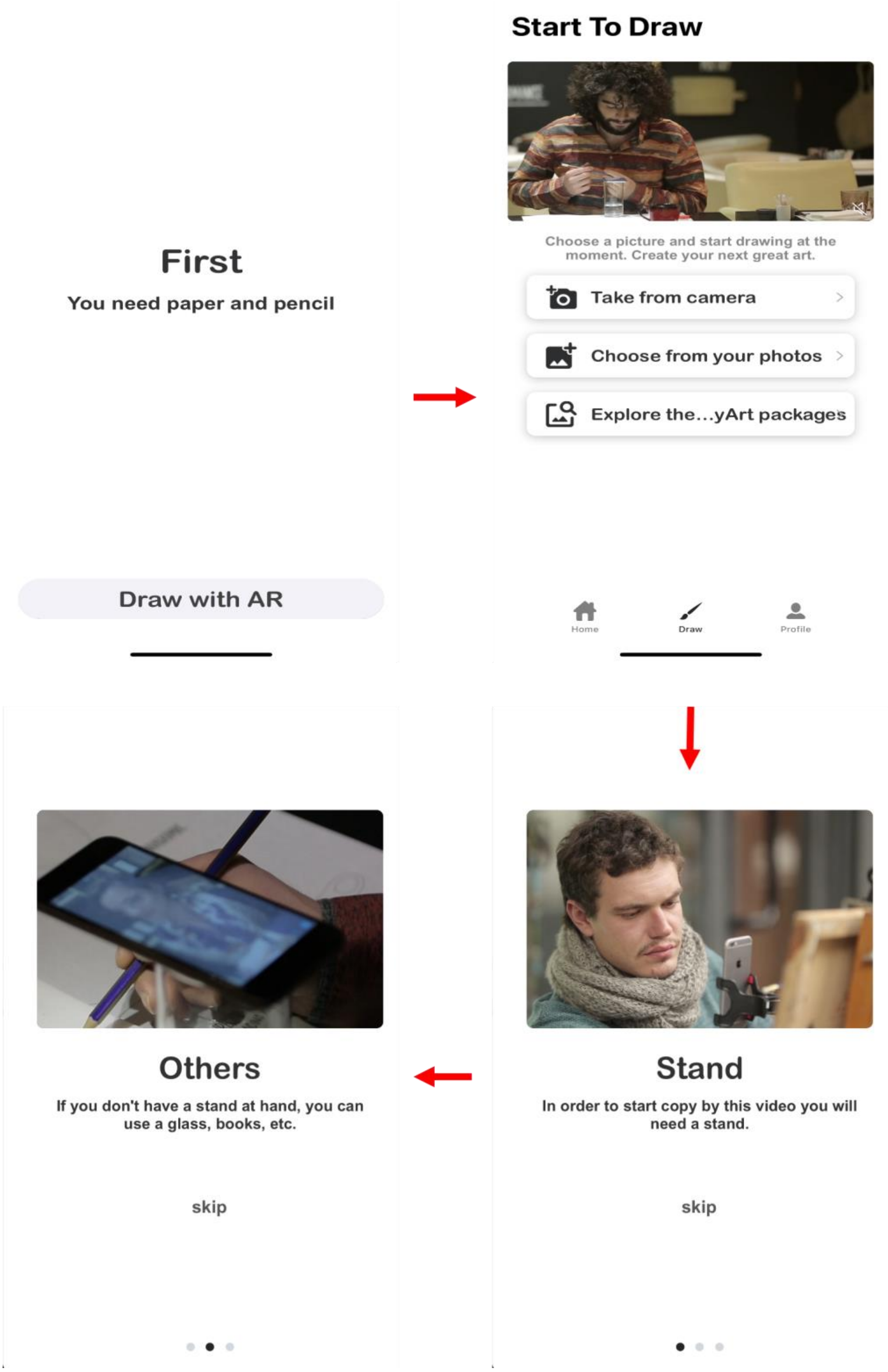

Figure 5.10: Instructions for using the app affordances

Moreover, the app gives the user the option to take a picture they wish to draw from their own camera, choose from their photos, or choose an image from the app itself *(personalisation affordance)*. For example, the researcher decided to draw a face from the pictures available in the app itself. Figure 5.11 shows the app's affordances.

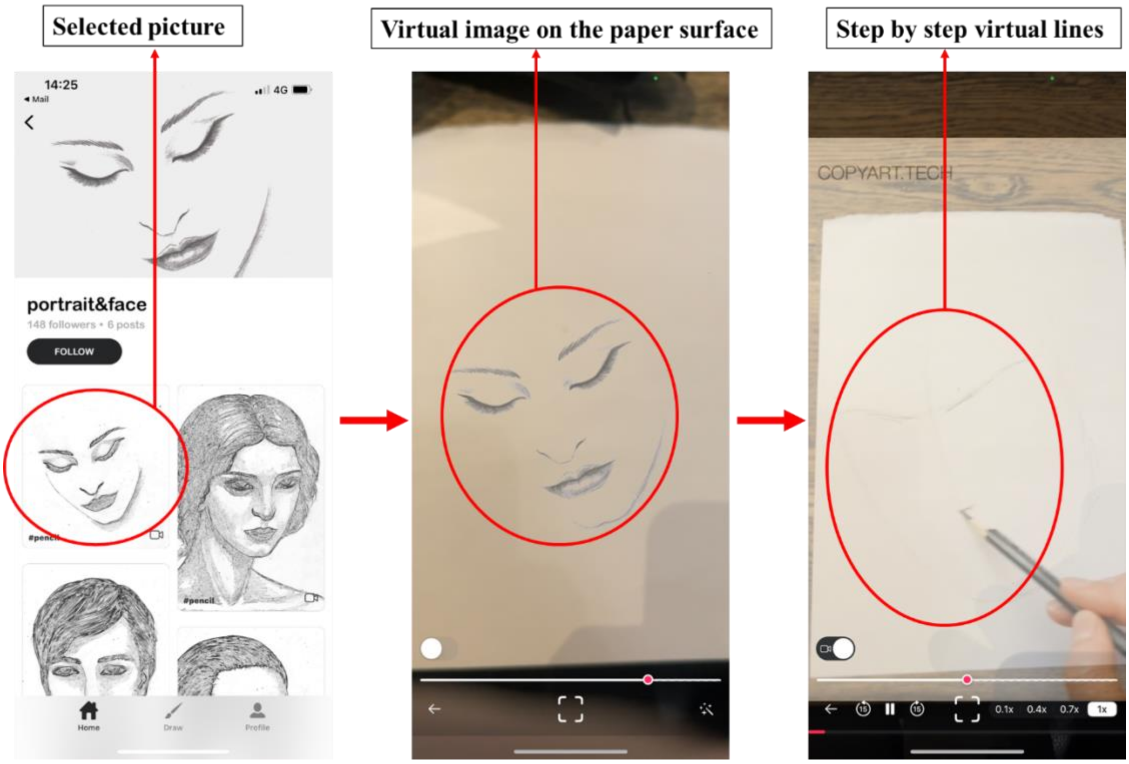

Figure 5.11: Personalisation affordance

Moreover, the app's online reviews reveal the *personalisation affordance*, as described by this reviewer:

> *"It is the best app I draw a picture just a few second ago and I was eager to write this review, u can also take your own picture and draw".* **(Personalisation affordance)**

This app is also a platform for sharing as it allows users to share their achievements with others; a video of each of their sessions is automatically saved on the device *(social connectivity affordance).*

5.1.8 Dance Reality app walkthrough

The registration and entry step of this app is straightforward. For example, the app is available in the App Store and Google Play, it is free to download and offers in-app purchases. This app allows users to learn to dance in AR and to select the kind of dance they wish to learn. For example, the researcher chose Basic Salsa. The app gives an overview of the specific dance and offers free classes for the first week. Then, if the user is happy with the lessons and wishes to continue, they need to buy the remaining lessons.

This app gives precise instructions to its users. After choosing the kind of dance they wish to learn, the user must find a place to dance and point their camera at their own space to find their feet and place the instructor. Then, virtual instructors will appear directly in their environment, where the user can see and listen to the instructions (*Interaction with a virtual object existent affordance*). The app will also place footprints on the floor in front of the users, so that they can look through their phone to step on the footprints *(representation of virtual existent object affordance)*. Finally, they can follow the animation to practise common dance patterns *(support learning affordance)* in an enjoyable way. Figure 5.12 shows the apps' affordances. This AR app brings the dance class to users' homes and *supports learning to dance*, so they can enjoy *learning to dance anywhere and at any time* (users' goal: enjoyment).

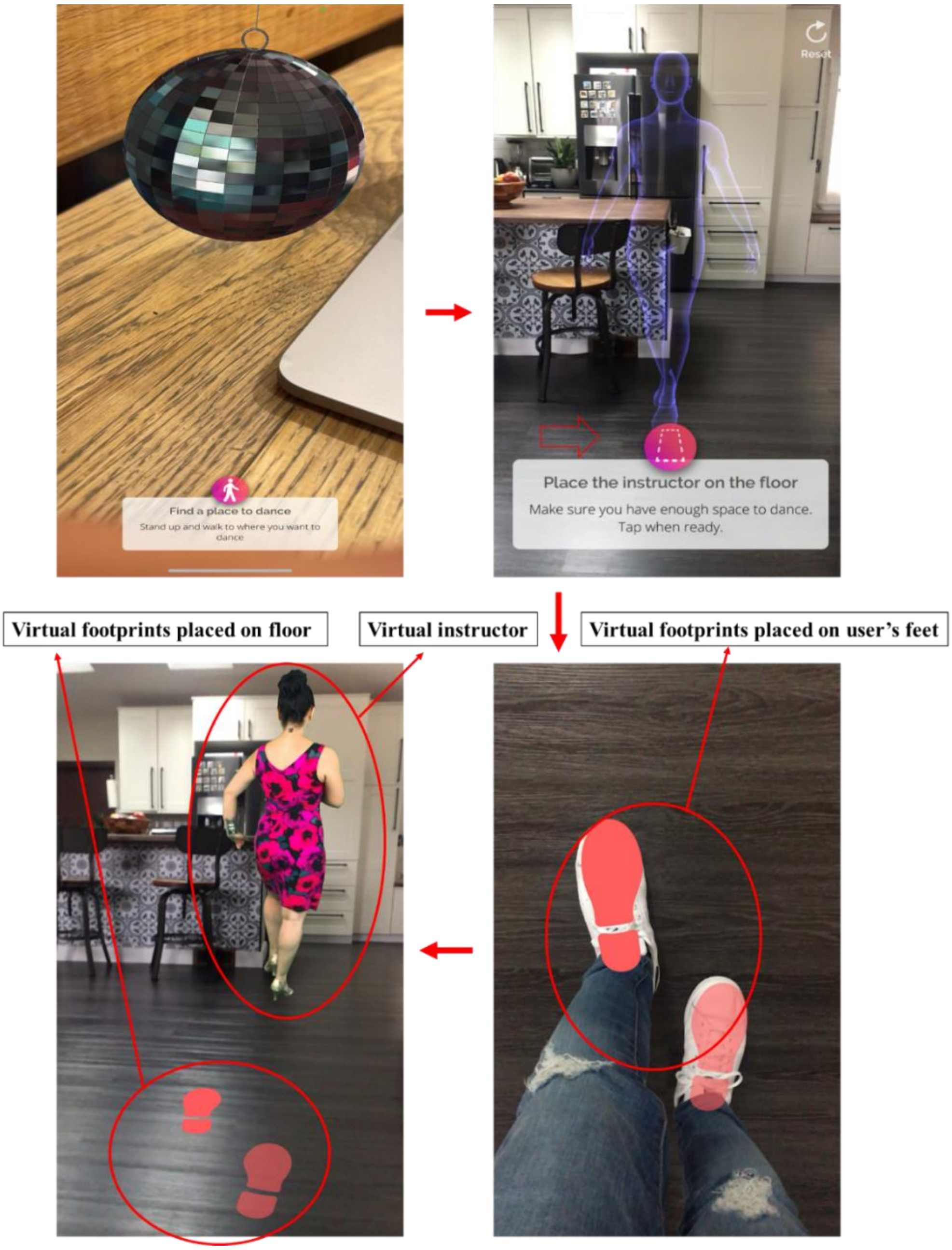

Figure 5.12: Steps to use Dance Reality app affordances

5.1.9 Google app walkthrough

The Google app is free to download and use for Android and iOS users, and it does not require the users to create an account. It allows users to search with their camera and identify plants and animals. This AR app affords a *depiction of the non-existent* (Steffen et al., 2019). For example, it enables users to view animals that do not exist in the physical world. To experience the app affordance, a user can use the search engine to search for the desired object, e.g., dinosaurs. Then, the app will give an option for the user to view the selected object *(representation of virtual non-existent object affordance)* in their space where they can interact with it. For example, they can see an animal moving and hear its voice *(Interaction with a virtual non-existent object affordance)* and then they need to point their phone to an empty place. The object that does not exist in the real world will appear directly in front of them *(representation of virtual non-existent object affordance*). Figure 5.13 shows the Google app's AR affordances.

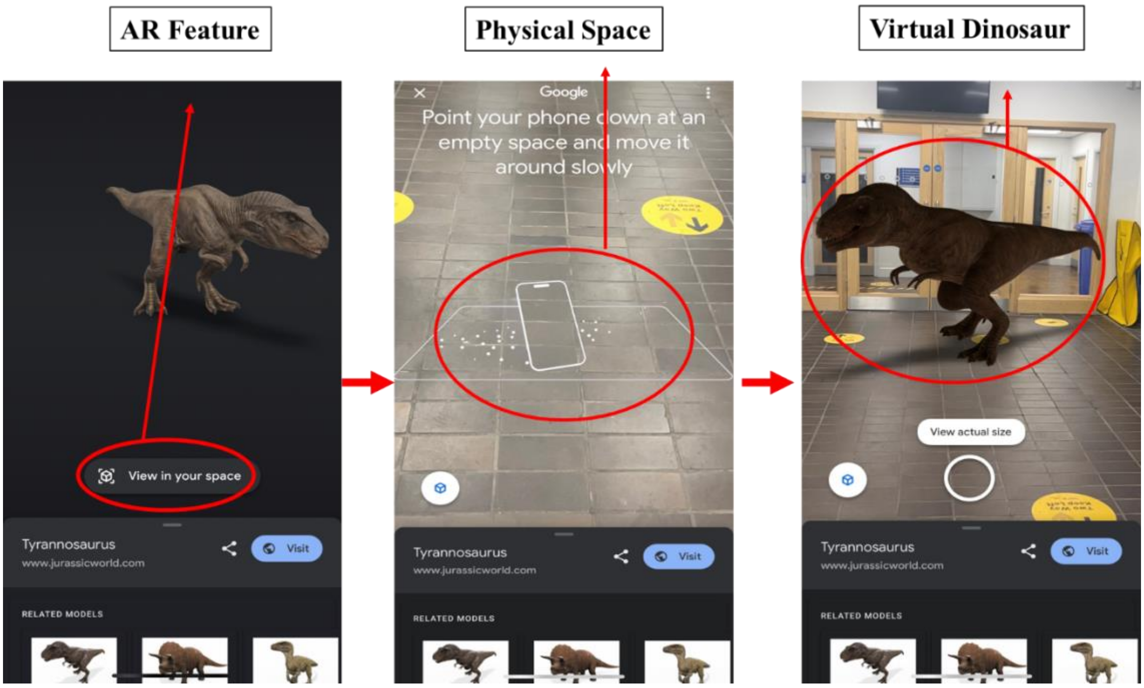

Figure 5.13: Representation and interaction with non-existent virtual objects affordance

5.1.10 Relax & Meditation app Walkthrough

This health and fitness app is free to download and use for iOS users only, and there is no need to create an account**.** This AR app affords six kinds of meditations, including the sound of the rain, the melody of the ocean waves, the secrecy of space, the beauty of the morning, the calmness of the night, and the mosque's prayer.

This app is straightforward as the user can simply choose the kind of meditation they desire, then point their camera to an empty place, and the scenario will appear *(representation of virtual existent environment affordance)* in their own space. They can feel the environment of their selected scenario with supported sounds in their own space *(Interaction with a virtual existent environment affordance)*, as shown in Figure 5.14.

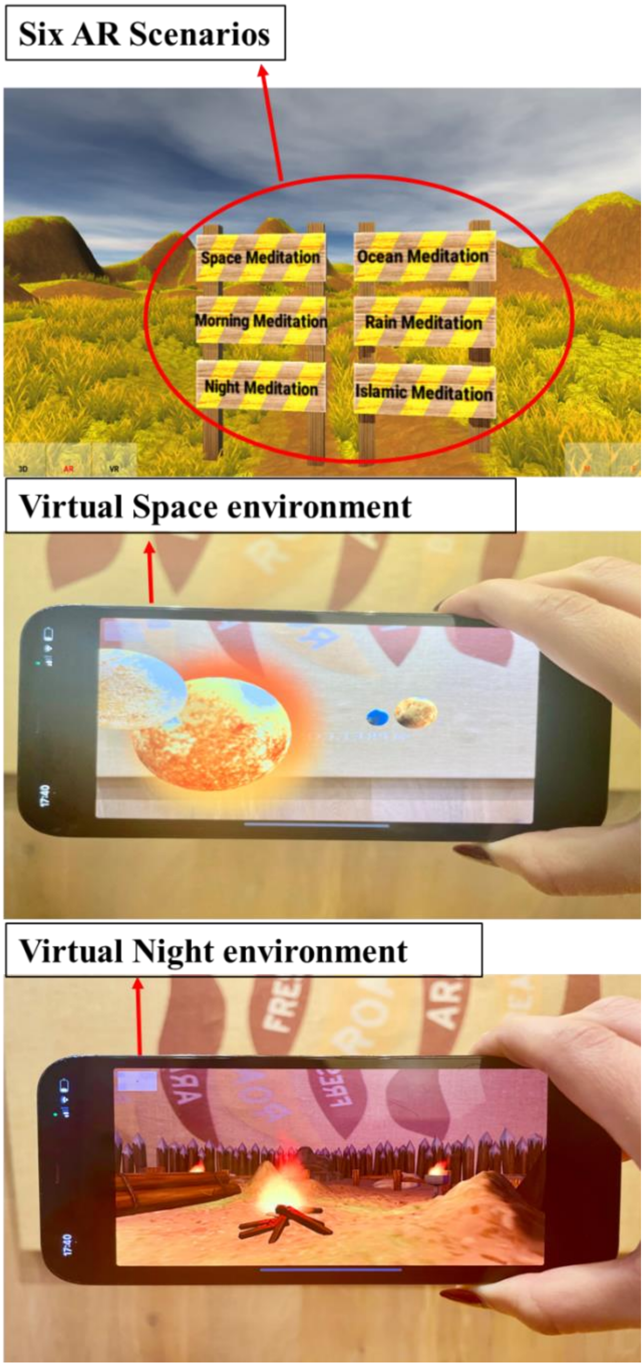

Figure 5.14: Representation and interaction with virtual existent environment affordances

Moreover, the online app reviews also reveal the representation and interaction with virtual existent environment affordances. For example:

> *"Although it is a very basic app, I have thoroughly enjoyed using it for a few minutes. I explored the six scenarios, Cool application with 3D/AR/VR. Also like the Islamic Meditation"* **(representation and interaction with virtual existent environment affordances)**

> *"I like the selection of meditation, AR is amazing! Night meditation assists me in a peaceful sleep and general meditation, highly recommended."* **(representation and interaction with virtual existent environment affordances)**

5.1.11 Skin & Bones app walkthrough

This education app is free to download and use for iOS users only. This app was initially created for use in the Smithsonian's Natural History Museum in Washington; however, the new version of this app allows users to create the same 3-D experience at home or in the classroom.

If the user of the app is not in the museum, all they need to do is to print out some papers that the app provides. They then point their phone camera to the printed papers to frame them (*representation of virtual non-existent object affordance).*

This app brings to life skeletons at the Smithsonian's Natural History Museum in Washington *(representation of virtual non-existent object affordance*). Users can use the app to peer into animals' inner lives, for example, bats and cows. The app also allows users to meet the scientists who study these animals, so it also serves as an education app *(support learning affordance).* Figure 5.15 demonstrates the process of using the app at home.

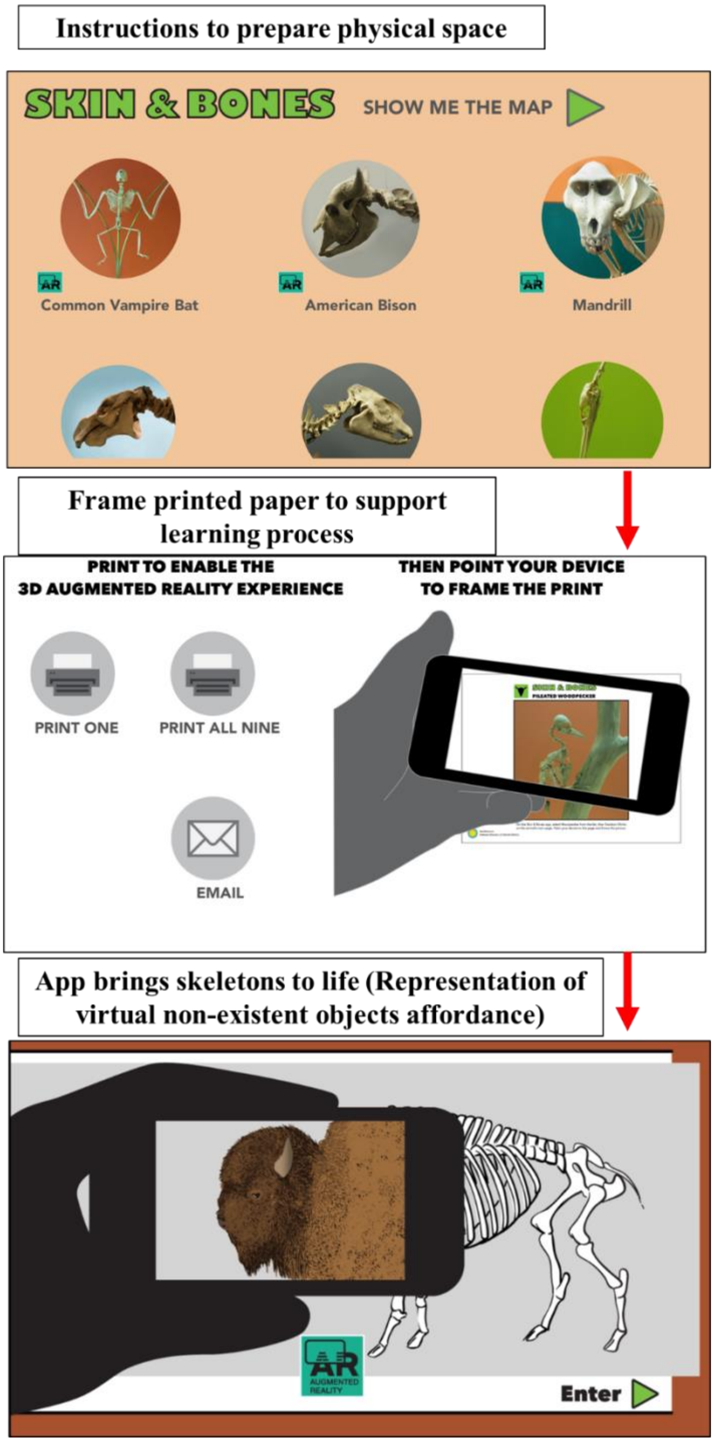

Figure 5.15: Steps for the use of the app's support learning affordance

5.1.12 Pocket Universe Express app walkthrough

This education app is free to download for iOS users only and offers in-app purchases for the experience of the AR affordance, as shown in Figure 16.

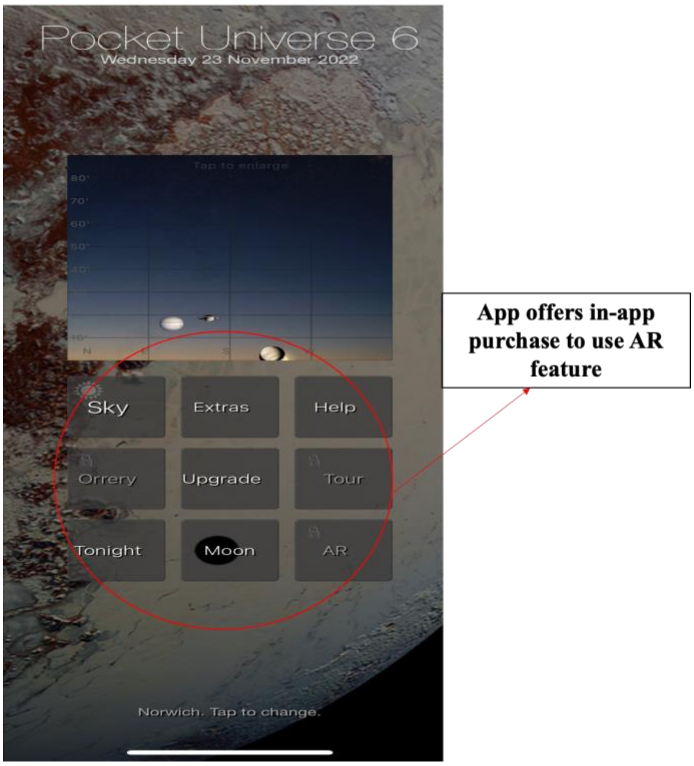

Figure 5.16: Steps to experience AR feature

This app allows users to visualise the sky in AR and see the planets and the solar system floating around them (*Interaction with a virtual existent object affordance*). The app helps users to learn the names of constellations, bright stars and plants by just holding up their mobile in front of them; the app will use the *built-in compass* to display the view of the sky that they see in the morning or evening, but one that is complete with names and information *(representation of virtual existent object affordance)*. It also allows users to search for the brightest satellites by name or from a provided list that helps them to learn about solar systems (*support learning affordance*). Figure 5.17 shows the app's affordances.

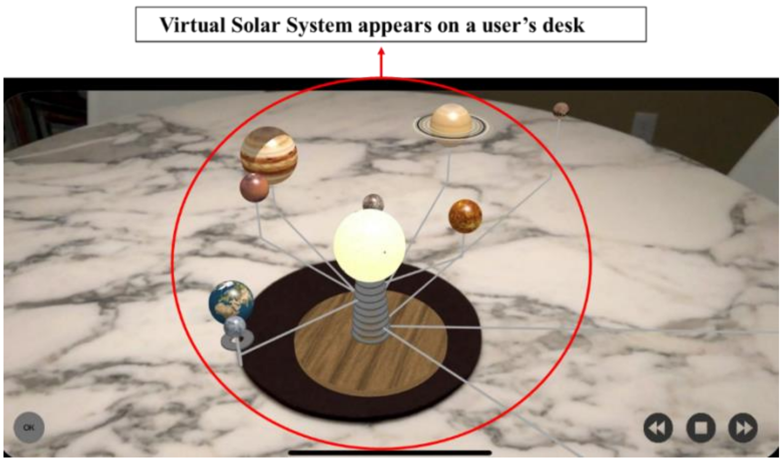

Figure 5.17: Pocket Universe Express app affordances (source: App Store)

The app's online reviews also reveal the *support learning, representation of virtual existent object affordance* and *interactions affordances* of this AR app, as described by these reviewers:

> *"A great app to get you interested in the night sky and to show how to the compass feature of the iPhone can bring learning to life, will recommend this to my friends in the hope they upgrade to the full app to get the benefit of a truly brilliant app*" **(support learning process affordance)**
>
> *"Been using this app for years, and it just keeps getting better. I really wouldn't mind if the dev charged for big updates. The AR feature is the best I've seen; the children blown away by the planet and solar system views. Well done all who have developed this"* **(representation of virtual existent object affordance)**
>
> *"I love that you gave humanity an interactive representation of our sky!"* **(*Interaction with a virtual existent object affordance*)**

5.1.13 Summary of identified affordances

In this section, the researcher provides further details about the ten identified affordances: (1) representation of virtual existent objects, (2) interaction with virtual existent objects, (3) representation of virtual non-existent objects, (4) interactions with non-existent objects, (5) informed navigation, (6) virtual guide, (7) personalisation, (8) informed decision making, (9) supporting the learning process and (10) social connectivity. Table 5.1 provides a definition of each affordance. Table 5.2 shows the ten affordances identified through a walkthrough of 12 AR apps, reflections on four apps, and online reviews of the apps. Figure 5.18 shows the link between these identified affordances and the five major user goals: (1) real-time experience, (2) convenient experience, (3) getting accurate/required information, (4) enjoyment and (5) social sharing.

Table 5.1: Definitions of each type of affordance

Affordances	Definitions
Representation of virtual existent object	Enables users to see virtual objects or a simulated environment that exists in the real world in the user's psychical world. For example, looking at a 3D VR environment such as ocean waves, in a user's physical space.
Interaction with a virtual existent object	Enables users to interact (visually and auditory) with objects or environments that exist in the physical world. For example, seeing a virtual crocodile moving around a physical space and hearing its voice.
Representation of virtual non-existent object	Enables users to see objects or environments that do not exist in the physical world. For example, "Physical environments do not afford riding dragons simply because dragons do not exist" (Steffen et al, 2019, p.699).
Interaction with a virtual non-existent object	Enables users to interact (visually and auditory) with objects or environments that do not exist in the physical world. For example, seeing virtual dragons moving around a physical space and hearing its voice.
Informed decision making	Enables users to obtain information that could be relevant to decision making.
Personalisation	Enables to fulfil individuals' requirements, for example, showing products based on a user's preferences.
Informed navigation	Enables users to obtain accurate required information and directions.
Virtual guide	Enables users to obtain location-specific information.
Social connectivity	Enables users to connect virtually and visually with others e.g., family and friends, for example by seeing each other while trying clothes on virtually.
Support for the learning process	Enables users to have a visual and virtual practical view of the everyday learning that can happen in a classroom or museum.

Table 5.2: The ten identified affordances

Apps	Representation of virtual existent object/ environment	Interaction with a virtual existent object/environment	Representation of virtual non-existent object	Interaction with a virtual non-existent object	Informed decision making	Personalisation	Informed Navigation	Virtual Guide	Social Connectivity	Support for Leaning
Gucci	X	X			X	X			X	
Travel Guide apps	X					X		X	X	
Portal To Paradise	X					X		X		
IKEA Place	X	X			X					
Dulux Visualizer	X	X			X	X			X	
Google Map	X						X			
Google	X	X	X	X						
Relax & Meditations	X	X								
CopyArt	X	X								X
Skin& Bones	X		X	X						X
Dance Reality	X	X								X
Pocket Universe Express	X	X								X

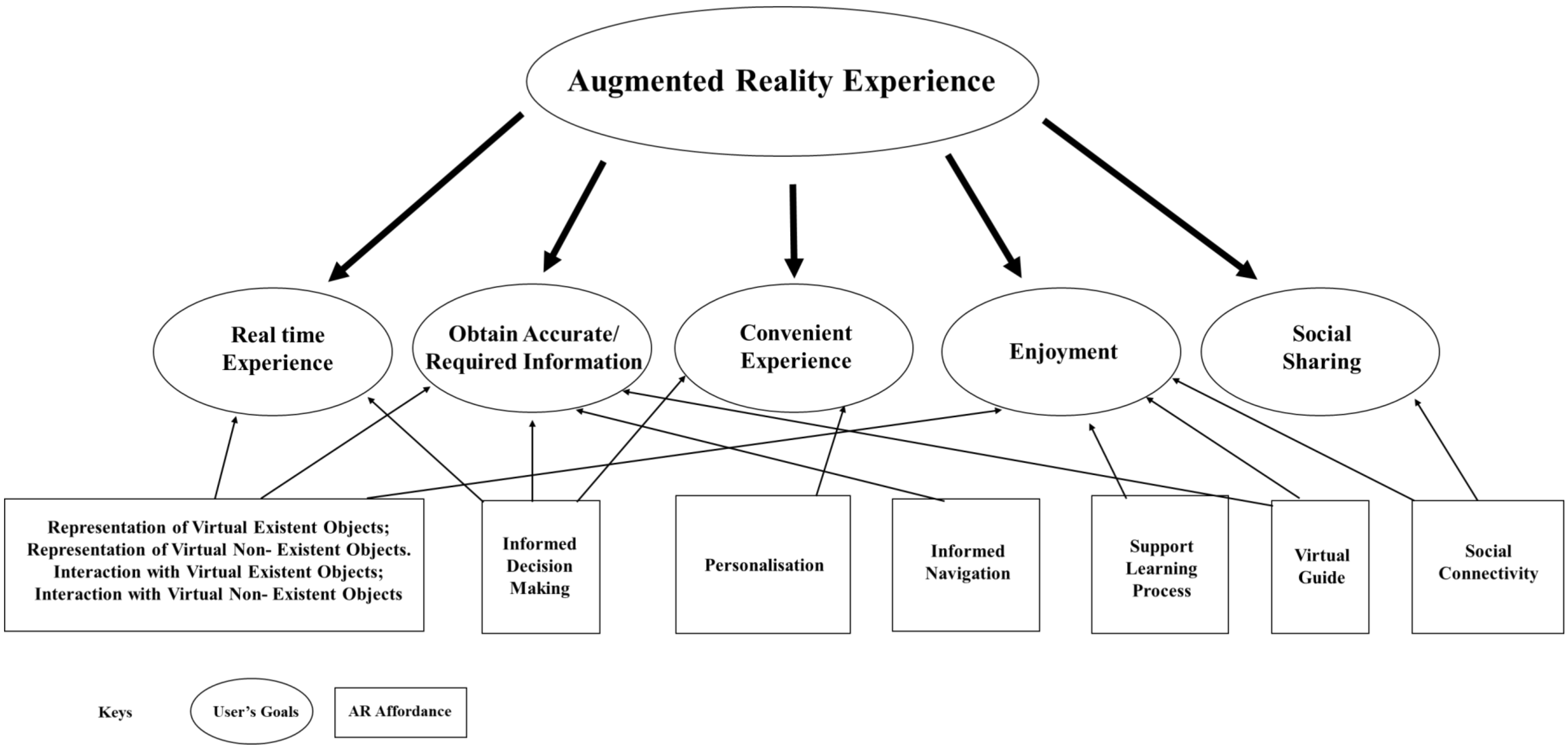

Figure 5.18: Link between apps; affordances and users' goals

5.1.14 An AR theoretical framework: Bridging affordances and SPT

In the previous sub-sections 5.1.1-5.1.12, the researcher went through 12 AR apps (in-depth) and experienced their physical features to identify the affordances they offer for potential users, and their expected goals. Ten affordances and five users' goals were identified through the walkthrough, supported by users' online reviews and reflections. Also, the researcher went through the online reviews of other AR apps that afford similar services to their users, to support the affordances findings. However, there is still a need to understand what the users expect from this technology when they use its affordances. Social Practice Theory, which consists of three elements – materials, competency, and meanings (Shove et al., 2012) – can help the researcher to identify why these affordances (AR apps) are still not highly used.

Meanings, as essential components of social practice, represent symbolic or shared meanings, social norms, ideas, and collective aspirations (Shove et al., 2012). Meanings in SPT only refer to the ideas or expectations that the users already have in *their* minds. However, the researcher of this study is interested in understanding users' expectations (before using the AR app) and their experience (after trying the AR app). Therefore, the meanings will be expanded; on the one hand, meaning will be considered as "what a user expects from this technology". In other words, it represents what the user expects to accomplish by using AR technology; AR apps are used to achieve the users' expected goals, such as having a real-time experience. On the other hand, the researcher also considers meanings to be the ideas and beliefs that the users develop after experiencing AR apps. These new ideas about AR apps could influence their future behaviour, for example, whether or not they would recommend AR apps to others.

Materials, as a second key element of SPT, include things, technologies, tangible physical entities, and the materials that objects are made from. Materials in this research are the AR app itself, its content, and its features.

Moreover, **Competences**, as the third essential element of social practice, primarily encompass the knowledge and skills needed to carry out the practice (Shove et al., 2012). The researcher identified that the SPT theory ignores system competency and only focuses on users' skills. Therefore, the competency element of SPT will be expanded to cover the system competency. System competency in this research is the quality of the app's functionality in terms of performing the required tasks. Therefore, the next section will start by showing the users' goals and then looking at the AR affordances through the lens of SPT, considering the AR theoretical model as shown in Figure 5.19.

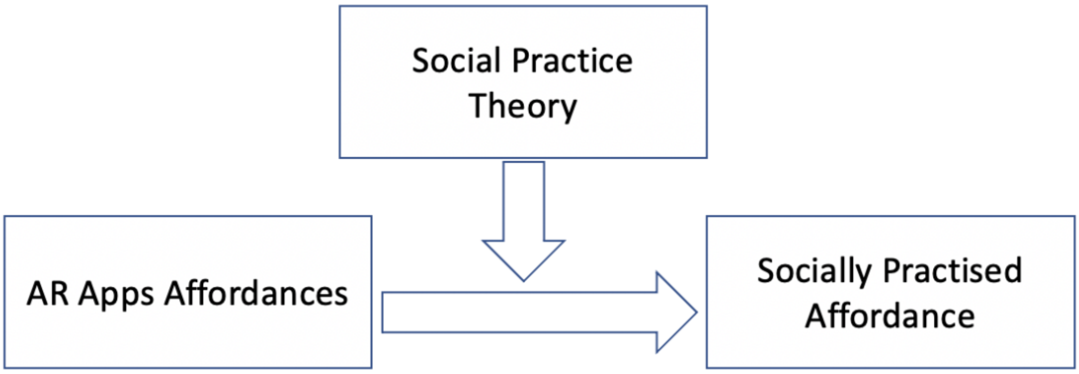

Figure 5.19: AR Theoretical Framework (Basic Model)

The following sections will look at the five users' goals and the ten identified affordances through the lens of SPT. Then they will clearly describe the new idea of socially practised affordances, where the findings show the importance of the coherence between the SPT elements e.g., meanings, materials, and competencies, in order to actualise the AR apps' affordances.

5.2 Goal: Real-Time Experience

The real-time experience goal is achieved through six multiple affordances: representation of virtual existent and non-existent objects, interaction with a virtual existent and non-existent object, virtual guide, and informed decision making. The sub-sections 5.2.1 and 5.2.2 will discuss the first four affordances, while the virtual guide and informed decision making are discussed further in sections 5.3.2 and 5.4.1 respectively.

5.2.1 Representation of virtual existent and non-existent objects

The researcher selected many AR apps that enable users to visualise virtual existent objects in their own space, such as IKEA Place, Portal to Paradise, Gucci, Asos, Dulux Visualizer, Paris Travel Guide, Pocket Universes Express-Sky Map and Mondly, as well as two apps, the Google app and Skin & Bones, that allow users to visualise non-existent virtual objects.

Through the reflections and online reviews of the selected apps, the researcher identified real-time experience as one of the primary goals of AR app users. For example, AR users shared their expectations and experiences about how AR experience affordances allow them to achieve their goal of being fully immersed in an experience:

> "*I would expect to get a fully immersed 3D experience as though I was there*". **(Portal to Paradise reflections; users' goal: real-time experience)**

> *"The AR app should allow us to experience products virtually with good accuracy and clarity."* **(IKEA Place reflections; users' goal: real-time experience)**

> *"I would recommend this IKEA AR app to others to help them get a sense of the furniture's availability and get "proxy" images in real-time."* **(IKEA Place reflections; users' goal: real-time experience)**

> *"Looking at products virtually like you are in person is an amazing characteristic. It saves time and effort Very brilliant step it"* **(Gucci online review; users' goal: real-time experience)**

However, the reflections and online review data also showed that, for several reasons, some users experienced difficulties with actualising these AR apps' affordances. As a result, they could not achieve their goal. For example, through the SPT lens, the researcher identified that, in order for AR apps to be utilised by users in a socially practised manner, the developers must design a system (materials) that aligns with or is compatible with the users' current skills (competency), values and needs (meanings). In other words, users need all the three SPT elements (meanings, competency, and materials) to use AR affordances. For example, the representation of virtual objects indicates a user's potential action (affordance) when they acquire the required skills and knowledge (users' competency), which helps them achieve their goals, namely, gaining a real-time experience with the products they are interested in. There are certain contextual factors that either enable or inhibit affordance: for example, skills and competencies, user perceptions, IT infrastructure, and technological features (Karlsen et al., 2019, Leonardi et al., 2019, Du et al., 2019, Krancher et al., 2018). Some users may lack the skills and knowledge required to use AR app affordances. For example, this study's findings show that some AR users have little knowledge or experience about how to utilise the app's functionality, and so the pre-expectation reflections (IKEA Place app) reveal that they expected understandable and straightforward instructions on how to use the app:

> *"I don't have much experience and knowledge* **(users' competency)** *about AR but I wanna see an app that will try to make their augmented details simple but good with good system functionality as this is important".*

> *"I got struggled a bit to figure out the way to use it because* **(users' competency)**

there is no instruction beforehand. Its appearance is quite simple, but I like it because it links with the simplicity of IKEA products in general".

Designing AR apps that are compatible with users' current skills would make it easier for them to use the app's affordances and develop a positive meaning in their minds. For example, Gucci app's users narrated a positive experience because they found the app compatible with their current skills:

> *"Based on my knowledge* **(users' competency),** *this was the first time I had used this technology. Really, it is very easy to use and interesting for me* **(developed meanings)** *especially when I tried the glasses on my face."*

According to Holden and Rada (2011), knowledge about technology and the user-friendliness of an app are crucial in evaluating the usefulness of the app in question. Some users shared that the lack of guidance on app use is a prime reason why they cannot achieve their goals. If the users cannot achieve their overall goals with AR apps, they feel disappointed and give poor app ratings. Therefore, AR app users expect app developers to guide them by providing video tutorials about how to operate advanced AR app features. For example, the Dulux Visualizer app should allow users to visualise different colours. However, some app users struggled to find out how to use this affordance. Therefore, they started writing negative reviews, saying that they expected to see some instructions such as how to try out a range of colour options for internal decorating:

> *"It didn't help me visualise at all as it coloured the entire ceiling and adjacent wall. Definitely could benefit from some easy start-here type instructions"* **(users' competency)**

> *"I cannot find any guidance on how to use the app* **(users' competency)** *other than for simply adding a colour to the wall! There are three rollers in the bottom right of the screen and three dots at the top right, but I cannot work out what they are for* **(users' competency)** *Please add an idiot's guide to using the app in its entirety to earn 5 stars."*

Therefore, there is a need for more accurate guidance, tutorial videos, and 24/7 online chat services on such AR apps to ensure that the users' expectations and goals are fulfilled. For example, one Mondly AR app user wrote:

> *"I expect to see a tutorial video to educate me on how I can find, book, as I am not an expert on using AR apps."* **(users' competency)**

Some users expressed their willingness to spend time learning how a particular AR app functions in order to increase their knowledge and skills about this advanced technology so that they could make the best use of AR affordances and achieve their goal of having a real-time experience. Below is an example of pre-expectations of the Gucci app:

> *"I have already tried a few apps and enjoyed using them but know little about how to use them. First, I want to learn more and then use this technology to buy sunglasses in-app* **(users' competency).** *I want the app to give me real-time experience* **(user's goal)** *which is new thing and may be awesome too".*

5.2.2 Interactions with existent and non-existent objects

The representation of virtual objects' affordances will be followed by the potential action that enables the users to interact with those objects in their virtual space, such as trying on products and choosing different colours, which is the second affordance of AR apps.

Interacting with virtual objects in a virtual space also requires some skills. For example, the Dulux Visualizer app's user (online review) had a bad experience. The user's goal was to interact with this app by adding different colours. However, they reported that they failed to perform the required actions because the app did not match their abilities (user's competency) when comparing different shades of green. The user's initial expectation was that the *representation of different colours* affordance would be great, but because the app was not compatible with their current knowledge, they were unable to interact with the virtual colours, so developed the idea that the app was frustrating:

> *"I thought this sounded like a great idea* **(expected meanings)**, *but it was so frustrating* **(developed meanings)** *It kept wanting to add 'colour if the tear, stone' to my choices. I just wanted to compare different shades of green, but the app didn't match up with my knowledge and needs"* **(users' competency)**

Current users' skills and knowledge are influenced by their level of education and previous experience, which strongly affects their ability to use AR apps. The findings show evidence that users' abilities and needs vary. For example, competent users find AR apps easy to use, to search for products and to operate. Consequently, they may be able to fulfil their needs more quickly than less skilled users, who may provide some negative feedback that could influence other users' expectations about AR apps. Therefore, if bad reviews are posted about some AR apps, this does not mean that all users have difficulties using the same app. The below is an example from IKEA Place (online review):

> *"After reading a bunch of bad reviews I downloaded the app thinking it will not work for me either* **(expected meaning)** *To my surprise it worked very*

> <u>*well.*</u>*"*(**developed meanings),** *so thank you developers for making it so user-friendly".*

On the other hand, the researcher identified that, as well as user competency, system competency is crucial for allowing users to use AR affordances. System competency emerged through the analysis as a potential new element for SPT; it covers the app's functionality, which affects users' ability to use AR affordances. The failure of an app system to work properly **(system competency)** will definitely prevent users from experiencing AR affordances and achieving their goals, even if they have the required skills, resulting in poor ratings and negative reviews. App system capabilities and functionality should be effective as these aspects can improve the ability of the app to facilitate successful interaction and meet users' expectations (Xiao et al., 2016). An example from the Mondly app is given below. Although the users find AR apps fun and beautifully designed, one user wrote that the app did not perform as expected, and they therefore developed the meaning that using the AR app wasted their valuable time:

> *"Can't believe people think this is a good app.* <u>*I mean sure it is AR so that's fun*</u> **(expected meaning).** <u>*Would be actually fun if it worked*</u> **(system competency),** *though). The 4.7 stars are an insult to all those amazing apps on the App Store that actually work and are designed beautifully.* <u>*Two hours of my life that shall never come back"*</u> **(developed meanings)**

Meanwhile, a Dulux Visualizer app user wrote that it did not meet their initial expectations. A lack of competence in this AR app prevented the user from taking some photos and visualising different colours. As a result, it did not fulfil their goal of having a real-time experience, so they developed the meaning that the app is poor. They wrote:

> *"*<u>*Very poor app*</u> (**developed meanings),** <u>*I expected the idea was to take a photo then change the colours of various parts of the photo?*</u> **(expected meanings).** *Well,* <u>*it fails, as the app is counter intuitive and can't find how to do what it supposed to do"*</u> **(system competency)**

Moreover, for AR users to have a real-time experience, AR developers must ensure that the app's content (materials), such as the virtual images, are like the real ones. Otherwise, users will not be happy with those apps. For example, a user reported having a bad experience when using the Dulux Visualizer app due to the differences between the actual and virtual colours provided by the app. Even though their expected meaning was that the app's concept would be good, the app materials failed to fulfil their expectations. Furthermore, the user's SPT-related meanings were compromised as they reported wasting £20, which increased their frustration and strengthened their intention to share the following negative review:

> *"Just wasted £20 getting some test sample paints mixed up. They bear absolutely zero similarity to the colours on the Dulux Visualizer app* **(materials).** *Such a shame as the concept is very good* **(expected meanings).** *However, it makes the whole thing an incredibly frustrating waste of time* **(developed meanings)** *when buying sample paints which bear no resemblance whatsoever to the colours on the app"* **(materials)**

Moreover, McKenna (2020) highlighted that affordances could be used to explore users' goals related to app usage and technology design. The app's design plays a significant role in the user experience, enabling or constraining them from using the app affordance. The design of the AR apps is part of the materials**.** For example, a Gucci app user stated that the layout design of the app, its appearance and the search engine (materials) facilitated their online shopping experience. As a result, they developed the meaning that the AR shopping experience was easy and pleasing to the eye. The user also believed that suitable app materials improved the app's functionality (system competency):

> *"The design and the search engine* **(materials)** *in the app make shopping a piece of cake; this feature specifically significantly improves the app's functionality* **(system competency).** *The theme of the app's appearance* **(materials)** *makes is pleasing to the eye and comfortable to use"* **(developed meanings)**

Online review data confirmed that the app's material improves the system competency, which ultimately facilitates the ability of the users to use the AR affordance of interaction with virtual objects. The user interface (material) is an essential feature of interactivity: it enables users to successfully interact with the app in order to complete tasks and achieve their goals (Hassan et al., 2018) . For example, a Paris Travel Guide app user shared their positive experiences of the in-app navigation, interface, colour scheme, and clarity. This facilitated their interactions with the app and they wrote about their high level of satisfaction with the app's competency:

> *"I love the way I can navigate throughout the app* **(developed meaning).** *The interface is nice. The images of Paris are so colourful and clear!* **(materials)** *I didn't have any issues while using this app"* **(system competency)**

Similarly, a Portal to Paradise user reflected on their positive experience and emphasised that materials are as important as the system competency in terms of enabling the user to enjoy the AR experience:

> *"Functionality is key* **(system competency)** *but aesthetic* **(materials)** *is what catches the eye and makes something user friendly Error free and functionality goes hand in hand"* **(developed meanings)**

Another user reviewed and shared their positive experience of the design of the Pocket Universes Express-Sky Map (online reviews) app. This meant that they developed positive meanings:

> *"The design is a thing of sheer beauty* **(materials)** *that gets you outside looking upward and cheers you inside when the weather beats us back indoors* **(developed meanings).** *Thank you very much indeed".*

Conversely, other AR app (IKEA Place app, reflections) users reported that the design, chat interface and search text field (materials) of the app, as well as the app functionality (system competency), failed to meet their expectations of using AR affordances. This led to them feeling dissatisfied with the app's technological features, therefore in turn they developed the meaning that the app was annoying and they did not wish to recommend it to others. For example:

> *"I find the app's design to be very clunky***(materials).** *The chat interface* **(materials)** *when you first use it is annoying* **(developed meanings),** *as I just want to get to the main AR part of the app. The search text field* **(materials)** *made it hard to edit* text" **(system competency)**
>
> *"No I wouldn't recommend the apps yet* **(developed meanings)** *because I think there good apps* **(expected meanings)** *but still rudimentary in functionality"* **(system competency)**

The Dulux Visualiser app delivered a similar experience (online review) where the users reviewed the app as being good; however, the failure in the app's functionality (system competency) meant that app crashes made it difficult for the user to use certain functions such as the camera function. This app affords *interactions with a virtual object* (colours) in the users' physical space, which requires the use of the camera function (material). In contrast, the user here was unable to use it because the kept app crashing (system competency), and there were awkward materials, and a lack of colour options, preventing them from experiencing the apps' affordances.

> *"This Dulux Visualizer app* **(materials)** *is good for completely plain walls that don't have any windows or items in the way* **(system competency)** – *the masking tool is really awkward* **(materials)** *and is almost impossible to move around, which makes it hard to differentiate between ceilings and window-panes etc."* **(system competency)**

> *"The visualizer doesn't even work well anymore. The app lag and crashes and I can't even use* **(system competency)** *the camera function* **(materials)** *well. The colour options are really limited* **(materials)** *compared to what they were before".*

Moreover, an important consideration is the AR app system's design: for example, how user-friendly an app is. AR apps' design, interface, and layout determine the level of user skill (competency) required to use them. For example, a user-friendly interface can increase user confidence in using AR apps, which means that they will be more likely to post positive reviews and thus attract more users, including those who lack confidence in using AR apps. For example, an online review of the Paris Travel Guide commented:

> *"The AR interface is sleek and great to use as well* **(materials).** *Even the least tech-savvy person can use it"* **(users' competency)**

Therefore, when AR app features (materials) are complex and challenging to use, this increases the probability that users will develop a meaning that the app is just a waste of time, which will drive their future behaviour to leave negative online reviews. The app's affordance cannot be used until the user can successfully use the AR app to achieve their goals; here is the example of the Dulux Visualizer app (online review):

> *"It's not enough to give just one option of trying the product, especially when the app features* **(materials)** *are very complicated to learn and use* **(users' competency)**. *It's just time-wasting* **(developed meanings)** *so please add more instruction***(materials)** *and make it simple to use"* **(system competency)**

Some users shared their suggestions to the AR app developer on how the layout and design of a particular AR app could improve the app's competency. An example from the Asos app (online review) demonstrates that the Asos layout design does not facilitate moving backwards and forwards: therefore, the user experienced difficulties with browsing. Consequently, they preferred to use other apps, such as the Zalando app, which provided a better layout and design.

> *"Please add a slide function* **(materials)** *to the AR app so when you're viewing an item, you can just slide the screen back to the previous page, rather than having to click the X at the top of the screen. I know it sounds minor, but it makes browsing on your phone so much easier* **(system competency)** *(the Zalando app is great for this!). Only reason it's not 5 stars."*

The findings also show that developers need to pay attention to the fact that adding new features (materials) such as AR to an existing app might not always enhance the user experience; conversely, it might reduce the system competency. Some users reported some functionality issues, such as crashes and shutdowns, therefore they developed the meaning that adding the AR feature was pointless as they could not use it. For example, the addition of the AR feature to the Google app, which was supposed to afford representation and interactions with non-existent virtual objects, was not a positive move from the users' perspective (online reviews) as it negatively affected the app's competency:

> *"This used to be a great app, it did everything I could possibly want from a search engine app. Until several weeks ago. Now you can only use the app for approx. 30 seconds before it shuts down completely* **(system competency).** *What is the point in the "new features" in updates if we can't be on the app for long enough to use them?* **(developed meanings)** *I'm forced to use google on safari which is not user friendly. Google need to sort it; I want the working app back!"*

Furthermore, the findings confirmed that missing features (materials) from AR apps could lead users to delete and not recommend them to others, as in this example from the Dulux Visualiser (online reviews):

> *"Many people will use this on an iPad, but it only works in portrait mode, not landscape* **(materials)** *This alone enough for me to delete the app"* **(developed meanings)**

Another similar example from IKEA Place reflections:

> *"I don't think I'll recommend it to anyone* **(developed meanings),** *as it was a bit difficult to navigate and place the items* **(system competency)** *and didn't have a wider selection of items"* **(materials)**

5.2.3 Section outcomes

For the representation of virtual existent and non-existent objects, and interactions with these objects, and for these affordances to be used as a social practice to achieve the users' goal of having a real-time experience, the following elements must be considered:

1- **User competency:** users must have the skills and knowledge required to use AR advanced technology. The findings show that competencies vary among users for many reasons, such as their level of education, skills, and past experiences. For example, if they have used AR technology before, they possess a higher level of knowledge. Moreover, AR apps should be compatible with users' current skills; otherwise, they will not be able to use the app's affordances. Therefore, developers must provide instructions and guidelines such as video tutorials to guide the users using the app. The findings also confirmed that some AR users are willing to spend time learning how to use AR apps, and user-friendly materials can increase their confidence in using such apps, even if they do not possess the required skills.

2- **System competency:** users expect AR developers to develop high-quality apps that perform the required tasks; for example, ease of navigation, browsing, editing, and high-quality services. The findings show that adding AR features to existing apps may affect the system competency, for example by increasing app crashes and shutdowns.

3- **Materials:** developers need to pay attention to the material of the app itself, for example, the app's appearance, interface and how easy it is to use. Also, developers need to provide standard features that are available in perfect apps. The findings show that sometimes users tend to delete AR apps, not because of the AR itself, but due to some missing features (materials). Also, the quality of the provided materials is essential for the apps' users; for example, users expect the 3D images provided by AR apps (virtual objects) to be similar to the real things in terms of colours, size, etc. Furthermore, users believe that suitable materials improve the apps' functionality.

4- **Developed meanings:** before using AR apps, users usually have an expected meaning in their minds. Also, after experiencing AR apps, they typically develop some meanings. Therefore, the difference between what they expected and what they experienced drives their future behaviour of adopting the app, recommending to others, or simply deleting it and looking for other apps. The findings show that users who have the required skills to use AR apps and the required materials, and experienced good app competency in terms of meeting their expectations, usually developed the positive meaning that the app was a fun interaction. They are therefore most likely to recommend it to others. Conversely, if one of these elements is missing, users will not be able to use the AR affordance and they will not achieve their goals. Consequently, they will develop negative meanings and view the app as just a waste of time and possible a waste of money as well.

5.3 Goal: Obtain Accurate and Required Information

The goal of obtaining the required and accurate information is achieved through multiple affordances: the representation of virtual existent objects and interaction with them, informed navigation, and virtual guide affordances.

5.3.1 Informed navigation

The Google Maps app provides live view navigation, an AR service that informs navigation.

Many users reflected positively on their use of the Google Maps navigation affordance, because it helped them to achieve their goal of knowing an accurate direction. For example:

> *"Yes, as I am very bad in directions, and with the support of AR, it actually will cut off some confusions".* **(users' goal: obtain the accurate directions)**

> *"Overall experience was good. Sometimes it gets confusing as GPS does not work very well, AR helped me to accurately locate buildings which helped me with my directions*." **(users' goal: obtain the accurate directions)**

However, for many users, using AR apps is quite fun at the beginning (expected meanings), but they may lose interest in using them once they realise that the app lacks some features (materials) that are vital for them to continue using the app. For example, Google Maps only affords navigation. Moreover, some users mentioned that the app does not work if they are walking around; in other words, they must stand still to use the AR navigation. The findings show the emergence of a lack of system competency, which probably prevents some users from using the app's affordance. Therefore, the users commented that in order to make this app more interesting for them and for them to use it as a social practice (developed meanings), it needs improvements in system competency and for some features to be integrated with AR, such as the ability to use it when walking, and adding places of interest, which are considered as materials in SPT. For example:

> *"I turned on Live View and saw that an arrow overlaid over the camera view and was pointing for me to turn left. I thought this was quite cool* **(expected meanings)** *I started walking and the map warned me that I can only use it while standing still* **(system competency).** *I kept the phone in my hand and started walking. When I got to the next intersection, I pulled the phone up again and saw that the Live View had disappeared and was replaced with a map* **(system competency),** *but*

> *there was a button to return to Live View. I found this quite annoying* (developed meanings). *So, I returned to the Live View, paused my walking, and got directions again. I did this several times, but then to be honest I lost interest in using it* **(developed meanings).** *I thought it would have more features available, like pointing out landmarks*" **(materials)**

System competency is essential for the users, and it determines whether or not they are going to continue using the app or not. For example, a user mentioned that the app only works for walking, and he wanted to use it while driving. Moreover, the app was not compatible with his wife's phone, and he believed that it was not worth (meaning) buying a new phone (materials) only to use AR! For those reasons, users may prefer to use the old version of Google Maps.

> *"It's only work for walking on my phone* **(system competency)** *I don't know why. Even its not available on my wife phone* **(materials)** *do you think we will buy new phone to use AR app no way"* **(developed meanings)**

> *"I would like to recommend in some case once you need to find the exact building or location nearby you otherwise the old google map is better* **(developed meanings).** *The google should more work on it to make more friendly user and it should also work for driving* **(system competency).** *Additionally, it should be compatible to connect it with built in car navigation system"* **(system competency)**

Moreover, system competency could also refer to how user-friendly the system is, as this can also determine whether the users continue to use it in the future. For example, after experiencing AR, some users still preferred (developed meanings) the usual street view map, rather than the live AR navigation. They believed that the live navigation was too complicated (system competency). For example:

> *"I was expecting it to be simplified and easy to use* **(expected meanings),** *however, from my experience, I still prefer the usual street view maps* **(developed meanings).** *as it is less complicated and easier to follow"* **(system competency)**

Moreover, the app must provide a high-quality service for users to enjoy, one that enables them to use the informed navigation affordance (system competency). For example, it must demonstrate good loading times, processing speed, and reaction processing duration (Kucirkova, 2017, Delagi, 2010). Having an adequate system speed means that the AR app can complete the assigned tasks and fulfil users' goals successfully in a short time. An AR app's system speed, responsiveness, and loading time can be categorised as system competency in SPT-related aspects. Excessive loading times and overly long reaction processing durations can irritate users and motivate them to switch to other suitable apps. For example, users found that the Google Maps AR navigation took too long to load, which could be considered a failure in the system competency, and it led to a negative meaning among users:

> *"The AR app needs more improvements. The app takes a long time to load* **(system competency)**, *which can be annoying"* **(developed meanings)**

> *"Once we put in the destination, it takes time to load and many times it goes back to the main map* **(system competency),** *which is irritating"* **(developed meanings)**

Technology users often tend to simply quit apps that are difficult to use, unclear, or hard to navigate (Labrecque, 2012). Difficulty and a lack of clarity in navigation are some of the most common issues that prevent AR app users from achieving their goals of obtaining the required information about their desired destination. Therefore, some AR app users provided some recommendations on what they wished to see in such apps. They mentioned the apps' compatibility with different mobiles, and auto-updates of the technical features. These are important, especially when users are involved in performing multiple interactions, as they can improve user motivation to use such AR apps. For example:

> *"I prefer to use AR apps that work on all mobiles* **(materials),** *are easy to change route, offer auto-updates of all new destinations or routes, are compatible with my car's navigation, and they should work while I am on a call on my phone"* **(system competency)**

> *"I am expecting that AR feature is Google Map to offer simplified and easy to follow directions* **(system competency)** *to allow users to safely and reliably get from point A to B. Also, I am expecting that the feature includes an up to date and recent road/building developments"* **(materials)**

Moreover, users raised another issue with Google Maps, which was that they did not like the fact that they had to hold the phone up most of the time to use the AR navigation affordance. Users found that holding the phone up in public places could cause problems as some people may think that the person is filming them. Therefore, holding an AR camera up is not socially compatible. It can lead to the perception that the user is taking photographs and videos, ultimately raising concerns about privacy in public places. As a result, the social incompatibility of this affordance (holding up a camera in public places) may prevent users from using the AR navigation affordance. Examples of Google Maps reflections show the importance of material and the meaning of social practice theory, as holding up a mobile to recognise buildings and streets in public places can create trouble for users. This means that AR app is not socially practicable for some users:

> *"It was not as easy as I assumed to be* **(expected meanings),** *You have to keep your phone up most of the times for the camera to recognise buildings* **(materials),** *so, I found myself holding up my phone most of the time"* **(developed meanings)**
>
> *"It could be rather awkward if you are in a public place. as people might think what person is doing, it is odd"* **(developed meanings)**
>
> *"I will only use in the situation where I confuse about the direction otherwise it could create trouble* **(developed meanings)** *because once you use it you have to hold our mobile at front of you to keep camera on toward the street or direction* **(materials),** *that could make upset to anyone because anyone can believe that you can making their video"* **(developed meanings)**

Furthermore, besides the social incompatibility of the AR navigation affordance, holding the mobile phone up could be complicated and annoying for some users in some circumstances, such as cold weather, as per this user's reflections:

> *"I used it to navigate from my hotel to the University of Surrey. I started the app and chose my destination. But my first thought before I started using it was that it was so cold outside, and I felt like I don't want to keep holding the app as my hand would get too cold. So, I decided to stop using it because my hand was too cold!"* **(developed meanings)**

In terms of cost, the findings show that users are unwilling to pay for navigation affordance. Users expect developers to provide free AR navigation services, as many available apps provide free street views:

> *"I do not think there should be a charge for this service; however, if there is a charge, then I would not be willing to pay for the service. I believe a simple street view map would do the job and be suitable for me"* **(expected meanings)**

5.3.2 Virtual guide

Some tourism apps afford their users a virtual guide that helps them to obtain the required information before and during travelling in a real-time experience. For example, the researcher considered the Portal to Paradise app and ten city travel guide apps for this research, which help users to access accurate and useful information about many tourist destinations.

Reflections and online reviews show that many users found those AR apps useful, and they achieved their goal of accessing the information they were looking for free of charge. Here are some examples of feedback on different apps:

> *"This AR app is useful as it provides me many functions with the help of 3D camera as well as descriptive content. It meets my real expectations and most important it is free and time saving"* **(users' goal: obtain the required information).** (Portal to paradise, reflections)

> *"So, before I went to Dubai I felt totally lost and had no idea what I was going to do there. Where was I to go, what was I to see, who would I meet up with. Well, this app was a life saviour* **(users' goal: obtain the required information)** *with its extensive features for Dubai!"* (Dubai travel guide, online reviews)

> *"This New York travel guide is perfect for someone who plans on making a trip there. Everything you need to know is all in one place"* **(users' goal: obtain the required information)**. (New York travel guide, online review)

> *"I went three weeks to Thailand, where I've spent two in Bangkok. Offline maps were useful as Bangkok is a big city and it is handy to have the maps in your smartphone, and they don't get crumpled! I liked the Augmented Reality Feature, especially when I went to Vimanmek Palace and Silom District* **(users' goal: obtain the required information).** *Language aid is also very helpful"*. (Bangkok travel guide, online review)

The findings show that the appearance and how the developer presented the content of those apps (materials) attracted the users to use them. An example from the Portal to Paradise reflections:

> *"Overall, I am impressed with the structure and presentation of the app"* **(materials)**

Similar examples from the London Travel Guide app (online reviews):

> *"The set-up of this app is beautiful. It is very informative and easy to navigate* **(materials).** *It makes me actually want to go to London and explore"*.

However, the researcher went through the reflections and online reviews in depth in order to identify why those AR apps are still not used. It was identified that some apps users were very annoyed as there was a gap between what the developers promised to provide and what they experienced, which in turn developed into a negative meaning that they had been deceived (developed meanings). For example, if the users liked the advertised free features (materials) of the AR app, they would expect to be able to access and use those features immediately, once they had downloaded the app. Below are examples from the London Travel Guide (online reviews):

> "*App promises a lot - delivers nothing. much like my ex-employers. App has a lot of features none of which are accessible with the free version* **(materials).** *Now I am all for commercial enterprises but not a fan for bait n switch. Want people to pay for an app? List it as that is all I ask. Am sure it's a lovely app but I can't comment as the free version does absolutely nothing. nada. zilch. Much like my bonus"* **(developed meanings)**

> *"Would be much better if the entire screen wasn't taken up by an Ad asking you to buy the full version every 5 seconds. Plus, most of the features you have to buy beforehand, like offline maps, which isn't advertised until after you've downloaded the app"* **(developed meanings)**

Another example from online reviews of the New York Travel Guide app:

> *"I downloaded this app only to find out that it's 1.99 for each section of the app and 3.99 for the tour guide info. It says it's free but it's not! Deceiving!* **(developed meanings)** *I'm springing for the 4 dollars and hope it gives me some good info... ☹"*

> *This is totally annoying. Without spending In-App money on every turn, you can do nothing with this app"* **(developed meanings)**

This is a common issue that the researcher identified with most tourism AR apps, for example, the Singapore Travel Guide app:

> *"You will only get a teaser portion of app described unless you pay to download the full version"* **(developed meanings)**

And the Paris Travel Guide app:

> *"As soon as you download this allegedly FREE app it asks you to pay $3.99 to download the actual map. Garbage"* **(developed meanings)**

And the Bangkok Travel Guide app:

> *"Waste of time downloading. Says it's free with in app purchases. How about once you download it's useless unless you pay $3. Every option or map needs to be downloaded for a fee. Deleted It"* (**developed meanings**)

Moreover, some users reported losing some money while using the London Travel Guide app (online review), which underlines a lack of accountability on the part of the developer and affects the credibility of the app, which in turn develops negative meanings in users' mind:

> *"I lost some money on an app during my trip to London. The information given was "scattered" and unclear, even though they were asking for more money for some functions, which amounts to deception to me"* **(developed meanings)**

> *"I didn't even touch my phone screen and the next thing I know I have been charged $3.99"* **(developed meanings)**

Another example from the Dubai Travel Guide app (online review) shows that this kind of travel guide app may trick foreign tourists into spending money unnecessarily if they are not familiar with the city they are visiting:

> *"The app tricks you into buying other city guides. Why would a Dubai guide have pop up in app purchases for other cities? I ended up buying a Doha guide because I wasn't sure if that was part of Dubai guide"* **(developed meanings)**

Some users do not know what the experience of a virtual guide will be like because developers do not provide videos explaining this service, or provide a free trial version. Providing a free trial version would inform users of the app's affordances, which may attract them to use it. The findings show that the users expected the crucial AR app features (materials) to be free of charge, as all they wanted was to have a street map with names on. If this is the case, they would not be willing to pay to unlock AR features, and they would not be able to experience the virtual guide affordance. For most of the users, AR is not worth buying as many other options can do the job for them. For example, the below is from an online review of the Dubai Travel Guide app:

> *"Well you have to unlock everything for Dubai with $3. Not worth it while you should even pay for metro map which you can find for free on almost all website"* **(developed meanings)**

And a similar example from the Istanbul Travel Guide app (online review)

> *Do not buy this App. I'm amazed that Apple had approved to place this App in their iTunes store. Think of it this way, the NYC Way, Chicago Way, San Francisco Way, Boston Way Apps are free and provide you with lots of information on hotels, restaurants, nightlife, shopping, etc. This Istanbul travel App is a $4.99 Application with less than 1% of the information that these NYC, San Francisco, Chicago, Boston Way apps have to offer. Please don't waste your money like I did"* **(developed meanings)**

On the other hand, some users were aware of the value of AR apps, and they paid for the AR service. However, they experienced a problem with downloading and using the upgraded version, which was considered a failure in system competency. This failure prevented users from experiencing the virtual guide affordance; here are some examples from the London Travel Guide app (online reviews):

> *"I purchased the upgrade for the maps but it wouldn't download"* **(system competency)**

> *"I paid for it, but it still shows free version. I have also tried to restore the purchase. Deleted the app and reinstalled it. Still no luck.!"* **(system competency)**

And similar examples from the Paris Travel Guide app, online reviews:

> *"Tried multiple times to get the offline maps to load. App totally failed* **(system competency).** *Huge waste of time"* **(developed meanings)**

> *"This app crashes continually. Purchased the offline guide and it won't finish installing* (**system competency**). *Not worth it* (**developed meanings**)*"*.

The Portal to Paradise app reflections show system competency issues as well:

> *"The functionality of this app needs improving as this app has freezed a few times*
> **(system competency)**

The failure in system competency affects the credibility of the AR app. This may lead users to warn others not to download these kinds of apps, as they believe that they are a fraud. Below is an example from a Paris Travel Guide online review (uppercase used in original text):

> *"THIS IS A FRAUD* (developed meanings) *I PURCHASED ONLINE AND NEVER FINISHED DOWNLOADING THE UPDATE* **(system competency).** *THIS IS A FRAUD YOU ARE STEALING PEOPLE WITH THIS APP I WANT MY MONEY BACK"* **(developed meanings)**

System competency could also be considered as the app's compatibility with different devices. For example, a user of the Dubai Travel Guide app (online review) reported a positive experience as the app was compatible with the Apple watch.

> *"This is the best Dubai guide I've come across! There's tons of restaurants, hotels and tourist attraction suggestions. There's even an offline map which is incredible. A really great app overall and it even works with the Apple Watch"* **(system competency).**

However, other users shared that they found the Dubai Travel Guide app to be incompatible with their mobile phone and their iOS system. Therefore, they reported a negative experience in their online reviews:

> *"Application doesn't work on iOS 8.4 it always shuts down and immediately crashes"* **(system competency)**

Knowing what users expect from these tourism apps could help developers to design apps that better meet their needs, in order to satisfy them and ensure that the app will be used as a social practice. For example, protecting users' personal information is one of the most important elements that developers need to pay attention to. For the tourists to be confident about using the virtual guide's affordance, developers must ensure that their personal data, such as their locations and bank details (secure payment options) are protected. Also, there should be an online customer service to guide any users who do not have experience with this type of app (users' competency), in case they face difficulties with using it. For example, a user shared their expectations of the Portal to Paradise app (reflections) and provided some recommendations on what they would like to see and experience in such tourism apps:

> *"The most important thing is for me* **(expected meanings)** *whether this tourism app is provided what I searched/required* **(materials).** *Second is whether my personal information is within save hand or not* **(expected meanings)** *as well as how fast it is completing the assigned tasks* **(system competency).** *Third is if I need any help whether the online help is available* **(user competency)** *which can save my time and tension".*

> *"I would include many different features such as doing video call with anyone who is calling to verify my bank details* **(materials).** *This shows more rustication in the longer run* **(expected meanings).** *I would also like to also have the opportunity to remove the locations section from settings as this setting is dangerous for people who can hack accounts through smart phones"* **(expected meanings)**

5.3.3 Section outcomes

For the informed navigation and virtual guide affordances to be used as a social practice and for them to achieve the users' goal of obtaining accurate information, many things should be considered:

1- **User competency:** Besides the skills required to use AR navigation and virtual guides, the findings show that users want an online customer service that can provide immediate online help if they struggle with using the app, as they may lack the necessary skills.

2- **Materials:** The AR navigation provided by the Google Maps app is not sufficient for the users to use the app effectively. Therefore, AR developers must provide more features that attract their users, such as adding some points of interest based on users' preferences. Moreover, AR apps must be compatible with different user devices, such as iOS and Android devices. The compatibility of these apps with the users' current devices will attract more people to use the app, as they will not buy a new device simply to use AR features. Also, the app's content must be updated in terms of buildings and street names. Furthermore, the findings show that the material of some AR apps is not socially compatible; for example, needing to hold your phone up to use AR navigation may cause social problems. These materials are also incompatible with weather conditions, for example, cold or rainy weather. For travel guide apps, their appearance is of vital importance in terms of attracting more users. All AR apps must provide a customer service that helps users if they encounter some issues with using the app.

3- **System competency:** To use the informed navigation affordance to obtain accurate directions, users want a high-quality service that provides information in a short time. For example, no one will be willing to adopt an app that takes a long time to load or that crashes continually, especially if they are driving or walking to their workplace. Also, the system must be user-friendly and automatically updated to ensure a high-quality service.

4- **Developed meanings:** After experiencing AR apps, users usually develop a meaning that is different from their expected meanings, which in turn drives their future behaviour in terms of adopting this app, i.e., recommending it to others, or just deleting it and looking for other apps. The findings show that some users develop the meaning that using AR navigation is annoying and could place them in trouble. Also, most users of travel guide apps encountered a gap between what the developers promised and what they experienced; therefore, they developed a negative attitude towards these apps. For example, the users expected to use the AR virtual guide affordances free of charge. Most users found that it was not worth paying for AR apps when they could find other options to do the job for them. The issue of the cost of AR apps reduces their adoption rate. Moreover, failure in system competency develops the meaning in users' minds that the developers deceived them, especially if they believe that they paid for a service that they did not receive or need. Therefore, developers must pay attention to providing customer services with their apps. Lastly, as some of these apps provide in-app purchases, developers must provide secure payment options for their users that ensure the credibility of the apps.

5.4 Goal: Convenient Experience

Besides the representation of virtual objects and interactions with them, informed decision making and the personalisation AR affordances give users convenient experiences by facilitating decision making before making a purchase.

5.4.1 Informed decision making

Some AR apps allow users to try on some products and see how they would look if they were in a physical store. This makes online shopping a more enjoyable, convenient, and straightforward activity that informs decision making. The researcher identified many apps that afforded informed decision making, such as Gucci, IKEA Place, Dulux Visualizer, and Asos.

Some users voiced their expectations of AR apps before they experienced them, which helped the researcher to identify the user's goal. For example, one user reflected (before using the Gucci app) that they had previously experienced the Ray-Ban app and they confirmed that the app afforded them an enjoyable, convenient experience for buying glasses online.

> *"I have a few AR apps and have enjoyed this technology a lot. Firstly, I used the Ray-ban app to buy sunglasses. It offers a convenient way to 'try on' the glasses on my wish list from the comfort of my home before making the final click to buy. It is simply awesome."* **(users' goal: convenient experience)**

A Gucci app user also reflected that they were impressed by the app's affordance of *informed decision making.* They reflected that they never expected to be able to buy glasses online (expected meanings); however, after using the AR app, they developed the meaning that with AR affordances, buying sunglasses online was possible. Some AR apps afford the user a more accurate understanding of the options available, so that they can select their favourite model without being in the store physically (users' goal).

> *"It met my expectations so far. I like the feature of trying the products on* **(materials)** *especially the glasses. I never expected that I could buy glasses online* **(expected meanings)** *but with AR tech* **(materials),** *this option is possible now!"* **(developed meanings)**

Also, another user reflected on how the virtual representation of IKEA's products in their own home made the shopping experience more enjoyable (developed meanings) and allowed them to determine whether a particular item of furniture was suitable for its intended location in their house or not. IKEA Place app's users reflected that the app informed decision making. The users mentioned that they were satisfied with the IKEA app because it helped them to make a purchase decision, which meant that the app saved their time.

> *"Yes, using the IKEA app is fun* **(developed meanings)** *and gives you good idea how the furniture will look inside your house before buying it".*

> *"To support decision-making during the pre-purchase stage and to save the time of returns when buying IKEA products* **(developed meanings),** *I will recommend it to my friends".*

Some users may like AR app affordances *(informed decision making)* because they fulfil some of their values, which are part of the meanings in SPT. For example, users of the Dulux Visualizer app (online reviews) appear to enjoy the virtual experiences that allow them to decorate their home for free at their convenience. The users' value here was to experience the products without spending money (expected meanings), which developed the positive meaning that the app was wonderful, and therefore they encouraged others to use it.

> *"This AR app is wonderful!* **(developed meanings)** *It is helpful to plan out what you want, wherever you want! If you're looking to know how to decorate it without having to spend money first* **(expected meanings)** *this is the app for you."*

AR apps such as Gucci, IKEA Place and Asos could be ideal online places for virtual shopping as it *informed decision making*, which saves users' time; however, missing material could develop a negative meaning in users' mind, and drive them to write a negative review to the app's developer. For example, an Asos app user shared in a review that although they liked how the app was flexible and user-friendly (system competency), having to wait for some products to be available created a negative meaning (frustrating) in their mind. Therefore, for informed decision-making affordance to be utilised, users should be able to find the desired products in the sizes they need. This aspect requires urgent attention from the developers. For example:

> *"I absolutely love this app. I find it really easy to use and flexible* **(system competency).** *I love the variety of clothing* **(materials)** *and other bits and bobs they sell. Although, it's frustrating* **(developed meanings)** *when stock runs out in the sizes* **(materials)** *needed and the downfall is the waiting time for stock to be brought back. Apart from that, it's a nice place to shop online''.*

A similar example came from IKEA Place (online review). While some users recognised the usefulness of the app and developed the meaning that the app was great, they shared their suggestions about how this app could be modified to be more useful. This highlights that the informed decision affordance cannot be used if the app fails to provide the variety of products (lack of materials) that users are looking for. This detracts from an enjoyable shopping experience:

> *"It's great!* **(developed meanings)** *Just wish you had more products on it! Like I wanna see rugs and other stuff"* **(materials)**

The findings show that, for AR app users to be able to use their affordances, these apps must be compatible with their current devices (materials). Barnes and Meyers (2011) highlighted the importance of mobile app compatibility with existing software; therefore, AR app compatibility also includes technological compatibility with existing infrastructures that users are using. Some users experienced a gap between what the developers promised and what they themselves experienced in terms of compatibility. Therefore, they reported some compatibility issues. For example, this user reported that although their mobile phone was fully compatible with the Dulux Visualizer app (online review) according to the specifications given by the developer, the app failed to operate successfully. This was a failure in system competency, which prevented them from experiencing the app (use its affordance).

> *"It says it works for iOS 11.0* **(materials)** *and later, but I have iOS 12* **(materials),** *and it still says my phone isn't compatible when I open up this AR app"* **(system competency)**

Moreover, the experience of the *informed decision-making* affordance depends on the ability of the user to control the app itself; for example, IKEA Place (online reviews) users shared a painful experience about how they were unable to control the AR app system. The users failed to achieve their goal of accessing accurate information that would help them to decide whether or not to purchase some shelving. This was due to the fact that the AR app's system did not function successfully (system competency). Therefore, this user requested that the developer worked on improving system performance.

> *"I have updated, deleted and redownloaded, and updated iOS. Nothing is working* **(system competency).** *Please fix this issue so I can decide on some shelving."*

5.4.2 Personalisation

Some AR apps afford personalisation for their users, which helps them to achieve their goal of having a convenient experience. The researcher identified this affordance in Gucci, Dulux Visualizer, Portal to Paradise, Wanna Kicks, and ten travel guide apps. For example, Gucci app users reflected that the app allowed them to choose products suited to their own personalities. The representation of Gucci virtual products in the users' space provided them with a convenient experience (goal) of interacting with a range of products and selecting the one that best suited their requirements and personality (affordance). For example:

> *"As we know that Gucci is well known and a high-end brand in the market, so they offer amazing features [via their AR app] to allow consumers to experience products suited to own personality before buying anything."* **(users' goal: convenient experience)**

However, the *personalisation affordance* cannot be used without technological materials and a competent system that allows the users to personalise and control the app. For example, when users feel that they can easily personalise and control the features of AR apps, this provides a good opportunity to create successful interactions between AR users and the apps themselves. Taking one example from the Dulux Visualiser app (online reviews), a user identified how the app was unable to provide complete control on the colour bar; this was very frustrating to the user and developed the meaning that the app was not usable:

> *"The pictures are upside-down and distorted; I can't move the colour bar to select a colour* **(system competency)** — *probably the worst app I've ever used"* **(developed meanings)**

> *"This app used to be better - you could mask off areas so you could put different colours in a space now it just fills the whole room in one colour, and you can't select all colours to use. The live visualisation is really jerky and slow. Very disappointed used to be so much better"* **(system competency)**

> *"Where have all the paint options gone* **(materials)** The *usability of this app is awful. If I select a colour and want to go slightly darker or lighter, I just have to guess now whereas the other app let me go up and down the colour scale"* **(system competency)**

Also, users of the Wanna Kicks app (online reviews) found the app very cool, but they could not enjoy the full *personalisation affordance* due to the system's (in)competency, as it was very slow and took too much battery power to operate:

> *"This is such a cool AR app* **(developed meanings)** *— so easy to personalise and quite good quality graphics* **(materials).** *The only fault is that it runs quite slowly and drains your phone battery"* **(system competency)**

> *"As a trainer/sneaker lover this app is great and has the potential to be amazing once some of the bugs are ironed out"* **(system competency)**

Similarly, IKEA Place users reviewed a similar issue of being unable to control their camera effectively to take real-time images due to the system crashing:

> *"For some reason, it [the app] was about to load* **(system competency),** *I was able to approve my phone's camera* **(materials)** *and agree to the terms, but now it just keeps crashing* **(system competency).** *I didn't even get to use it*
>
> 🤷*."*

For the users to enjoy using the *personalisation affordance*, developers must pay attention to the quality of service (system competency) and the materials they provide. For example, Dulux Visualiser (online review) users reported that even though the app affords *personalisation* by allowing its users to try and match colours, they found a big difference between the virtual colour that the app represented in their space and the actual colour of the item they were trying to match. This is a failure in system competency as the system was unable to recognise the exact colour of the users' items in order to afford them the *personalisation* that it promised. This developed the negative meaning that the user was wasting their time and money by using this app.

> *"Although I like the fact you can try and colour match. None seem to even come close to the colour of the item Also when visualising the room it's shows all the colours much lighter than they actually are* **(system competency).** *We bought a few samples, and they are nothing like on the visualiser or the website* **(materials).** *Complete waste of time and money"* **(developed meanings)**

Moreover, developers usually update apps to provide better versions for their users. However, this is not always the case, as although some users were able to use the personalisation affordance of the Dulux Visualiser app to create their own projects, they reported that they lost all their saved items when they uploaded the updated version of the app. This developed a negative meaning (disappointed) and even ruined the brand image in their minds:

> *"well thanks a bunch developer. In the previous app I had every room in my house stored under My Projects. The upgrade has wiped them all out so all my work with photos and colours using this app is lost. I've looked for somewhere to sign back in but that seems to have disappeared. very, very disappointed!"* **(developed meanings)**

> *"I lost all my room ideas which I had done for the whole house and was gradually getting rooms painted using these saved ideas. Lots of time spent on this, and all gone with the update. Nightmare!"* **(developed meanings)**

> *"Totally agree with the last review - wish I hadn't updated the app as I've lost all my saved colours!"* **(developed meanings)**

> *"Worse still, this version is a total nightmare to use. Who designed it? A ridiculous product from such a big name!"* **(developed meanings)**

Also, developers need to pay attention to the appearance of the app (materials) as the findings show that based on individual characteristics, the appearance of the app may attract visual people and give them a value (meanings) so that they use the app and even recommend it to others. For example, a Gucci app user reflected:

> *"Because I'm a visual person, I would recommend this to others Yes* **(developed meanings**), *because of its appearance and creativity in browsing their products"* **(materials)**

Some IKEA Place app users (reflections) provided recommendations to tell the developers what they wanted to see in the app to improve its usability. Some of the suggestions were about improving the system's competency, while others were about adding some features (materials). For example:

> *"I will add the ability for the users to create their own items, Have a larger selection of items, Recommendations based on user's preferences* **(materials).** *The easiness and fastness of navigation. Automatic backup and recovery"* **(system competency)**

Another user of the IKEA Place app (reflections) recommended integrating artificial intelligence features with AR apps (materials) to enhance the system's competency. This provides evidence that the addition of advanced technology such as AI can enable AR apps to perform multidimensional interactions to provide higher-quality services. For example, integrating AI into AR apps will likely improve the system abilities of the apps (system competency) so that they can learn about users' choices. This could also enable the system to more easily interact with users and predict their expectations by becoming more closely aligned with users' goals. For example:

> *"To make the AR more appealing for users, I would love to see in future* **(expected meanings),** *the developers integrate more artificial intelligence features into AR* **(materials)** *for its easy use, system can learn about users' preferences* **(system competency)** *and help them get what they are looking for faster"* **(users' goal: convenient experience)**

> *"Better use of Artificial intelligence by using the Ai to learn user Individual preferences"* **(materials)**

5.4.3 Section outcomes

For the informed decision-making and personalisation affordance to be used as a social practice, many things should be considered:

1- **User competency:** users must have the skills and knowledge required to use AR advanced technology.

2- **System competency:** most AR app users expect AR developers to develop high-quality apps that perform the required tasks, and which are straightforward and flexible. From the user's perspective, a competent system is a system that provides complete user control over it; for example, being able to control the app's material, such as the control bar. AR developers that develop apps that afford *informed decision making and personalisation* must ensure that the system is competent in recognising the users' materials in order to try and match products in a high-quality service; otherwise, users will not be able to make the right decision about the products. Also, users are looking for reliable apps that keep their personalised projects saved, even if the system crashes or updates. Automatic updates and recovery mode features enhance the system's competency. Moreover, users also look for apps that do not use too much of their battery power. Besides that, users suggested integrating other advanced technology with AR, as they believed that this would probably enhance the AR system's competency; for example, adding AI would enhance AR apps' ability to learn about users' preferences and it would make the app more appealing to its users.

3- **Materials:** developers need to provide AR apps that are compatible with all users' devices and systems. Moreover, the findings show that some users may give negative reviews about AR apps and discontinue using them, not because of the service itself but due to the lack of some materials, such as running out of some products or sizes in shopping apps. Also, users suggested that the developers should consider adding some features to the AR apps that could make *the personalisation affordance* more appealing for them, such as allowing them to create their own products.

4- **Developed meanings:** after experiencing AR apps' affordances, some of the users developed the meaning that some of the activities that had been impossible to do in the past had now become possible with AR materials, such as buying glasses online, which provided a convenient experience for them. It also gave the users the value of seeing how the products would look in their space without spending money. Most users like AR services that afford informed decision making and personalisation. However, problems with some apps may influence their future behaviour, such as discontinuing to use the app. For example, losing users' saved data in updated versions of the apps made them very angry. Consequently, they developed the negative meaning that the app wasted their time and effort when creating projects. Interestingly, some users mentioned that the appearance of the apps could attract visual people to adopt them, which is part of individual characteristics – the appearance of the app gives them some value.

5.5 Goal: Enjoyment

5.5.1 Support the learning process

The support learning process affordance has been identified in various AR apps, for example, Mondly and Pocket Sky. These AR apps afford support to their users to help them reach their goals of enjoying the learning experience. The Mondly app has excellent reviews as an education app that allows users to learn different languages. For instance, it creates images, games, and sounds that help users to learn Japanese. The excitement and fun provided by this app make language learning easy and enjoyable, as confirmed by the online reviewers:

> *"I spent around 20 minutes on the app, and I learnt so much! Japanese is a hard language to speak and write; in less than 24 hours I could even say most of the phrases correctly. That is incredible! Another reason why you should get this app is that it corrects you and the computer pronounces the words so clearly and perfectly. <u>It's also more of an exciting way to learn languages</u>,* **(users' goal: enjoyment).** *which is another bonus".*

> *"This game is amazing all it just needs that there must be more lessons and that's it but even though this game is mind blowing that's all I can say it has amazing games u can play while learning new language this game is just amazing* **(users' goal: enjoyment).** *that's all I can I'm just speechless I don't know how to describe this game all I can say that this game is amazing"*

Some users mentioned that the Mondly app is perfect for learning new languages. For example, during the COVID-19 pandemic, this app was helpful for some users when the world stopped. This gave value to the users as the app helped them to use their time in the right way, which is considered meanings in SPT

> *"Over the corona virus I have learnt French and Chinese so it's a good app*" **(developed meanings)**

> *"This app is great to learn a new language! There are daily lessons and so much content which will keep you busy for years!!*" **(developed meanings)**

However, many other AR users found that the Mondly AR app was not useful; they wrote negative reviews and warned others about using it. The researcher went through the online reviews to identify the reasons behind that. One of the reasons could be the user's competency, as the app's developers did not include any instructions on how to use this education app. A competent user had read many negative reviews and therefore did not expect that the app would perform well; surprisingly, they found that it outperformed their expectations and so the user was pleased with the app's performance.

> *"I do not know why most of the reviews on the app were not good* **(expected meanings).** *If you are looking for a more fun and exciting way of learning languages, then this app is definitely the one for you* **(developed meanings).** *Well, done, the creators of the app*
>
> 😁*!"*

Another reason that was identified was the materials of the app itself. For example, if the content of the app is not straightforward, this confuses users. Some wondered whether they needed the premium version or whether the free version was enough for them; developers must provide a clear explanation of the additional features they provide (materials):

> *"I am studying German after a 20+ gap and the lessons are ok. I have the free trial, but I have not yet explored or understand what additional benefits the paid version comes with"* **(materials)**

The researcher also went through the reviews of another educational app (Pocket Sky) and identified that the materials of AR apps also need to be as good as the users expect; this requires the developers to update and check the content regularly. For example, the Pocket Sky app's users (online reviews) mentioned that the material is not accurate:

> *"We've given you, our trust! I love that you gave humanity an interactive representation of our sky! <u>Please let it be as accurate as you can possibly make it</u>"* (**materials)**

> *"Great app. Simple easy to use. I like the predication for when the planets right a certain height at specific times at night<u>. However, there must be a bug as the sun is still up at 2 in the morning" </u>* **(materials)**

Also, developers must consider different users' skills or experience levels while creating the app content (materials). It is an education app, so it is so vital that the app provides easy materials to understand and is suitable for beginner users:

> *"Not bad, not as good as Duolingo, but ok. <u>The Arabic version</u>* **(materials)** *<u>is unsuitable for beginners </u>* **(users' competency)** *<u>- even starting out at a decent basic level of Arabic I'm struggling</u>* **(users' competency).** *<u>It does not 'teach' sounds or writing or grammar just throws phrases and even phrases in different tenses right at you"</u>* **(materials)**

A similar example from the Pocket Sky (online review) app shows that the material did not match the users' competency:

> *"Disappointed, I am sorry to say that regardless of its many great features I have found this app very difficult to navigate. <u>Pocket sky was simple didn't have as many features but then I'm not an amateur astronomer. Just a simple stargazer who wants to know what I'm looking at on any given night. I don't want an all bells and whistle app. that is so complicated that I just give up"</u>* (**users' competency**).

Moreover, from the researcher's experience, almost all AR apps that support learning provide in-app purchases, so the AR feature that supports the learning process is not free. For example, users of the Mondly app (online reviews) mentioned that the app's free version is limited. The cost of the app could prevent many users from using its affordances as the willingness to pay for the AR service depends on users' values. For example, some users were happy to pay for the app while others found it too much. Cost is considered as a user's expected meaning, as users expected to experience this app affordance for free:

"I am enjoying this app after buying a discounted lifetime access through mashable. I would find it rather limited on just the free access" **(expected meanings).**

"I give mondly five stars because it is an AMAZING app were you learn different languages and if you want to download it do it but there is one thing you have to pay for it if you want all of the levels unlocked but they give a free day trial 😁 so you can try it out this app is free **(expected meanings)** *and also I have had it for a bit and I am learning polish and at the start, I knew nothing but when I started using it helped me a lot so now I can speak it a little bit but I am still practising".*

"If it was free this would be the best language app ever" **(expected meanings).**

Spending money on in-app purchase can develop very bad meanings in users' minds and affect the credibility of the app itself, especially if the developers are not very clear about the payment options. This will drive the behaviour of deleting the app or at least writing a negative review, as per the examples from Mondly below (online reviews):

"Offered me a 7-day free trial of premium and straight away took £9.99 from my account, even more unbelievably **(developed meanings)** *I don't even have access to any of the premium features, I want my money back! SCAMMERS!"*

"Developers should made it clear for the users as what they are paying for and for how long When I downloaded the app it said it was £9.99. Is that a month or year. It didn't say. I deleted the app as it wasn't clear" **(developed meanings)**

"The subscriptions on this app do not unlock the paid content. The "free" trial will actually charge you £9.99. It's an absolute scam. Stay clear of this app **(developed meanings)**

Furthermore, failure in system competency is also a reason for not using the app's affordances. For example, even for users who were willing to pay for this service (meaning), the app did not perform as expected (system competency). Therefore, the users developed the meaning that they had just wasted their money on a bad app:

"*I paid for monthly subscription, but app continues to treat me like free customer and keeps trying to sell ANOTHER monthly subscription when I already have one active* **(system competency).** *They need to have « restore purchases » button like all the good apps have!!!"* **(expected meanings)**

Similarly, another user of the same app reported their frustration due to the failure in system competency:

"Omg this app is frustrating. it has me literally yelling at my phone because it can't hear me although I'm speaking extremely loud **(system competency),** *sad*

> *because it seems like it would be a great way to learn and a lot of fun"* **(developed meanings)**

Interestingly, some users reported their concern about the authentic look of the AI instructors provided by the Mondly app. This AR app affords a virtual learning environment in the user's space. Therefore, the users need to see virtual instructors representing the language they wish to learn (meanings). To maintain the authenticity of the app, developers need to pay attention to the appearance and pronunciation of the AI instructors (materials); below are examples of Mondly online reviews:

> *"I love the app. One thing I wish for though is an authentic look to the AI* **(materials).** *If I am learning Japanese, then the AI should look Japanese* **(expected meanings).** *Otherwise, it's a great app! Thanks!"*

> *"It is hard to place the virtual teacher* **(system competency),** *so she looks natural in the space, and her voice in Spanish is strangle different from that in English"* **(materials)**

When users experience difficulties with using the app features, such as activating the premium version, they usually expect to be able to contact the app's developers to solve the issues. However, the customer service for this app was terrible, as the users could not reach the developers, and this was one of the most common reasons for the bad experiences of users:

> *"Be careful this application they make you pay for a lifetime subscription then without leaving a trace in your subscriptions or be a direct debit in your account they charge you 50£ as they wish and good luck talking to their customer service! No one replies. They just store your credit card details and help themselves* **(materials).** *I had to dispute all the money they stole via my bank. Whatever you do dont waste your time or money here app!"* **(developed meanings)**

> *"I paid for Premium, but You didn't get anything.I sent you an email but You ignored me and my problems* **(materials).***No money and no English lessons!"* **(developed meanings)**

> *"I pay a year subscription for £47.99. But it's never work!!! I contact the app developer, but they never reply!!! I even contact apple and apple said you should contact the app developer* **(materials)**.*!!! They just steal my money!"* **(developed meanings)**

From the reflections data (general recommendations), it was clear that for the AR affordance to be utilised in any AR app, there are several essential features (content) that the developers should consider, especially in education apps. These include, for example, customer service, seeking customers' feedback (materials), and the capability of AR app's system to restore data through email (system competency).

> *"Recovery mode by using email is an important option* **(system competency).** *Customer service is important and probably will add an option that asks the customer "Are you happy with us? If not, tell us why* **(material)".** *This helps me also as a developer to make my app better."*

An example from the Pocket Sky app (online reviews) shows how the customer service is essential for the users, as it can develop the meaning in their minds that the app is reliable and that their money and bank details are in very safe hands:

> *"Been using this app for years, and it just keeps getting better. I really wouldn't mind if the dev charged for big updates. Messaged them a couple of times for issues got a quick response every time. This Dev cares!"* **(developed meanings)**

5.5.2 Section outcomes

For the support learning process affordance to be used as a social practice, many aspects should be considered:

1- **User competency:** users may provide a negative review about the app because they do not have the right skills to use it. This will influence other people's decisions about whether to adopt this app, if they like to read online reviews.

2- **System competency**: most AR educations apps are not free as they provide in-app purchases. Therefore, users expect these apps to provide a high-quality service and to automatically upgrade them to the premium version after they pay. Also, some users recommended a recovery mode by email as an essential feature to enhance the app's competency.

3- **Materials:** AR developers who develop apps that support learning must provide materials suitable for all levels of education; otherwise, users will find these apps difficult to follow. Also, as educational apps, developers must ensure that the materials are accurate; otherwise, they will lose their users' trust.

4- **Developed meanings:** The cost of AR apps is one of the reasons why users do not experience their affordances; however, after experiencing AR educations apps, users found that they give them the value of using their time in the right way, especially in a challenging situation such as the COVID-19 crisis. Users like AR educations apps and they enjoy learning. The findings show that users are willing to pay for this service as it gives them the good value of learning something new at their own convenience and in an enjoyable way. However, some users encountered difficulties with activating the premium version after they had paid for it, and they were very frustrated as they could not contact the app's developers. Consequently, they developed negative meanings and ideas about these apps and started warning others about using them. The findings show that good customer service determines how good the app is in users' minds and it will also influence their decision over whether or not to adopt it as a social practice.

5.6 Goal: Social Sharing

Besides having fun interactions with virtual objects, most users are interested in using AR technology to share their preferences and experiences with family and friends; this goal is achieved through the social connectivity affordance.

5.6.1 Social connectivity

Pulijala et al. (2016) highlighted that many users are now increasingly expecting to see more interactive socialisation functions in apps to help them to gather relevant information. This study identified that the social connectivity affordance of AR apps not only affords users the ability to communicate with others about their product selection and purchase activity, but it also opens a door to others who live in different countries. Through the socialisation function, they are able to request users to shop for specific products, as with AR apps they can try the products online and decide whether or not to purchase them. This helps to ensure that users purchase the right products for others and it makes their shopping process more flexible.

Therefore, AR apps have created hope among users as some provide opportunities for group shopping (social connectivity affordance), even when users live in different parts of the world (e.g., Saudi Arabia and the UK). The participants expressed a wish to engage in shared online shopping experiences to "try on" clothing, shoes, and glasses using the AR app affordances of *representation of virtual objects and interaction with them*. Below is an example from the Gucci app (reflections):

> *"My family in Saudi Arabia always ask me to buy them shoes and glasses from the shops in the UK. So, this app might help them to see if these items are suitable*

> *for them or not by allowing them to try on the products on their own. It will be useful for me to see their decisions before I buy these items for them."* **(users' goal: social sharing)**

The researcher also identified that some tourism AR apps afford *social connectivity affordances* that allow tourists to plan their journeys with others. For example, Paris Travel Guide (online reviews) users encouraged others to try this app to plan their holidays, and they explained how it can help them make the most of their experiences:

> *"When you are travelling, you will see to it that you will have a good travel guide. With this Paris travel guide app, travelling in this beautiful city can be done on your own. The app has lots of features like a picture gallery, offline city map, GPS, and more. Check this out as it is easy to learn, share with friends, and good for collective use."* **(users' goal: social sharing)**

> *"Once we have to select products for all classmates as we are going to trip so this app really makes easy to share with everyone and select the best products that made our trip memorable"* **(users' goal: social sharing)**

Social connectivity affordance was only found in three AR apps, but the users gave these apps a high rating because they believed that they made their experience memorable. For other AR apps that do not afford social connectivity for their users, many users recommended and suggested that the developer should consider social features to make the app more usable. Users recommended including some features (materials) that would allow them to socialise with their family and friends to make their experience enjoyable. Below are examples from Gucci (reflections):

> "*There should be an option to see the product of friends they are trying one."* **(materials)**

> *"A feature to invite others to add in-app to participate and assist in my shopping* **(materials)** *this feature will allow a replacement of group shopping in which family member or friends will be able to quickly login to the App only when invitation may be sent by the person who would like to add someone"* **(expected meanings)**

> *"There should be option to share the screen with a friend* **(materials)** *to do group shopping"* **(expected meanings)**

> *"If I design this app, I would like to add the following features in the app a simple list of products with AR features to try the product, there should be option to share any product on social media or instant messaging with friends there should be option to share the screen with a friend to do group shopping there should be a*

> *feature to share the basket with friends and there should be an option to see the product of friends they are trying one"* **(materials)**

> *"It would be great if the feature of adding someone into the moment of selecting, trying and finalizing the product"* **(materials)**

Similar users' recommendations were identified in the Portal to Paradise app reflections:

> *"I might add a feature to post whatever the customer creates or explores using the app* **(materials),** *which could help others to enjoy the app more"* **(expected meanings)**

> *"I might add a feature to post whatever a user creates* **(materials),** *to help other users to have a vision of what they can do or discover"* **(expected meanings)**

In some AR apps, the developers have already added features that afford *social connectivity*. However, it can be difficult for the users to find out how to use them. For example, the Dulux Visualizer app developers said that the app allows the user to share personalised designs and room ideas with friends and family and to obtain instant colour feedback (social connectivity affordance). However, the researcher could not find any evidence of this feature. Moreover, the app's users wrote reviews stating that due to the poor design of the app and poor system competency, they could not work out how to use its features. This applied especially to users with minimal skills (user competency):

> *"This app has some clever functionality in it, and with a bit of playing around you can successfully see what one of your rooms would look like painted in any dulux colour. However, it is so poorly designed* **(materials)** *that you will have a nightmare trying to do this"* **(developed meanings)**

> *The app has amazing features* **(materials)** *but it's not easy to find all features of the app therefore, it would be hard for the customers who are not a digital native* **(user competency).** *Moreover, it is much complicated to selected different product quickly event the categories of the product to try them one by one therefore, I would like to say that hard to enjoy or find all feature of the app"* **(developed meanings)**

Moreover, the users raised some issues with internet accessibility that could prevent them from using the *social connectivity* affordances. They suggested that the developers should create AR apps (materials) with a high level of performance (system competency). AR app users want these apps to work at slower internet speeds or offline, especially when travelling in less-developed countries. The extract below (general user recommendations) underlines this point:

"I come from a less-developed area where the internet speed is low; many apps take a lot of time to work, so I need AR apps that work at low internet speeds or offline anywhere along our trip" **(system competency)**

5.6.2 Section outcomes

For social connectivity to be used as a social practice, many things should be considered:

1- **User competency:** users must have the skills and knowledge to use AR affordances. However, developers, on the other hand, must provide AR apps that are easy to use so that even non-native digital users can use their social connectivity affordance.

2- **System competency:** with regard to the social connectivity affordance, users expect AR developers to develop apps that can operate in developing areas with a very slow internet, or apps that work offline.

3- **Materials**: developers need to think about adding social share features to their AR apps as most of the users suggested that this would give them a higher incentive to adopt those apps. Developers also need to pay attention to the app's design, as the findings proved that poor design can prevent users from experiencing the features that afford social connectivity.

4- **Developed meanings**: the findings show that users like AR apps that afford social connectivity. This could be one of the most commonly voiced suggestions provided by the users. Users like to share and discuss their shopping selections with friends and family. Socialising through AR apps could encourage more users to adopt AR apps as it gives them the value of being connected with others, even if they are doing online shopping.

5.7 Chapter Outcomes

This chapter illustrated the research findings. The first component of the chapter (section 5.1) started with the walkthrough technique for 12 selected AR apps; this included an account of the researcher's experiences of using AR apps. That process was combined with users' online reviews and reflections. The outcomes of section 5.1 are ten identified affordances that AR app users can actualise: (1) *representation of virtual existent objects, (2) interaction with virtual existent objects, (3) representation of virtual non-existent objects, (4) interactions with non-existent objects, (5) informed navigation, (6) virtual guide, (7) personalisation, (8) informed decision making, (9) support the learning* *process, and (10) social connectivity*. This chapter also provide definitions for the ten identified affordances and linked them with five users' goals; (1) real-time experience, (2) convenient experience, (3) obtaining accurate/required information, (4) enjoyment, and (5) social sharing. The section then concluded with the basic model of the AR framework, which linked to the second section (5.2). This section critically analysed the identified affordances through the lens of SPT elements namely, meanings, materials, user competency and system competency.

The next chapter, the discussion, discusses these findings in relation to the extant literature (see Chapter 2) to answer the two research questions, and to explain this study's theoretical and practical contributions.

Discussion

Chapter 6

6.1 Introduction

This current chapter discusses the contributions this study makes to both theory and practice. The primary focus of this research has been to explore how the usability of AR is impacted by user experience and expectations. Chapter 3 determined that affordance forms the interaction between users and the system to achieve their goals. In addition, Chapter 5 identified ten different affordances emerging using the walkthrough technique and five goals relating to user engagement (online reviews and reflections) in the walkthrough method. Finally, the researcher examined these goals through the lens of Social Practice Theory (SPT), in order to establish the differences between user expectations and experience.

This chapter discusses the findings, comparing them with the extant literature in order to answer the central Research Questions (RQs) of this study: (1) how might users' expectations influence AR app use? And (2) how might usability characteristics of AR influence user experiences? These enable this thesis to present the final framework, which offers: firstly, an understanding of users' behaviour; secondly, their expectations of AR technology; and finally, to establish how AR creates compelling user experiences.

6.2 Influence Of User Expectations on AR App Use and User Behaviour

The first research question focusses on the influence of user expectations on the use of AR apps. Olsson et al. (2013) demonstrated that users' experiences are impacted by their expectations, values, requirements, and needs, with a subsequent influence on their behaviour.

Previous studies have highlighted affordance as consisting of a relationship between users and technology (McKenna, 2020). For example, the affordance of mobile-based applications enables users to achieve their daily goals, i.e. improving fitness and losing weight (Benbunan-Fich, 2019). The existing literature indicates that AR has helped to develop a virtual mirror, permitting the users to have an interactive and realistic experience (Parise et al., 2016). This led the current researcher use personal testimonies and empirical studies to understand AR affordances, including users' expectations and experiences. The findings show the affordances of AR apps as the potential actions enabling users to achieve their goals through interaction with the apps. For example, section 5.2.2 in the findings chapter reveals that *interactions with virtual objects affordance* allows users to successfully interact with virtual products/environments and achieve their goal of real-time experience.

A further example is that an AR *informed navigation affordance* allows users to find, and reach, a destination without losing their way or wasting time. Volkoff and Strong (2017) suggested that the affordance lens promotes understanding of the bundles of affordances and their interactions, including those IT artefacts provide to capable users. IS studies note that an affordance represents the potential for action (i.e. interactions with virtual objects), but that an affordance must first be triggered for an action performed by an actor (in this context, a potential user). Once a course of action has been triggered, the goal-focused actor then seeks to achieve a particular goal (i.e. purchasing a product by means of an AR app) (Volkoff and Strong, 2013, Strong et al., 2014).

Volkoff and Strong (2017) highlighted that affordance actualisation can be beneficial for understanding user actions and system interactions, but fails to clarify the relevant factors (Burton-Jones and Volkoff, 2017, Hand, 2016, Schmidt and Etches, 2012). Therefore, this thesis provides an understanding of how affordance actualisation can play a role in improving the adoption rate of AR apps, in particular through understanding users' expectations and experiences.

The expectations of users of AR apps relate to the following: (1) previous experiences; (2) Word of Mouth (WOM); (3) company promises; (4) personal opinions; (5) personal needs; (6) trust; (7) price; and (8) the ranking of apps by others (McLean and Wilson, 2016). User expectation denotes the features a user wishes to see in a particular app, which can be formed *before* they have an opportunity to use a specific app or technology and *after* having experienced the technology in question. Existing studies demonstrate only limited understanding of the differing expectations and perceptions of AR users, including how they actualise the technology. The current researcher therefore explored users' expectations through the meanings element of SPT, including: (1) symbolic meanings; (2) ideas; (3) shared meanings; (4) aspirations; and (5) users' previous experiences (Shove et al., 2012). Using the SPT lens, the researcher identified that users' goals and expectations were based on their existing (i.e. expected) meanings, including usefulness, ease-of-use and enjoyment. In addition, their expected goals tended to relate to how an *ideal* version should perform, in order to make their virtual experience as straightforward and enjoyable as possible. For example, if the user expected AR to provide an enjoyable interaction, but the app failed work as expected, they developed a new meaning, assuming the app system was not sufficiently competent to allow them to fulfil their goals. These findings align with existing studies, such as that of Heller et al. (2019), indicating that, when faced with such disappointed expectations, users are less likely to recommend AR to their friends (Rese et al., 2017), as well as giving the app negative reviews. This study therefore suggests that user expectation and experience forms a continuous cycle in user behaviour in relation to AR technology.

Moreover, the literature states that users have yet to fully realise the value of AR and have been unimpressed by their existing experiences (Hilken et al., 2018), primarily due to the divergence between the features that are expected and those that are actually offered (Fan et al., 2020). Thus, the main finding of this study is that users are unable to achieve their goals because the app failed to meet their expectations. The researcher chose to study reviews left by users, as these can provide an in-depth understanding of different characteristics required to meet essential criteria (Lin et al., 2011, Liu and Park, 2015, Liu and Ji, 2018). For example, despite acknowledging that the app was free to use, some users declared their dissatisfaction with the design of the layout, i.e. invisible street names, the inability to zoom the map, and the cost of some of the more specialised features. This therefore resulted in an adverse experience, potentially reducing the overall adoption rate of the app, and forcing developers to focus on improving the features, as well as ensuring they fully deliver those promised in the publicity. The existing IS literature confirms that a negative experience has an adverse impact on future use of a system (Alhudaithy and Kitchen, 2009, Lee et al., 2015, Kesharwani and Singh Bisht, 2012). This indicates a need to address such issues, in order to improve the attraction of such apps for users.

AR app users tend to share their goals, complaints, recommendations, and suggestions capable of increasing their adoption. This can include views of beneficial future modifications, in particular in terms of using the app's affordances and achieving goals. Furthermore, expectation-confirmation theory reveals that expectation confirmation (assessed through post-use responses on how the actual performance conformed to expectations) influences both perceived usefulness and satisfaction (Bhattacherjee, 2001). For example, users taking part in this study suggested that the developer add Artificial Intelligence (AI) to recognise user preferences and enable the AR app to carry out multi-dimensional interactions to improve its performance. In addition, AI can facilitate improved understanding of user preferences (i.e. the material used for social practice) and easily interact following the goals of users (i.e. the meaning of the social practice). Even those users who considered the AR app performed effectively expressed a wish to see more variety in its products, to increase the available options. In addition, when describing the failure of an app to meet expectations, one user highlighted the need to hold up their mobile phone to determine their destination, which had the potential to lower the rates of both AR adoption and users satisfaction.

This study revealed that the users of AR apps consider the most important criteria to consist of firstly, appearance and secondly, ease of use. For example, the participants expected the *representations of virtual objects* and *interactions with virtual objects affordance* to be straightforward, so enabling successful and enjoyable interactions in terms of both appearance and high-quality visuals. Moreover, Faqih and Jaradat (2021) stated that it is vital to understand the expectations of users, as this enhances the user experience and subsequently drives their behaviour. Furthermore, both the previous experiences and future expectations of AR users play a critical role in the adoption of a new technology (Smink et al., 2020, Sung, 2021), including its expected usefulness (Osatuyi et al., 2020, Yang et al., 2014). Taylor and Todd (1995) stated that the impact of expectations vary in relation to a user's actual experience, both direct and indirect, of utilising the technology, including whether it creates a satisfactory, efficient, and effective interaction, so offering a more emotionally appealing association between product and user (Parise et al., 2016).

A further study also highlighted that technical affordances can offer users a wide range of possibilities (Markus and Silver, 2008), demonstrating a variety of experiences when using the same app, i.e. some users noted being sceptical of the negative reviews, arguing that those posting them were simply unable to determine the benefits of the app. This led to the development of the second research question, in order to establish how usability characteristics of AR influence users user experiences.

6.3 AR Usability Characteristics Influence User Experiences

This study adopted Valbø's (2021) definition of affordance as consisting of the possibilities of actions emerging from the use of technology to fulfil a user's goal (Valbø, 2021). However, this definition fails to capture critical characteristics involving both users and the technology in question. This can be enhanced through the lens of SPT, to determine: firstly, whether the AR user possesses sufficient competency (i.e. skills); secondly, whether the materials of AR apps align with users' goals; and thirdly, the users' expectations when using AR technology affordances. Therefore, the researcher selected to discuss these elements of SPT in relation to the usability characteristics of AR apps (see the discussion in Chapter 2), these consisting of interactivity, compatibility, and credibility, as discussed in the following sub-sections.

6.3.1 Interactivity

AR apps provide information concerning visual products (Brynjolfsson et al., 2013) by integrating virtual content in the physical environment of technology users, both interactively as well as in 'real-time' (Azuma, 1997). The existing AR literature shows that such apps can save users time, effort and cost, as well as reducing the stress associated with the online service experience, which forms the primary users motivation for using this technology (Linaza et al., 2012, Hassan et al., 2018). Poushneh (2018) noted that such interactive innovations can create 3D content in a variety of styles, orientations, and colours, showing the importance of interactivity for AR. Therefore, the current researcher employed the lens of SPT elements to understand the interactivity of AR technology. This enabled the researcher to demonstrate competency as being vital for enabling users to successfully interact, navigate and operate the functionality of AR technology and achieve their intended goals (Yang et al., 2014, Jafari et al., 2016).

SPT understands user competency to consist of the skills and knowledge (Shove et al., 2012) required for successful interaction with AR apps. The existing literature concerning competencies has highlighted that this includes the practical knowledge, training and experience required to perform certain practices (Røpke, 2009, Shove and Pantzar, 2005, Shove et al., 2012, Reckwitz, 2002), i.e. the use of AR app technology. However, there remains only limited literature focusing on how to enhance such skills and individual abilities. Thus, Labrie and Cheng (2020) indicated that, as it is still an emerging technology, most AR app users should be considered novices, and therefore the use of a variety of different actions should be viewed as potentially confusing. As shown in section 5.2.3, the current findings demonstrate that users' levels of education and experience level can influence their AR competency, although this can be improved by providing in-app instructions, including tutorial videos, chat facilities, and 24/7 guidance. In addition, users can be given information concerning system usage and technical functions, which can be of particular benefit for new users. Furthermore, the findings reveal that, as the users appreciated the concept, they wished to learn more about the most effective use of AR apps, in order to improve their experience.

The findings of this study reveal that many users lack familiarity with AR technology and expect the system's functionality to be user-friendly and straightforward. Previous studies, including those of Barbosa and Faria (2008) and Heller (2012) have explored the impact of the required skills on individuals wishing to adopt a technology, including their continued use. Through applying the SPT lens, the researcher identified that users' competence plays a role in achieve their intended goals, with greater skills allowing them to benefit by adopting AR apps as a routine aspect of daily life. However, by applying the combined lenses of affordance and SPT theories, this research identified that user's competencies remain generally insufficient to achieve the required goals.

The current researcher identified that SPT theory overlooks the concept of system competency, focusing solely on the skills of users. Noble (2009) stated that those engaging with technology are expected to experience the system's characteristics operating in conjunction, in a satisfactory manner together. This study views system competency as the quality of the app's functionality to perform the required tasks, in particular by facilitating successful interactions with users. Therefore, the researcher expanded SPT, adding the dimension of *system competency* to assist in the understanding of AR apps' usability, including their function-based performance, durability, and recovery process. The findings revealed that current AR apps require further improvement to achieve users' goals, including: firstly, the reaction process; secondly, the system response speed; and thirdly, the loading time (Kucirkova, 2017, Delagi, 2010). For example, this study revealed that the participants experienced a number of issues when using AR apps: firstly, the system tended to constantly crash while multitasking; secondly, it took a long time to load; and thirdly, it drained the mobile phone battery.

An essential dimension of interactivity consists of the speed of a system, which plays a vital role in helping users when multi-tasking over the same device (Gao et al., 2010). The previous literature on IS also confirmed that poor speed, loading and reaction time (Dantas et al., 2009, Dinh et al., 2013) can decrease motivation to continue to use a particular technology. This raises the importance of the system's capability to ensure that it is user-friendly (Butler and Gray, 2006), alongside improving its ability to maintain interest. Moreover, some users have shared their annoyance with the length of time an AR app takes to load, while at the same time stating that their interaction with the system would be improved by requiring less time to control or learn. In addition, others have shared losing control over the camera while trying to achieve real-time experiences, due to the AR system constantly crashing.

Moreover, some users felt that adding AR to existing apps is not always a positive experience. One example given was that of Google maps, with the street view map being harder to operate, as well as new updates requiring more knowledge and expertise, so making the system more difficult to control. This led them to recommend that the AR app developers should focus on addressing this issue. They also posted negative reviews, warning others of the length of loading time, as well as the system's tendency to constantly crash, and noting that a black screen can sometimes appear when the AR app is opened.

This current study revealed that competency of both the users and the system forms a vital prerequisite for facilitating successful interaction. For example, if users wish to employ an AR app affordance to plan a journey, their success depends on their skills and knowledge (user competency), alongside the capability of the selected app to perform the required task (system competency). Consequently, system competency is considered an integral element of the affordance of this technology. For example, some users stated that, although they enjoyed the *personalisation affordance* of the AR app, they felt it used too much battery power, so lessening the app's convenience. This demonstrates the link between affordance and SPT elements (e.g., system competency).

6.3.2 Compatibility

Huang and Benyoucef (2014) highlighted usability elements as compatibility, cost, and usefulness, In addition, previous literature has viewed compatibility as multi-dimensional, including being presented from various perspectives, i.e. cost and benefit (Yoon and Youn, 2016), and suitability for performing system operations (Huang et al., 2011). Therefore, the researcher used the SPT material element to discuss the issue of compatibility from a number of different dimensions, i.e. the apps' materials, its users, and social compatibility:

1/ *Mobile phone compatibility:* The compatibility of an AR app includes its technological compatibility with existing infrastructure (i.e. differing models of mobile phones) enabling ease of use, as well as downloading, installing and updating. For example, mobile devices may have additional software and hardware requirements and dissimilar operating systems. According to Adamczyk (2017), the applications successfully pass the testing stage if they meet the suitability of hardware and software. However, many AR users have been unable to employ apps due to being incompatible with their devices.

2/ *Suitability of materials to achieve users' goals:* The existing literature has established that some of the common prominent reasons behind the failure rates of emerging technologies consist of: (1) a lack of uniqueness; (2) poor design; and (3) insufficient knowledge of user needs and expectations (Jigyasu, 2018, Blair, 2018). This indicates that it is vital to address user expectations concerning AR app materials, i.e. appearance, including how it looks and feels. For example, this study's findings (section 5.4.2) revealed appearance as being one of the essential usability characteristics attracting users to use the app, particularly 'visual persons'. Moreover, the app's content attracted negative reviews due to the absence of some features and materials, i.e. shopping apps that ran out of products or sizes. Furthermore, the users considered the authenticity of the app's content important to emphasise its experience, including for education apps to provide a convincing virtual classroom environment, i.e. those used for learning Japanese requiring AI animation using a related style.

3/ *Compatible experience:* Costa et al. (2014) emphasised the need for the materials of AR apps to align with the user's current knowledge, existing values, and needs. For example, users confirmed that such materials are not always straightforward to use, as well as being incompatible with their current skills. According to Jetter et al. (2018), the required level of skills also depends on the system design, i.e. its ease of use. For example, the findings revealed that some users lacked a complete practice-based knowledge of AR apps. Stowell et al. (2018) stated that the skills level required is dependent on effective system design (Jetter et al., 2018). This study is consistent with Røpke (2009), Holden and Rada (2011) and Labrecque (2012), confirming that continued popularity depends on both systems and materials being user-friendly. Therefore, this study provides a rich understanding of user-friendly AR apps, including the levels of expertise and knowledge required to operate them successfully. This established that the design and layout must be simple to work and be easily used by those with less expertise and practical learning experience. In addition, the layout should include the organisation of visual elements to ensure ease of interaction, comfort, and attractiveness, i.e. search engines, images, 3D information, offline GPS, slide functions, and phone browsing.

Although existing studies of smartphone interactions have attempted to evaluate the elements associated with user experience (Kim et al., 2012, Kim and Sundar, 2014), there is still little understanding of the benefits of system compatibility and layout design. The current study has revealed that an excellent layout, colour scheme and design can result in a positive experience and improve user satisfaction. For example, some have shared their purchasing experience as being more enjoyable due to the design and search engine of the AR app. Another user cited the benefits of colourful and clear visual elements, as well as being easy to navigate and having a good interface.

4/ *Social compatibility of AR*: According to Barnes and Meyers (2011), the social acceptance of an app is considered a compatible feature, resulting in users wishing to match the system to their needs and lifestyle (Kocheilas, 2018), and any failure decreasing their intention to continue its use . For example, this thesis's findings (see section 5.3.1) revealed that AR material is not necessarily socially compatible. Thus, holding the camera up and using AR apps in public places can increase concerns related to privacy, particularly as these can capture video/pictures of others in public places.

To the best of the current researcher's knowledge, no studies concerning AR apps have discussed the issues regarding social harmony, i.e. their use in public spaces. This thesis has found some complaints regarding the social harmony of AR apps, with users highlighting that holding up their mobile to recognise buildings and streets can cause difficulties, as well as being incompatible with some weather conditions, e.g. extreme cold, wind and rain. This demonstrates the need to improve this feature, as it can enhance the usage of AR *informed navigation and virtual guide affordances.*

5/ *Compatibility between the benefits and cost of AR apps:* The relationship between the benefits and cost of AR technology is more balanced in the adoption process (Yoon and Oh, 2022),with the monetary value related to the user's experience of the balance between cost and value for money (Venkatesh et al., 2012). This thesis's findings (section 5.3.2) indicate that users expect AR apps to be free to use, and are disappointed when the app constantly asks for upgrades. However, results also showed (see section 5.5.1) that users are willing to pay if they feel the app gives them value for money, e.g., AR education apps.

One of the essential factors influencing continued use of the AR app was found to be cost, as supported by existing studies of IS (Barnes and Meyers, 2011, Van Rijnsoever and Castaldi, 2011, Yoon and Youn, 2016, Venkatesh et al., 2012). Many of the users considered that, in addition to being free, AR apps should also provide users with the best services. The participants shared their previous experiences, outlining the attractiveness of the AR app as being due to its various features, but noted that, after downloading, they discovered the features they wished to use required a payment they considered unaffordable. This led to the suggestion that AR app developers should offer cost-free features that are useful. Furthermore, the existing literature concerning IS highlights that, over recent years, low prices have driven the rapid growth and expansion of new technologies (Garrett, 2010, Kim, 2015, Van Rijnsoever and Castaldi, 2011, Yoon and Youn, 2016). This reveals that the primary expectation of AR app users concerns high-quality supportive services at an affordable price, so helping users to achieve their expected goals.

6.3.3 Credibility

A further critical dimension of usability relates to credibility. The current researcher used the SPT Meanings and Materials elements to discuss the related issues through a number of dimensions, i.e. trustworthiness, privacy, and security. The element of meaning focuses on users' expectations of the system, i.e. the usefulness of the technology. The existing literature on technology views usefulness and value-added features as influencing long-term use (Buellingen and Woerter, 2004, Bomil and Ingoo, 2003, Wang and Liao, 2007, Dantas et al., 2009, Karahasanović et al., 2009, Dinh et al., 2013). However, the researcher identified that meanings in SPT focus solely on the user's existing ideas or expectations of AR apps. Therefore, in order to understand the aspect of user credibility usability, this study expanded the meanings elements of SPT to cover those users develop *after* experiencing the app.

1/ *Trustworthiness*

Dimitriadis and Kyrezis (2011) described trust in the context of the online environment as the willingness of users to give personal and financial information. As some AR apps offer the facility for in-app purchases, the user expects such payments to be secure. However, this study revealed that some users had lost money when they upgraded some of their AR apps, resulting in a feeling of being deceived. Moreover, user expectations of such apps are largely based on the claims made by service providers (i.e. in their advertisements), in conjunction with their previous online (or app-based) experiences. However, a failure to meet these expectations can result in a service gap (McLean and Wilson, 2016). For example, the findings of the current research showed that users experienced a gap between the paid version of a service advertised by the developers and their experience, including the system continuing to treat them as if they were still using the free version. According to Wu (2013), users' complaints concerning technology tend to increase in line with a failure to provide the promised performance. This was found to be the case with the users of AR apps, in response to their negative experiences, along with issues related to trust.

2/ Users' privacy

Olsson et al. (2013) considered the chief drawbacks of AR apps as users' privacy concerns over privacy. The findings of this study confirmed that users are aware that these apps require access to their data and read the app's privacy policy before using the app, which was not provided in most of the AR apps selected for this study. Huang et al. (2019) stated that AR users wish to control their personal information, and regard privacy as an integral aspect of quality and experience, which determined their views of the credibility and trustworthiness of AR apps. This indicates that privacy issues could prevent many users from using AR affordances.

3/ Security

The findings also showed that users were concerned about security when making payments through their AR apps. The findings in section 5.5.1 revealed that the app's content (materials), including successful interaction with customer service through the live chat option, is an essential feature determining the app's credibility by enhancing its security. For example, the findings showed that, when the participants experienced problems while making payments through AR apps, they were disappointed when they found themselves unable to reach customer service, and subsequently warned others against wasting their money on such apps. Some users also recommended that, in order to enhance the app's security, providers add an email verification step.

6.3.4 Users' behaviour characteristics

It has recently become popular to share both positive and negative experiences of AR technology on social networks (Sung, 2021), so engaging further users through WOM exchanges about brands and technologies. However, the findings suggest that online reviews fail to offer a complete picture, due to views of the performance of each specific AR app being subjective and depending on a number of factors, i.e. differing expectations and levels of competency. Therefore, it is specific user behaviour characteristics that align with AR app users' experiences and expectations. This research found that the existing literature did not provide much understanding of technological features determining user experience, which is the main focus of this study, in order to understand the user and technical characteristics in the context of the AR app adoption (Dantas et al., 2009, Karahasanović et al., 2009, Hassan et al., 2018). This study provided an understanding of the most likely technological expectations of system artefacts capable of improving the adoption of AR apps. Hutchby (2001) also highlighted that affordance may include constraining and enabling elements for technology users. However, this study provided an understanding of both the positive and negative views of AR users when it came to technological affordances. For example, while sharing their previous experiences, some revealed that a number of features only function when they are walking with the phone, in particular the live view feature of the Google Maps app, which *informs navigation*, but which tended to crash (section 5.3).

The existing literature focussing on affordance fails to capture AR users' most critical expectations (Karlsen et al., 2019, Strong et al., 2014) highlighting their significant goals. *The unique contribution of this study therefore concerns how the meanings, materials, and competencies of social practices are interlinked and facilitate the use of AR affordances*. This is particularly important as discussion of these linkages has found to be missing in the existing literature (Osatuyi et al., 2020, Yang et al., 2014, Shove et al., 2012, Røpke, 2009). For example, this study highlights that users desire real-time experience through multiple affordances, including representations of virtual objects and informed navigations. This indicates that users consider that this AR affordance enables them to save time by showing them an accurate direction, while the system artefacts, (i.e. the AR apps) include system compatibility with their device, including during phone calls. System competency relates to the apps' level of functionality (i.e., auto-update features about the destination during multi-tasking) capable of operating satisfactorily together in conjunction with current levels of user competency.

A number of researchers, including Sun and Zhang (2006), Dickinger et al. (2008) and Manovich (2006) have highlighted that the personal experience of users is directly associated with their motivation to continue to use technology, including characteristics they experience as pleasurable. Previous studies have also indicated that players who experience happiness or pleasure show a greater inclination to use that specific technology (Huang and Cappel, 2005).

However, there has previously been little discussion of *the specific characteristics involved, along with how these can encourage AR adoption, therefore confirming that* *this study has bridged this gap in the literature*. Bakhsh et al. (2017) and Zhang et al. (2017) found that the difference between users' expectations and their actual experience of the system's usability influences their future behaviour. This didn't explore, particularly in the context of AR apps using the lens of affordance and social practices theory. The meanings of user experience highlight the difference between their expectations and actual experiences, including how their meanings are changed after experiencing AR technology. This *is another contribution of this study*. In addition, this difference between the experiences and expectations of users can provide developers with the direction to enhance overall AR app performance. Table 6.1 provides an in-depth understanding of users' changes of meaning after experiencing AR apps using the lens of Socially Practiced Affordances (SPA).

Moreover, users' experience can also indicate the ideal attributes of an AR app, so enabling its developers to implement further improvements. For example, the participants in the current study gave a number of suggestions and recommendations for enhancing the adoption of AR apps. This included the integration of AI features to offer an additional ability to learn users' preferences, thus enhancing system competency and saving time in achieving users' personal goals. In addition, the social connectivity affordance of AR apps (which, as shown in section 5.6, was only found in three out of twelve) encourages their adoption, by allowing geographically dispersed users to communicate. This socialising aspect of AR apps allows users to share their ideas and experiences with their social circle, and employ the most effective 3D features to take real-time optimal purchase decisions. In addition, they can share different products and items with their home families in real time. This aspect can enhance the user's intention to continue to use this interactive technology, particularly as such social experiences enhance WOM within their social circle.

Furthermore, as users need to be convinced of the benefits of AR apps, they need to be encouraged to try them by being simultaneously low-cost and with clear advantages. AR users heavily rely upon technology to make purchases at all times and from all locations, indicating that apps should be capable of working on a low Internet speed, while providing 24/7 help and chat services and accessibility to Internet banking and social features. This also makes users more likely to recommend the app to others.

6.4 Socially Practised Affordance Framework

In this study, the researcher used affordance theory and SPT to develop Socially Practised Affordances to examine the potential impact of user expectations and experiences on AR usability. According to Volkoff and Strong (2017), affordances arise from the relationship between the technology and actor, making it therefore imperative to distinguish between the technology's affordances and its features. However, Norman (1999) believed that the designer of an artefact plays a pivotal role in facilitating affordance (McGrenere and Ho, 2000). Moreover, Fromm et al. (2020) indicated that several authors have identified contextual factors either inhibiting or enabling affordance actualisation, i.e. the work environment, individual competencies, skills, and attitudes, as well as IT features and infrastructure (Jung and Lyytinen, 2014, Strong et al., 2014, Bygstad et al., 2016, Burton-Jones and Volkoff, 2017, Thapa and Sein, 2018, Du et al., 2019, Krancher et al., 2018, Karlsen et al., 2019, Leonardi et al., 2019).

The current researcher adopted Valbø's (2021) definition of the affordances of IT artefacts (i.e. AR apps) as consisting of the actions users are able to undertake once they have the appropriate skills to achieve their personal goals. This demonstrates the three factors of affordance theory as consisting of: firstly, AR apps; secondly, the goals of users; and thirdly, users' abilities. However, affordance theory ignores both the usability characteristics of the app and the user competency. As a result, the current researcher identified a need to examine the elements capable of facilitating the affordances of AR apps by adopting SPT.

Table 6.1: User expectations and experience through the SPA lens (Expected and Developed Meanings)

AR app user understanding									
User expectations (Before use)					**User experience (During and after use)**				
User expectation	***Expected* Meanings**	**Materials**	**Users' Competencies**	**System Competency**	**User experience**	***Developed* Meanings**	**Materials**	**User's Competencies**	**System Competency**
It provides understanding of users' expectations (i.e., past experiences, WOM, promises) either before or after using the AR app. It can provide in-depth understanding about the usability characteristics sought by users.	Explains the intended goals of users when employing the affordance. It includes their inspirations and ideas that can help developers enhance the usability of AR apps.	The material of user expectations refers to the features of the intended system enabling users to employ AR affordances. For example, users expect AR apps to be compatible with both their mobile phone and their needs.	The ability of AR user to employ AR affordances. For example, users' expect AR apps to provide some instructions, i.e. video tutorials.	The capability of system and its technological features to perform the users' tasks, and which can influence the use of AR app affordances. For example, AR users consider the most important characteristics to include expectations functionality, appearance and reliability.	Includes users' feelings and thoughts after experiencing AR apps, primarily when they evaluated whether the technology fulfilled their expectations prior to use. This is helpful for improving users' attitudes to AR.	This discussed changes in users' ideas of AR technology after experiencing the apps, including their most motivating or disheartening experiences. This therefore offers suggestions to AR developers for enhancing user engagement, including recognising that users' shared meanings on the online platform can influence others to try the AR app.	This included various experiences related to the system artefacts helping to actualise the affordance of AR apps, i.e. social compatibility and cost/ value.	This focused on users' abilities and needs while experiencing AR apps, including whether their experience matched their current skills and knowledge to facilitate their interaction with the app and use its affordances.	This examined experiences of system functionality, appearance, reliability and durability, which are considered the most important usability characteristics by AR users.

In SPT, Shove et al. (2012) argued that, for a practice to be successful, its components must be mutually coherent. Hence, a successful practice must involve factors facilitating the smooth undertaking of routine practices or behaviour (Røpke, 2009). Holtz (2013) considered coherence to form a central concept of social practice. In addition, Røpke (2009) noted that such practice constitutes a routine behaviour when it harmonises meanings, materials and competencies. However, these elements of social practices have not previously been explicitly interlinked with affordance theory in the context of users behaviour relating to AR apps. Therefore, this research argues that the use of socially practised affordances relies on existing functional affordances. However, it is not possible to employ the existing affordances for socially practised affordances until SPT elements (i.e. meanings, materials and competency) are coherent, as shown in Figure 6.1.

The current researcher has identified ten affordances of AR apps, including: (1) *representation of virtual existent objects (2) interaction with virtual existent objects; (3) representation of virtual non-existent objects; (4) interactions with non-existent objects; (5) informed navigation; (6) virtual guide; (7) personalisation; (8) informed decision making; (9) supporting the learning process; and (10) social connectivity*. This study argues that the actualisation of these AR apps is created through the coherence between SPT elements.

To explore the underline motives prompting users to employ AR apps, the current researcher expanded SPT to also consider the response of users to their actual experiences. This included the difference between their expected meanings (i.e. prior to using the app) and their developed meanings (i.e. after using the app) determining their future use of these affordances. Establishing these meanings provided a number of insights into unfulfilled goals, complaints, recommendations, or suggestions capable of informing IT developers of potential strategies to increase the adoption of AR apps.

The material elements included the social actors and objects required to perform social practices (Reckwitz, 2002). Therefore, this research conceptualises AR apps as material elements from a social practice perspective (Shove et al., 2012). Thus, it examined the social usage of the AR app to gain a detailed picture of the relationship between its related elements. This enabled the study to extend the application of social practice theory in IS research, including from simply describing the features of services, to demonstrating how these elements are linked (Jin and Cai, 2022). Affordance theory define the role of system artefacts, while overlooking the overall material element related solely to the system, i.e.

the usability of AR app affordances. However, the ability to fulfil user goals also depends on the mobile itself, which includes various types of material, i.e. the operating system. On the other hand, the material element of social practice covers any related aspect required to achieve the goals of the users. Previous studies have also suggested that, in order to understand behaviours, it is vital to comprehend the harmony, or coherence, of social practices (Kasavin, 2017).

Furthermore, affordance theory provides an explanation for the relationships between the constituent aspects of social practice and the material components, such as the AR apps explored in this study. This theory focuses on interpreting users' expectations and experiences, in order to balance the objective properties of technology with individuals' subjective interpretation during actual use. Jin and Cai (2022) employed social practice theory and affordances to examine the smartphone shopping of Chinese tourists. However, in contrast to the current study, they explored how the smartphone as a material object was linked to the other elements of SPT (e.g., meanings and competency) by actualising the mobile's affordance, thus identifying that Chinese tourists used the smartphone affordance to improve their competency.

The current study employed affordance and SPT to explore the characteristics influencing the actualising of the app's affordances. In addition, Jin and Cai (2022) considered that researchers are able to shed new light on the interconnection of materials, individuals and social practices, in particular by synthesising affordance and SPT theories. This indicates that affordance theory describes both the enabling and constraining features of materials and their potential actions (Raymond et al., 2017, Bloomfield et al., 2010). Moreover, although social practice theory outlines how materials (i.e. technologies and tools) form constituent components of social practice (Shove et al., 2012), SPT is unable to determine the connections between materials and other elements of social practices, including how these are related. Therefore, this study links SPT elements with the usability characteristics (i.e. interactivity, compatibility, and credibility) of AR apps, by demonstrating the impact of users' expectations and experiences on the usability of app affordances. It is therefore one of the first studies to exclusively investigate the role of interactivity, compatibility, and credibility in the adoption of AR apps. Appendix D provides a visual representation of the SPA theory.

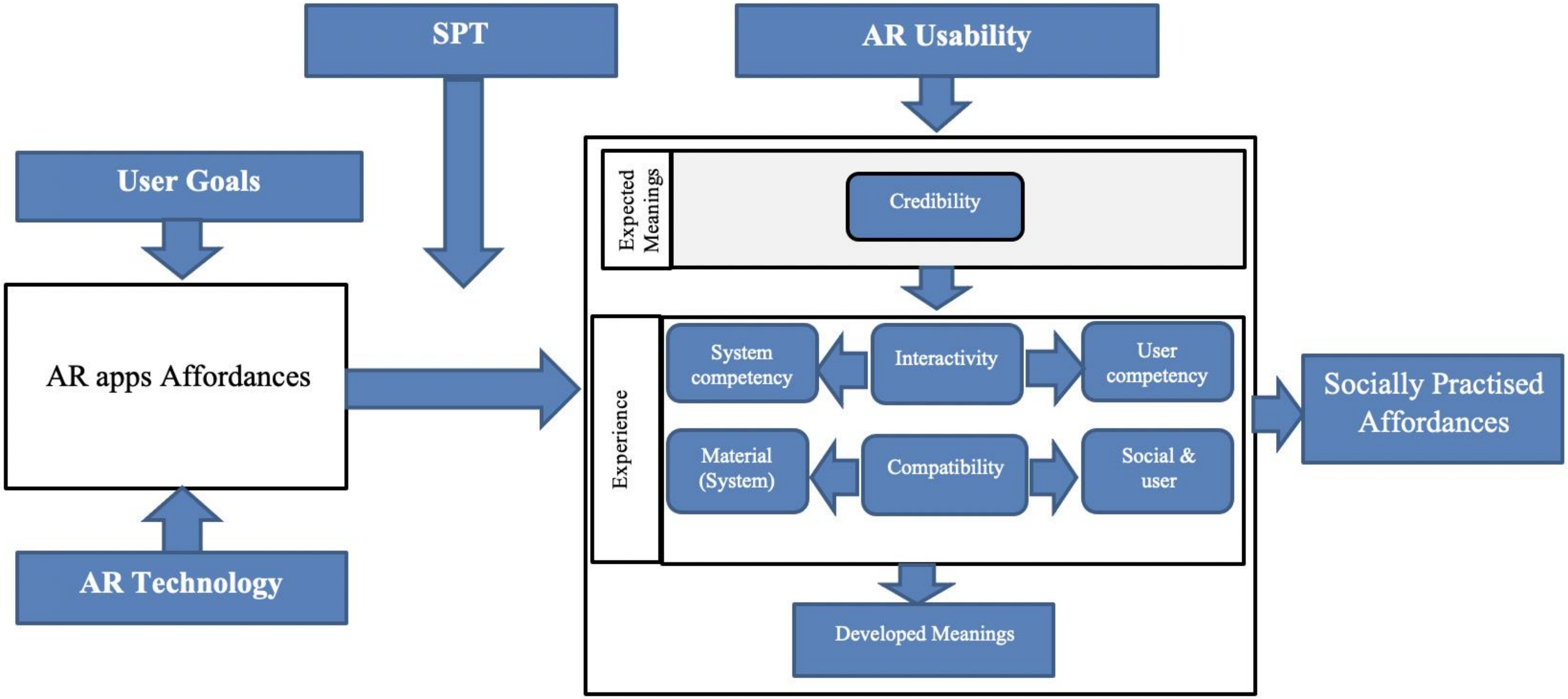

Figure 6.1: Socially Practised Affordance (SPA) framework

This research has introduced the term of socially practised affordance in relation to the usability of technology. Affordance theory focuses on the interaction between user and environment to achieve anticipated goals through interaction with technological artefacts (Valbø, 2021), but does not consider the role of user competency during successful interaction with the system to achieve their required goals. However, this aspect is addressed by SPT. This current research also contributes to SPT by considering the elements of system competency exerting a significant impact on the usability of AR apps.

Furthermore, it has examined how users' satisfaction with the ability to fulfil goals through technology such as the AR app is dependent on their expectations, as understood through the meaning element of SPT. Additionally, applying these theories can align the usability elements of AR apps with the theoretical aspects, which forms a further contribution of this research. The competency of both the user and the system competency form an integral element of interactivity of AR apps. At the same time, neither affordance theory, nor social practice theory, captures the compatibility required to achieve the required goals through a combination of materials, system, user competency, cost/value, and social aspects. Therefore, this current research contributes to the literature by determining the compatibility of competencies, including that material and social compatibility is vital for achieving users' goals as a socially practised affordance of the system. Furthermore, this study contributes the observation that the credibility of a system is influenced by the differences between the expected meanings and users actual experience, which can lead to the development of new meanings after experiencing the app.

6.5 Contributions

6.5.1 Theoretical contributions

This study presents SPA as a theoretical contribution combining affordance theory and SPT, to provide rich insights into understanding user behaviour and the usability of AR technology. This study provides new insights into AR app affordances, as well as users' individual goals, which prompts them to award differing meanings to the usability of AR apps. In addition, users have different abilities and knowledge (user competency) and use different materials, particularly when it comes to their mobile devices. Therefore, existing affordances are not used for socially practiced affordance until the SPT elements (i.e. meanings, materials and user and system competency) are aligned.

The framework developed in this research offers an understanding of the contextualisation and alignment of social practice theory elements and the usability of AR apps. A number of previous studies have explored technology usability by focusing on how the behaviours system users can impact on: (1) interactivity (McLean and Wilson, 2019); (2) compatibility (Zahabi et al., 2015); and (3) credibility (Jung et al., 2021). The framework of the current thesis is unique in that it provides an understanding of the three elements of AR app usability (i.e. interactivity, compatibility, and credibility), which play several roles in relation to user expectation and actual experience. Thus, this framework reveals that AR app interactivity can be explained through two significant elements of SPT, i.e. user and system competency. This differs from previous studies, which have determined user competency to form an element of social practice theory (Ryghaug and Toftaker, 2014). Therefore, this current thesis has added a new element to SPT in the form of *system competency*.

The researcher argues that both user and system competency can help achieve the goals of AR users, while compatibility demonstrates the compatibility of AR app materials. Furthermore, various studies have outlined the importance of credibility, which can influence the use of a particular technology. For example, Olsson et al. (2013) revealed that concerns over privacy could act as significant drawbacks when using AR apps. Therefore, the research framework of this study reveals that the expected meanings are linked with the credibility of AR apps. This demonstrates that the research framework extends an understanding that the meaning element of social practice theory can be divided into two types: firstly, expected meaning attached to credibility and secondly, developed meanings, capable of shaping specific user behaviour towards the adoption of AR apps. Table 6.2 summarises the theoretical contributions, followed by Table 6.3, which answers the two research questions and demonstrates the benefits of the two selected theories, i.e. affordance and SPT.

Table 6.2: Theoretical Contributions

Contribution	Description
Socially practised affordance theory	• This thesis introduces the new theory of SPA by integrating affordance theory and SPT. SPA allows AR apps users to actualise affordances when coherence is present between SPT elements (i.e. meanings, materials and competency) • The application of affordance theory with social practice (i.e., SPA) establishes a new lens to explore the usability of AR technology (AR affordances), and so to better understand user behaviour. • An exploration of how these AR affordances can be actualised through understanding the elements of social practice, how SPT elements are interlinked and influence AR users' behaviour, thus developing users' future behaviour.
Affordance theory literature	• This thesis contributes to the affordance literature by exploring and synthesising the user goals related to AR app affordances, through the dual lens of user expectation and user experience. In this study, AR affordances indicate potential actions enabling users to achieve their expected goals. This thesis also informs user behaviour through the lens of the usability of a system in the context of user expectation and experience. • Affordance theories do not tend to examine the role material elements play in achieving users' goals. This research explores the compatibility of the materials and the system with the users and their social practices, playing a critical role in using AR affordances. In addition, this compatibility developed the user experience capable of encouraging AR adoption. • This research also contributes to Affordance Theory by clarifying the role of the compatibility of the AR apps with the users and social practises that also encourage adoption of AR technology.

AR usability literature	• This research explored user behaviour by considering a system's usability. It identifies three significant characteristics of the usability of AR technology, i.e. the system's interactivity, compatibility, and credibility. Therefore, the identification and synthesis of the usability elements with SPT contribute to the understanding of the factors leading to the adoption of AR technology. • For example, this study suggests that the credibility of AR apps is influenced by the gap between users' expected and actual meanings, in particular in relation to the promises made by developers. This can develop a new meaning, influencing their behaviour.
Social practice theory	• This thesis contributes to SPT literature by identifying the importance of *system competency*. • SPT considers that users' competency in facilitating social practices. However, the achievement of users' goals, through their interactions with the AR system, is based on system and user competency facilitating the interactivity of the system. Therefore, this thesis contextualises the fact that users' experience is based on these competencies that facilitate (or hinder) the use of AR affordances and the achievement of users' goals. The addition of the aspect of system competency promotes its interactivity to develop user behaviour. • This research contributes to SPT by explaining two types of meaning attached to the social practices of AR technology, which drive user behaviour, consisting of: (1) expected meanings (i.e. before using the apps) and (2) developed meanings (i.e. after experiencing the app).

Table 6.3: Two research questions and how SPA helps answer these questions

Research Question	Findings
RQ1: How might users' expectations influence AR app use?	This research demonstrates how users' expectations of AR apps can influence both behaviour and future adoption. **Specifically, this study identified ten AR apps' affordances and five users' goals through the lens of SPA, in relation to participants' expectations.** **In terms of RQ1, this research suggests a user with a specific goal has expected actualised affordances that can influence their behaviour in using or adopting AR apps.** For example, a user may read/hear negative reviews about an AR app and this can result in negative expectations which might influence their behaviour in not using and adopting the aforementioned app.
RQ2: How might usability characteristics of AR influence user experiences?	This research also examined motives potentially determining users' behaviour in adopting and using AR app affordances. **Specifically, a conceptual framework consisting of affordances and the SPT elements of meanings, materials, and competency demonstrates how specific AR usability characteristics can influence user experiences.** **In terms of RQ2,** this research explored apps' usability through three characteristics of AR apps. Firstly, interactivity (i.e. user and system

	competency); secondly, compatibility (i.e. the compatibility between AR app materials and users' current skills, as well as social compatibility and compatibility between AR apps' value and their cost) and thirdly, credibility, which focuses on trustworthiness, privacy, and security. These three elements were found to create the user experience, in particular by developing unique expectations. For example, if one's experience of an AR app fails to meet their expectations, users viewed the app as incapable of fulfilling their goals. This can then direct their future behaviour, e.g., in writing negative reviews, and telling others not to waste time on such apps. However, both positive and negative experiences of participants also demonstrated how both the system and AR app users could become sufficiently competent to fulfil the latter's goals. Finally, combining RQ1 and RQ2, this research suggests that user expectations and experience are central to a continuous cycle in developing behaviours in relation to AR technology.

6.5.2 Practical Contributions

Volkoff and Strong (2017) highlighted that, when appropriately applied, affordance theory allows researchers to create new levers that enable managers to solve practical problems, including users' expectations of AR apps being confronted by the kinds of technical and social problems experienced during use. This research has identified a series of practical implications for the developers of AR apps, including identifying issues concerning usability that should be considered during the design stage. This thesis provides a guide to the app's designer of what users expect from the AR apps pre-design. The new model of SPA could help AR developers understand the users' needs and improve/enhance the current AR apps. In other words, as the developers may lack an understanding of what users expect from AR apps, this thesis's findings suggest how the developers could use the SPA framework to help users actualise AR app affordances. Hence, systems developers should place greater emphasis on providing more convenient apps for enhancing users' experience, so promoting their adoption as an aspect of daily life. For example, this study, by advancing SPT through a consideration of system competency, can assist AR developers in understanding that system competency can work as either an enabling or a constraint. Some of the prime features determining the quality of the system were found to include loading time, responsiveness, and system speed prevented the users from achieving their goals in a timely manner, so increasing their frustration. In this regard, several AR users in this study recommended the integration of AI features, as they believed this could improve system competency.

Moreover, AR developers need to urgently address a number of specific compatibility issues currently exerting a negative impact on the adoption of AR technology, including emphasising the harmonisation of apps and mobile systems. The participants also noted a divergence between the developers' statement that the AR app was compatible with current operating systems, and their own experience of difficulties when installing and during use. Furthermore, in highlighting the limitations of AR apps when it comes to user experience, this study can encourage system developers to understand the implications of social acceptance for the adoption of AR technology for daily life. For instance, some AR users complained that the materials of AR apps are not socially compatible, i.e., the requirement to hold up their mobile phones to determine destinations or buildings. The researcher elaborated that system compatibility must be made in parallel with user experiences and values, to enhance acceptance and levels of trust (Owen, 2008). Hence, users' actual experiences can assist AR developers in avoiding the perception of an invasion of privacy when using the app in a public place.

In addition to that, this research has identified a series of practical implications for organisations commissioning AR apps. Various practical implications concerning usability and users' developed meanings can provide insights into actual experience, i.e. unfulfilled goals, complaints, recommendations, and suggestions. For example, this study has gained a number of insights into the credibility of the current AR apps, including establishing that some AR users were unaware of the cost incurred by upgrades, which then decreased their level of trust. A recent study by Bradshaw (2021) found trust a significant factor when deciding to use a system, being directly associated with cognitive authority, and ultimately leading to credibility (Bradshaw, 2021). In addition, some AR app users stated being disappointed when the apps they had downloaded charged for most of the features they required. Therefore, this study recommends that either the company using AR provide these features free of cost or clarify which features require payment in the download description section. Also, this study identified the actual experiences undermining the trust of AR users and which therefore urgently require an immediate solution, including difficulties in challenging payment terms for the upgrade of the AR app, accompanied by an inability to access customer services. This indicates that companies should place additional emphasis on online customer services, i.e., live chat. This would also avoid negative online reviews about deception in relation to the cost of AR features.

Finally, this study identified a number of issues relating to system updates, including the addition of AR, which can be difficult to operate, particularly in the absence of advanced skills. Hence, organisations interested in adding AR services to their current apps should pay extra attention to these issues. For example, issues were found to relate to SPT's competencies, materials, and meanings, with a new update (material) often requiring additional expertise (competencies), which can result in the app becoming more difficult to use. In this regard, some specific AR app users, such as Dulux Visualiser and Mondly, emphasised that organisations should consider providing tutorials to guide users in accurately trying out a range of colour options for internal decorating, so enabling them to fulfil their goals. They also recommended the need for 24/7 online chat services to provide any related assistance. In applying SPA, this study has further contextualised the user experience, which can assist AR developers and the organisation commissioning AR apps to understand the specific hindrances to achieving users' goals. Thus, an improved understanding of users' needs will enable them to produce apps more able to meet their expectations.

6.6 Chapter Outcomes

This chapter has discussed the contributions of this study to both theory and practise. Firstly, it answered the two research questions in relation to: (1) the review of the existing literature and (2) the findings of this research, as seen through the lens of affordance and social practice theories. Secondly, it introduced a new term, i.e. *socially practised affordances,* referring to the actualisation of AR app affordances when there is coherence between the SPT elements of meanings, materials and competency. Thirdly, Table 6.1 defined users' expectations and experiences through the lens of SPA. Fourthly, Table 6.2 demonstrated the answers to both research questions. Finally, the chapter concluded by outlining the practical contribution of this research.

The following chapter forms the conclusion of this thesis, including summarising its limitations, as well as offering recommendations for future research.

CONCLUSION

Chapter 7

In chapter 6, the researcher addressed each research question in the context of existing literature to highlight the uniqueness of this study. The novel findings produced assisted in the development of a final research framework supported by social practice and affordance theories. To clarify further, this concluding chapter is divided into four sections. The first section summarises the aims, theory, methods, and findings of this study and both its theoretical and practical contributions. The second section considers the challenges the researcher encountered while completing the study and its limitations. Then, the third section provides some proposals for future research. Finally, the fourth section concludes with some final remarks demonstrating the importance of this research.

7.1 Summary of Research

This study was motivated by the reportedly high rate of failure of interactive technologies, specifically AR apps. It also sought to address the lack of understanding of user behaviour associated with poor adoption of AR among users. To achieve this, and to develop a fuller understanding of users' behaviour towards AR apps, this study focused on the user expectations and experiences that are understood to be directly associated with AR user behaviours that influence intention to adopt AR technology. The major objective of this thesis was to explore and comprehend how the usability of AR is impacted by user experience and expectations. To achieve this outcome and address the overall aims of this PhD study, two research questions were proposed. As every user experience and expectation is unique in nature and provides multiple realities concerning the same phenomena, the researcher selected an interpretivist epistemological position. By doing so it was possible to understand users' experiences and expectations with regard to the integration of AR apps as social practices into their lives, rather than to viewing this process according to concrete and singular realities.

In this thesis, the researcher remained actively in an outsider role for the first two phases of the data collection. This ensured her personal interests and experiences did not intrude on the process. However, the role adopted by the researcher during the third phase of data collection was that of the insider. This involved applying the *walkthrough method*, which included an account of the researcher's personal experience. Moreover, a qualitative research method was adopted, as the researcher aimed to offer interpretations of specific phenomena associated with AR app use. To achieve this, the researcher motivated AR users to reflect on their expectations and experience. Therefore, multiple data collection techniques, e.g., online reviews, pilot studies, reflections, and walkthroughs of twelve AR apps were collected throughout the three phases (recall the details given in sections 4.2.1.2 and 4.2.1.3) to provide an empirically rich, holistic account of AR apps. For example, online reviews afforded a deep understanding of the research phenomenon which was deemed critically important for the study. They allowed the researcher to more fully describe AR usability issues based on users' expectations and experiences. After which, reflections proved useful for refining and sharpening users' experiences with more accurate descriptions. The triangulation of multiple data sources allowed the researcher to obtain rich insights with which to develop the final research framework. In addition, it enhanced the validity and reliability of the research. In total, 858 online reviews were downloaded from multiple AR apps and 62 reflections from four AR apps. Furthermore, the walkthrough method were applied in the third phase of data collection to unpack AR apps' affordances and users' goals. This enabled the researcher to approach the data analysis by looking at the affordances identified through the lens of SPT. Thematic analysis was also used to identify the most relevant data, applying theoretical themes related to SPT and interpretations of the given phenomenon of AR app use.

This study addressed two major research questions concerning: 1. How might users' expectations influence AR app use, and 2. how might usability characteristics of AR influence user experiences. In terms of the first research question, the walkthrough technique is used to identify potential AR app affordances and users goals. Users' expectations and their influence on AR app use are then identified using the meanings element of SPT. The researcher, through SPA, uncovered that users' goals and expectations vary according to their predictions of what they would find (expected meaning). For example, a user with a specific goal has expected actualised affordances that may influence their behaviour.

In terms of research question two, there is a multitude of usability characteristics but in terms of users experiences of AR apps, interactivity, compatibility and credibility are the most important characteristics that align with SPT elements meanings, materials and competency. Combining these AR usability characteristics (interactivity, compatibility, and credibility) with AR affordances and users' goals resulted in a SPA conceptual framework (see Figure 6.1) which demonstrates how users' expectations and experiences can influence their behaviour towards AR apps. It is through the lens of the SPA that this research demonstrates that users' expectations and experiences are involved in an ongoing cycle that drives behaviours associated with AR technology use. For example, if a user with a specific goal and expectations experienced a difficulty in actualising AR app affordances, they began to suspect that the app may not be capable of fulfilling their aims (developed meanings). Consequently, these developed meanings can influence their future behaviour; e.g., in writing negative reviews, and warning others about wasting their time using such apps.

Usability characteristics - interactivity, compatibility and credibility – construct a user experience that developing unique behaviours among AR app users post-use. User experience, whether was positive or negative, depends on whether both the system and AR app users are sufficiently competent to use AR affordances to achieve their goals. For example, in the context of AR affordance, *Social Connectivity affordance* enables users to achieve their socialising goals. Consequently, users can engage in real-time connections that permit them to experience, for example, virtual shopping involving their friends and family. As a result, users can achieve personal and collective goals (i.e., socialising as a family while engaging in a shopping experience). However, the socialising goal cannot be achieved unless users have the required skills, the right materials, and a sufficiently competent system to allow them to interact successfully with AR apps. Thus, this research argues that user and system competency work both ways: either as an enabling affordance or a disabling one, in the form of constraints that affect the achievement of user goals. In addition, the credibility and compatibility of the system are key when enabling users to achieve their socialising goals. For example, AR app users are expected to read the app privacy policy before starting to use an app. Consequently, the user's actual experience, based on interactivity, compatibility and credibility usability characteristics, can provide direction for developers on how best to improve those AR app usability features that can develop positive behaviour towards AR adoption.

7.2 Challenges Faced During the Research and Limitations

The biggest challenge the researcher experienced related to the fact that exploring the immersive experiences offered by AR apps requires users to be physically located in set places. However, the COVID-19 pandemic forced people worldwide to remain at home. Therefore, the researcher was able to spend more than a month reviewing AR apps that people could use from home. The researcher also faced a challenge identifying alternative viable data collection methods, when selecting multiple online data collection sources in the context of various industries. Doing online qualitative research during the COVID-19 pandemic was one of the researcher's biggest challenges. A key concern was that the data quality would be compromised by moving 100% online; e.g., she would have no capacity to guide the participants' responses, as compared to the semi-structured interview method in which the researcher can direct the conversation and ensure the required data is collected. Shifting to web-based qualitative research also required additional work, as doing so requires researchers to be more flexible and proactive in response to participants' enquiries. Participants also required reminders to respond and complete tasks, to ensure they appropriately answered questions (especially as the participants may also have been experiencing personal challenges due to the pandemic). Therefore, to ensure the quality of data, the researcher provided detailed instructions to the participants, encouraging them to contact her if they had any queries.

According to Rice et al. (2017), online research provides some advantages over real world methods. For example, it affords easier access to large sample sizes, the opportunity to collect a more balanced ratio of genders, and easier provision of anonymity to participants. However, using online data sources can be difficult, as it increases challenges for the researcher. Specifically, it usually demands management of large amounts of data, e.g., online reviews, and can create difficulties determining what is and is not relevant to fulfil the study's proposed aims. This was one of the limitations of online data collection, as the researcher was unable to ask the participants follow-up questions to better understand their experiences with AR apps. For example, some users only responded to reflective questions with short answers, such as 'Yes' or 'No' and repeat answers. This provided direction for future researchers, as outlined in section 7.3.

Moreover, as this research involved an online qualitative study to identify AR affordances and teased out what usability factors could enable or constrain use, the key challenges concerned implications and relevance. For example, although the SPA framework employed in this study is based on a solid set of data and could be generalisable to other emerging technologies, the researcher does not claim that the results and findings are fully generalisable to a larger population. This is because AR apps are not at a high stage of maturity and their recent development, in terms of usability features, increased the participants' difficulties becoming aware of the features of the AR apps used in this study. For example, many participants were new to using AR or had limited experience with AR apps, which in turn limited the data obtained from them, as they could not freely express their views and explain usability issues. As a result, the researcher could not claim that AR users had all actual experience with all usability features.

Furthermore, interpretive studies have a component of subjectivity, e.g., the conceptualisation of usability is subjective in nature (Hoehle and Venkatesh, 2015). Therefore, on one hand, the researcher cannot claim to have covered every element of usability from all possible perspectives wholly understanding users' developed meanings and AR user goals. On the other hand, various people may interpret the results differently, although their interpretations are equally true (Glesne and Peshkin, 1992). To avoid subjectivity, the researcher shifted roles through the process of data collection and analysis, as outlined above in section 7.1.

7.3 Future Research Directions

Online reflections took place during the COVID-19 pandemic. As a result, the behaviours and decision made by users participating in the reflections for this study were affected by conditions created by the pandemic. Therefore, the research findings require further confirmation, involving reflections in a post-pandemic setting. For example, a comparative analysis of the market considering the usability of AR apps and user expectations and experience perspectives pre-and post-pandemic (Jiang et al., 2021).

This research explored AR usability using data obtained from online sources only. Therefore, this thesis could motivate social science and IS researchers to engage in more online qualitative research to explore affordances, SPT, emerging technologies, and usability factors based on users' perspectives linked to experience and expectations. They could also explore how SPA might provide a new theoretical lens to study other emerging technologies, to develop understandings of usability characteristics. Secondly, qualitative researchers could leverage the new concept of Social Practised Affordance to explore AR technology using alternative methods, such as interviews or focus groups. For example, as mentioned in section 7.2, AR remains in the early stages, and many participants were found to be unfamiliar with its features. Hence, future research would benefit from including semi-structured interviews with participants with prior experience using AR apps to better understand and underline the motives that might drive adoption of AR apps.

Moreover, according to Barnett et al. (2021), there are multiple app affordances; however, there is minimal understanding of the types of multiple affordances. Therefore, future studies could explore multiple affordances in AR apps across different sectors. When undertaking the in-depth literature review for this thesis, it emerged that all technology has enablers and constraints (Laitinen and Sivunen, 2021). Therefore, future studies might uncover specific enablers and constraints to assist the AR developer to improve AR apps' performance. Arguably the SPA framework employed in this study is based on a solid set of data; however, further improvement is likely as AR technology evolves, and researchers continue to evaluate how and why individuals use it and the usability issues that can hinder its optimum use (Steffen et al, 2019). Moreover, as this research identified ten AR affordances, many interesting questions arise; for example, are there any other AR affordances, and at what point are users willing to actualise these AR affordances routinely in their daily life? And how can affordances, SPT, and SPA provide a theoretical lens with which to understand the failures associated with emerging technologies?

Furthermore, while the research data was collected from various sources, themed apps, and engaged a variety of users with different backgrounds and experiences, future researchers could concentrate on one specific industry, or set of expertise, or exposure to validate and provide insights with regards to the SPA framework. Finally, according to Naeem and Ozuem (2021), qualitative studies cannot test a research framework, as the concept of affordances is subjective in nature. Thus, it would be useful to develop understanding in future studies around how AR app usability characteristics enable or constrain the actualising of app affordances. Hence, a research design utilising mixed methods would produce research addressing subjective realities and enable researchers to test the validity of research frameworks to ascertain the most critical factors concerning AR users' experience and expectations leading to AR adoption.

7.4 Final Remarks

The current chapter concludes this study. It outlined how the research explored two main research questions framed within the SPA conceptual framework. It summarised the aims, theory, methods, and findings reported herein. Then it provided an overview of the contribution of the thesis, including both its theoretical and practical contributions. Finally, this chapter discussed the limitations of the research and proposed some future research directions.

The research determined how user experiences and expectations play a critical role in influencing the adoption of AR technology. Although AR is presently in its early stages, and many users are still unfamiliar with its potential uses, the literature suggests it is a promising technology. It is interesting to discover that users like the concept of interactive technology and are willing to learn more about how to use it properly. Hence, AR apps designers should investigate maximising user awareness to ensure users are able to fully realise the benefits of AR apps. It is also necessary for designers to design apps that are compatible with users' circumstances, and to tackle all the usability issues users encounter when experiencing an app.

To conclude, with the rising number of brands introducing AR apps to enhance the user experience, we can expect to see more users adopt AR into their routine life, such that the virtual experience may replace traditional ways of shopping, traveling and even socialising. The researcher postulates that high-quality AR apps can enable users to access: positive real time-experiences, experiences when convenient to them, fast and accurate information when they need it, enjoy learning experiences and socialise with family and friends in an enjoyable way.

References

ABBOTT, L. 1955. *Quality and Competition,* New York Chichester, West Sussex, Columbia University Press.

ABRAN, A., KHELIFI, A., SURYN, W. & SEFFAH, A. 2003. Usability Meanings and Interpretations in ISO Standards. *Software Quality Journal,* 11**,** 325-338.

ADAMCZYK, B. 2017. *Foundations of Electromagnetic Compatibility: with Practical Applications*, John Wiley & Sons.

ADIPAT, B., ZHANG, D. & ZHOU, L. 2011. The Effects of Tree-View Based Presentation Adaptation on Mobile Web Browsing. *MIS Quarterly,* 35**,** 99-121.

AGARWAL, R. & KARAHANNA, E. 2000. Time Flies When You're Having Fun: Cognitive Absorption and Beliefs about Information Technology Usage. *MIS Quarterly,* 24**,** 665-694.

AHN, T. Y. & LEE, S.-M. 2016. User experience of a mobile speaking application with automatic speech recognition for EFL learning. *British Journal of Educational Technology,* 47**,** 778-786.

ALALWAN, A. A., DWIVEDI, Y. K., RANA, N. P. P. & WILLIAMS, M. D. 2016. Consumer adoption of mobile banking in Jordan. *Journal of Enterprise Information Management,* 29**,** 118-139.

ALBA, J. W. & WILLIAMS, E. F. 2013. Pleasure principles: A review of research on hedonic consumption. *Journal of Consumer Psychology,* 23**,** 2-18.

ALBEN, L. 1996. Quality of experience: defining the criteria for effective interaction design. *interactions,* 3**,** 11-15.

ALBERT, B. & TULLIS, T. 2022. *Measuring the User Experience: Collecting, Analyzing, and Presenting UX Metrics,* Morgan Kaufmann.

ALGHARABAT, R. & DENNIS, C. 2010. Using authentic 3D product visualisation for an electrical online retailer. *Journal of Customer Behaviour,* 9**,** 97-115.

ALHUDAITHY, A. I. & KITCHEN, P. J. 2009. Rethinking models of technology adoption for Internet banking: The role of website features. *Journal of Financial Services Marketing,* 14**,** 56-69.

ALLERSTORFER, P. A survey of augmented reality technology applied in mobile tourism. International Student Conference In Tourism Research, 2013. 90-100.

ANDRADE, A. D., URQUHART, C. & ARTHANARI, T. S. 2015. Seeing for understanding: Unlocking the potential of visual research in information systems. *Journal of the Association for Information Systems,* 16**,** 646-673.

ANTONIOU, G. & BATTEN, L. 2011. E-commerce: protecting purchaser privacy to enforce trust. *Electronic Commerce Research,* 11**,** 421.

ARGHASHI, V. & YUKSEL, C. A. 2022. Interactivity, Inspiration, and Perceived Usefulness! How retailers' AR-apps improve consumer engagement through flow. *Journal of Retailing and Consumer Services,* 64**,** 102756.

AZUMA, R., BAILLOT, Y., BEHRINGER, R., FEINER, S., JULIER, S. & MACINTYRE, B. 2001. Recent advances in augmented reality. *IEEE computer graphics and applications,* 21**,** 34-47.

AZUMA, R. T. 1997. A survey of augmented reality. *Presence: teleoperators & virtual environments,* 6**,** 355-385.

BABIN, B. J., DARDEN, W. R. & GRIFFIN, M. 1994. Work and/or Fun: Measuring Hedonic and Utilitarian Shopping Value. *Journal of Consumer Research,* 20**,** 644-656.

BAEK, T. H. & YOO, C. Y. 2018. Branded app usability: Conceptualization, measurement, and prediction of consumer loyalty. *Journal of Advertising,* 47**,** 70-82.

BAKHSH, M., MAHMOOD, A. & SANGI, N. A. 2017. Examination of factors influencing students and faculty behavior towards m-learning acceptance: An empirical study. *The International Journal of Information and Learning Technology*.

BARBOSA, N. & FARIA, A. P. 2008. Technology adoption: does labour skill matter? Evidence from Portuguese firm-level data. *Empirica,* 35**,** 179-194.

BARNES, M. C. & MEYERS, N. P. 2011. *Mobile Phones: Technology, Networks and User Issues*, Nova Science Publishers, Inc.

BARNETT, A., SAVIC, M., PIENAAR, K., CARTER, A., WARREN, N., SANDRAL, E., MANNING, V. & LUBMAN, D. I. 2021. Enacting 'more-than-human' care: Clients' and counsellors' views on the multiple affordances of chatbots in alcohol and other drug counselling. *International Journal of Drug Policy,* 94**,** 102910.

BECKER, M. C., LAZARIC, N., NELSON, R. R. & WINTER, S. G. 2005. Applying organizational routines in understanding organizational change. *Industrial and Corporate Change,* 14**,** 775-791.

BELDAD, A. D. 2021. Sustaining social capital online amidst social distancing during the COVID-19 pandemic: web-based communities, their mitigating effects, and associated issues. *International Journal of Web Based Communities,* 17**,** 35-52.

BENBUNAN-FICH, R. 2019. An affordance lens for wearable information systems. *European Journal of Information Systems,* 28**,** 256-271.

BEVAN, N. & MACLEOD, M. 1994. Usability measurement in context. *Behaviour & information technology,* 13**,** 132-145.

BEVANA, N., KIRAKOWSKIB, J. & MAISSELA, J. What is usability. Proceedings of the 4th International Conference on HCI, 1991. Citeseer, 24.

BHATTACHERJEE, A. 2001. Understanding Information Systems Continuance: An Expectation-Confirmation Model. *MIS Quarterly,* 25**,** 351-370.

BIVENS, R. & HAIMSON, O. L. 2016. Baking Gender Into Social Media Design: How Platforms Shape Categories for Users and Advertisers. *Social Media + Society,* 2**,** 2056305116672486.

BLAIR, I. 2018. *How to Turn Your Mobile App Failure into Success* [Online]. Available: https://buildfire.com/turn-your-mobile-app-failure-into-success/ [Accessed].

BLOOMFIELD, B. P., LATHAM, Y. & VURDUBAKIS, T. 2010. Bodies, Technologies and Action Possibilities:When is an Affordance? *Sociology,* 44**,** 415-433.

BOLLE, S., ROMIJN, G., SMETS, E. M. A., LOOS, E. F., KUNNEMAN, M. & VAN WEERT, J. C. M. 2016. Older Cancer Patients' User Experiences With Web-Based Health Information Tools: A Think-Aloud Study. *J Med Internet Res,* 18**,** e208.

BOMIL, S. & INGOO, H. 2003. The Impact of Customer Trust and Perception of Security Control on the Acceptance of Electronic Commerce. *International Journal of Electronic Commerce,* 7**,** 135-161.

BONNIN, G. 2020. The roles of perceived risk, attractiveness of the online store and familiarity with AR in the influence of AR on patronage intention. *Journal of Retailing and Consumer Services,* 52**,** 101938.

BORGO, S., FRANSSEN, M., GARBACZ, P., KITAMURA, Y., MIZOGUCHI, R. & VERMAAS, P. E. 2014. Technical artifacts: An integrated perspective. *Applied Ontology,* 9**,** 217-235.

BORSCI, S., FEDERICI, S., MALIZIA, A. & DE FILIPPIS, M. L. 2019. Shaking the usability tree: why usability is not a dead end, and a constructive way forward. *Behaviour & Information Technology,* 38**,** 519-532.

BOSLEY, J. J. 2013. Creating a Short Usability Metric for User Experience (UMUX) Scale. *Interacting with Computers,* 25**,** 317-319.

BOUHAMRI, Z., VIREY, E. & MUKISH, P. 2019. 46.3: Overcoming the challenges on the path to consumer AR headsets. *SID Symposium Digest of Technical Papers,* 50**,** 513-513.

BOYATZIS, R. E. 1998. *Transforming qualitative information: Thematic analysis and code development*, sage.

BOYD, K., BOND, R., VERTESI, A., DOGAN, H. & MAGEE, J. 2019. How People Judge the Usability of a Desktop Graphic User Interface at Different Time Points: Is there Evidence for Memory Decay, Recall Bias or Temporal Bias? *Interacting with Computers,* 31**,** 221-230.

BRADSHAW, R. 2021. Deception and detection: the use of technology in assessing witness credibility. *Arbitration International,* 37**,** 707-720.

BRANNON BARHORST, J., MCLEAN, G., SHAH, E. & MACK, R. 2021. Blending the real world and the virtual world: Exploring the role of flow in augmented reality experiences. *Journal of Business Research,* 122**,** 423-436.

BRUUN, A. & STAGE, J. 2014. Barefoot usability evaluations. *Behaviour & Information Technology,* 33**,** 1148-1167.

BRYNJOLFSSON, E., HU, Y. J. & RAHMAN, M. S. 2013. *Competing in the age of omnichannel retailing*, MIT Cambridge.

BUCY, E. P. 2003. The interactivity paradox: Closer to the news but confused. *Media access.* Routledge.

BUELLINGEN, F. & WOERTER, M. 2004. Development perspectives, firm strategies and applications in mobile commerce. *Journal of Business Research,* 57**,** 1402-1408.

BUJAK, K. R., RADU, I., CATRAMBONE, R., MACINTYRE, B., ZHENG, R. & GOLUBSKI, G. 2013. A psychological perspective on augmented reality in the mathematics classroom. *Computers & Education,* 68**,** 536-544.

BURTON-JONES, A. & VOLKOFF, O. 2017. How Can We Develop Contextualized Theories of Effective Use? A Demonstration in the Context of Community-Care Electronic Health Records. *Information Systems Research,* 28**,** 468-489.

BUTLER, B. S. & GRAY, P. H. 2006. Reliability, Mindfulness, and Information Systems. *MIS Quarterly,* 30**,** 211-224.

BYGSTAD, B., MUNKVOLD, B. E. & VOLKOFF, O. 2016. Identifying Generative Mechanisms through Affordances: A Framework for Critical Realist Data Analysis. *Journal of Information Technology,* 31**,** 83-96.

CABONI, F. & HAGBERG, J. 2019. Augmented reality in retailing: a review of features, applications and value. *International Journal of Retail & Distribution Management,* 47**,** 1125-1140.

CAI, W., MCKENNA, B. & WAIZENEGGER, L. 2020. Turning It Off: Emotions in Digital-Free Travel. *Journal of Travel Research,* 59**,** 909-927.

CANHOTO, A. I. 2021. Leveraging machine learning in the global fight against money laundering and terrorism financing: An affordances perspective. *Journal of Business Research,* 131**,** 441-452.

CARROZZI, A., CHYLINSKI, M., HELLER, J., HILKEN, T., KEELING, D. I. & DE RUYTER, K. 2019. What's Mine Is a Hologram? How Shared Augmented Reality Augments Psychological Ownership. *Journal of Interactive Marketing,* 48**,** 71-88.

CASTILLO S, M. J. & BIGNE, E. 2021. A model of adoption of AR-based self-service technologies: a two country comparison. *International Journal of Retail & Distribution Management,* 49**,** 875-898.

CAUDELL, T. 1995. *Introduction to augmented and virtual reality*, SPIE.

CAVAGNUOLO, M., CAPOZZA, V. & MATRELLA, A. 2022. The Walkthrough Method: State of the Art, Innovative Aspects, and Application Fields. *In:* PUNZIANO, G. & DELLI PAOLI, A. (eds.) *Handbook of Research on Advanced Research Methodologies for a Digital Society*. Hershey, PA, USA: IGI Global.

CECCACCI, S., GIRALDI, L. & MENGONI, M. Product Usability: Is it a Criterion to Measure "Good UX" or a Prerequisite? International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, 2016. American Society of Mechanical Engineers, V01AT02A049.

CELIK, H. 2016. Customer online shopping anxiety within the Unified Theory of Acceptance and Use Technology (UTAUT) framework. *Asia Pacific Journal of Marketing and Logistics,* 28.

CHEMERO, A. 2018. An outline of a theory of affordances. *How Shall Affordances be Refined? Four Perspectives.* Routledge.

CHEMERO, A. & TURVEY, M. T. 2007. Complexity, Hypersets, and the Ecological Perspective on Perception-Action. *Biological Theory,* 2**,** 23-36.

CHEN, R., PERRY, P., BOARDMAN, R. & MCCORMICK, H. 2021. Augmented reality in retail: a systematic review of research foci and future research agenda. *International Journal of Retail & Distribution Management*.

CHEN, Y., WANG, Q., CHEN, H., SONG, X., TANG, H. & TIAN, M. 2019. An overview of augmented reality technology. *Journal of Physics: Conference Series,* 1237**,** 022082.

CHENAIL, R. J. 2012. Conducting Qualitative Data Analysis: Reading Line-by-Line, but Analyzing by Meaningful Qualitative Units. *Qualitative Report,* 17**,** 266-269.

CHENG, K.-H. & TSAI, C.-C. 2013. Affordances of Augmented Reality in Science Learning: Suggestions for Future Research. *Journal of Science Education and Technology,* 22**,** 449-462.

CHIANG, L.-L. L., HUANG, T.-L. & CHUNG, H. F. 2021. Augmented reality interactive technology and interfaces: a construal-level theory perspective. *Journal of Research in Interactive Marketing*.

CHILDERS, T. L., CARR, C. L., PECK, J. & CARSON, S. 2001. Hedonic and utilitarian motivations for online retail shopping behavior. *Journal of Retailing,* 77**,** 511-535.

CHINOMONA, R. & SANDADA, M. 2013. Customer Satisfaction, Trust and Loyalty as Predictors of Customer Intention to Re-Purchase South African Retailing Industry. *Mediterranean Journal of Social Sciences,* 4**,** 437.

CHIU, C.-M., CHENG, H.-L., HUANG, H.-Y. & CHEN, C.-F. 2013. Exploring individuals' subjective well-being and loyalty towards social network sites from the perspective of network externalities: The Facebook case. *International Journal of Information Management,* 33**,** 539-552.

CHIU, C. L., HO, H.-C., YU, T., LIU, Y. & MO, Y. 2021. Exploring information technology success of Augmented Reality Retail Applications in retail food chain. *Journal of Retailing and Consumer Services,* 61**,** 102561.

CHO, M., BONN, M. A., SUSSKIND, A. & GIUNIPERO, L. 2018. Restaurant dependence/autonomy in the supply chain and market responsiveness. *International Journal of Contemporary Hospitality Management,* 30**,** 2945-2964.

CHOW, A. S. & BUCKNALL, T. 2011. *Library Technology and User Services: Planning, Integration, and Usability Engineering*, Chandos Publishing.

CHUNG, N., HAN, H. & JOUN, Y. 2015. Tourists' intention to visit a destination: The role of augmented reality (AR) application for a heritage site. *Computers in Human Behavior,* 50**,** 588-599.

CIPRESSO, P., GIGLIOLI, I. A. C., RAYA, M. A. & RIVA, G. 2018. The Past, Present, and Future of Virtual and Augmented Reality Research: A Network and Cluster Analysis of the Literature. *Frontiers in Psychology,* 9.

CITTÀ, G., GENTILE, M., AUGELLO, A., OTTAVIANO, S., ALLEGRA, M. & DIGNUM, F. 2019. Analyzing Creativity in the Light of Social Practice Theory. *Frontiers in Psychology,* 9.

CLAGGETT, J. L. & KARAHANNA, E. Understanding the role of technology in coordination: An affordance perspective. International Conference on Information Systems (ICIS), 2018. Association for Information Systems (AIS).

CLARKE, V. & BRAUN, V. 2013. Successful Qualitative Research : A Practical Guide for Beginners. London: SAGE Publications Ltd.

COBB PAYTON, F. & ZAHAY, D. 2005. Why doesn't marketing use the corporate data warehouse? The role of trust and quality in adoption of data-warehousing technology for CRM applications. *Journal of Business & Industrial Marketing,* 20**,** 237-244.

CORNFORD, T. & SMITHSON, S. 2005. *Project Research in Information Systems: A Student's Guide*, Palgrave Macmillan.

COSTA, F., LABOURE, E. & REVOL, B. 2014. *Electromagnetic compatibility in power electronics*, John Wiley & Sons.

COURSARIS, C. K. & KRIPINTRIS, K. 2012. Web Aesthetics and Usability: An Empirical Study of the Effects of White Space. *International Journal of E-Business Research (IJEBR),* 8**,** 35-53.

COWAN, K., JAVORNIK, A. & JIANG, P. 2021. Privacy concerns when using augmented reality face filters? Explaining why and when use avoidance occurs. *Psychology & Marketing,* 38**,** 1799-1813.

CRESWELL, J. W. 2014. *A concise introduction to mixed methods research*, SAGE publications.

CRILLY, N., MOULTRIE, J. & CLARKSON, P. J. 2004. Seeing things: consumer response to the visual domain in product design. *Design Studies,* 25**,** 547-577.

CROW, G., WILES, R., HEATH, S. & CHARLES, V. 2006. Research Ethics and Data Quality: The Implications of Informed Consent. *International Journal of Social Research Methodology,* 9**,** 83-95.

CYR, D., HEAD, M. & IVANOV, A. 2009. Perceived interactivity leading to e-loyalty: Development of a model for cognitive–affective user responses. *International Journal of Human-Computer Studies,* 67**,** 850-869.

DAASSI, M. & DEBBABI, S. 2021. Intention to reuse AR-based apps: The combined role of the sense of immersion, product presence and perceived realism. *Information & Management,* 58**,** 103453.

DACKO, S. G. 2017. Enabling smart retail settings via mobile augmented reality shopping apps. *Technological Forecasting and Social Change,* 124**,** 243-256.

DAMGHANIAN, H., ZAREI, A. & SIAHSARANI KOJURI, M. A. 2016. Impact of Perceived Security on Trust, Perceived Risk, and Acceptance of Online Banking in Iran. *Journal of Internet Commerce,* 15**,** 214-238.

DANIELSON, D. R. & RIEH, S. Y. 2007. Credibility: A multidisciplinary framework. *Annual review of information science and technology,* 41**,** 307-364.

DANTAS, V. L. L., MARINHO, F. G., DA COSTA, A. L. & ANDRADE, R. M. Testing requirements for mobile applications. 24th International Symposium on Computer and Information Sciences, 2009. IEEE, 555-560.

DELAGI, G. Harnessing technology to advance the next-generation mobile user-experience. IEEE International Solid-State Circuits Conference - (ISSCC), 7-11 Feb. 2010 2010. 18-24.

DESURVIRE, H. & WIBERG, C. 2015. User Experience Design for Inexperienced Gamers: GAP—Game Approachability Principles. *In:* BERNHAUPT, R. (ed.) *Game User Experience Evaluation.* Cham: Springer International Publishing.

DICKINGER, A., ARAMI, M. & MEYER, D. 2008. The role of perceived enjoyment and social norm in the adoption of technology with network externalities. *European Journal of Information Systems,* 17**,** 4-11.

DIMITRIADIS, S. & KYREZIS, N. 2011. The effect of trust, channel technology, and transaction type on the adoption of self-service bank channels. *The Service Industries Journal,* 31**,** 1293-1310.

DINH, H. T., LEE, C., NIYATO, D. & WANG, P. 2013. A survey of mobile cloud computing: architecture, applications, and approaches. *Wireless Communications and Mobile Computing,* 13**,** 1587-1611.

DOWLING, G. R. 1986. Perceived risk: The concept and its measurement. *Psychology & Marketing,* 3**,** 193-210.

DU, W., PAN, S. L., LEIDNER, D. E. & YING, W. 2019. Affordances, experimentation and actualization of FinTech: A blockchain implementation study. *The Journal of Strategic Information Systems,* 28**,** 50-65.

DUFAUX, F., PESQUET-POPESCU, B. & CAGNAZZO, M. 2013. *Emerging technologies for 3D video: creation, coding, transmission and rendering*, John Wiley and Sons Ltd.

DUGUAY, S., BURGESS, J. & SUZOR, N. 2020. Queer women's experiences of patchwork platform governance on Tinder, Instagram, and Vine. *Convergence,* 26**,** 237-252.

DUTTA, S. & OMOLAYOLE, O. 2016. Are there differences between men and women in information technology innovation adoption behaviors: A theoretical study. *Journal of Business Diversity,* 16**,** 106-114.

DWIVEDI, Y. K., HUGHES, D. L., COOMBS, C., CONSTANTIOU, I., DUAN, Y., EDWARDS, J. S., GUPTA, B., LAL, B., MISRA, S., PRASHANT, P., RAMAN, R., RANA, N. P., SHARMA, S. K. & UPADHYAY, N. 2020. Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life. *International Journal of Information Management,* 55**,** 102211.

ELO, S. & KYNGÄS, H. 2008. The qualitative content analysis process. *Journal of advanced nursing,* 62**,** 107-115.

ESTRELLA-RAMON, A., SÁNCHEZ-PÉREZ, M. & SWINNEN, G. 2016. How customers' offline experience affects the adoption of online banking. *Internet Research,* 26**,** 1072-1092.

FAIOLA, A., NEWLON, C., PFAFF, M. & SMYSLOVA, O. 2013. Correlating the effects of flow and telepresence in virtual worlds: Enhancing our understanding of user behavior in game-based learning. *Computers in Human Behavior,* 29**,** 1113-1121.

FAN, X., CHAI, Z., DENG, N. & DONG, X. 2020. Adoption of augmented reality in online retailing and consumers' product attitude: A cognitive perspective. *Journal of Retailing and Consumer Services,* 53**,** 101986.

FAQIH, K. M. S. & JARADAT, M.-I. R. M. 2021. Integrating TTF and UTAUT2 theories to investigate the adoption of augmented reality technology in education: Perspective from a developing country. *Technology in Society,* 67**,** 101787.

FAYARD, A.-L. & WEEKS, J. 2014. Affordances for practice. *Information and Organization,* 24**,** 236-249.

FEATHERMAN, M. S., MIYAZAKI, A. D. & SPROTT, D. E. 2010. Reducing online privacy risk to facilitate e-service adoption: the influence of perceived ease of use and corporate credibility. *Journal of Services Marketing,* 24**,** 219-229.

FENG, Y. & XIE, Q. 2018. Measuring the content characteristics of videos featuring augmented reality advertising campaigns. *Journal of Research in Interactive Marketing,* 12**,** 489-508.

FENN, J. & LEHONG, H. 2011. Hype cycle for emerging technologies, 2011. *Gartner, July,* 28.

FILL, C. 2009. *Marketing communications: interactivity, communities and content*, Pearson Education.

FINK, A. 2019. *Conducting research literature reviews: From the internet to paper*, Sage publications.

FINSTAD, K. 2010. The Usability Metric for User Experience. *Interacting with Computers,* 22**,** 323-327.

FINSTAD, K. 2013. Response to commentaries on 'The Usability Metric for User Experience'. *Interacting with Computers,* 25**,** 327-330.

FIORE, A. M., JIN, H.-J. & KIM, J. 2005. For fun and profit: Hedonic value from image interactivity and responses toward an online store. *Psychology & Marketing,* 22**,** 669-694.

FISHER, J., BURSTEIN, F., LYNCH, K. & LAZARENKO, K. 2008. "Usability + usefulness = trust": an exploratory study of Australian health web sites. *Internet Research,* 18**,** 477-498.

FLANAGIN, A. J. & METZGER, M. J. 2008. *Digital media and youth: Unparalleled opportunity and unprecedented responsibility*, MacArthur Foundation Digital Media and Learning Initiative Cambridge, MA, USA.

FLAVIÁN, C., IBÁÑEZ-SÁNCHEZ, S. & ORÚS, C. 2019. The impact of virtual, augmented and mixed reality technologies on the customer experience. *Journal of Business Research,* 100**,** 547-560.

FROMM, J., MIRBABAIE, M. & STIEGLITZ, S. A Systematic Review of Empirical Affordance studies: Recommendations for Affordance Research in Information Systems. ECIS, 2020.

FUENTES, C. & SVINGSTEDT, A. 2017. Mobile phones and the practice of shopping: A study of how young adults use smartphones to shop. *Journal of Retailing and Consumer Services,* 38**,** 137-146.

GAO, Q., RAU, P.-L. P. & SALVENDY, G. 2010. Measuring perceived interactivity of mobile advertisements. *Behaviour & Information Technology,* 29**,** 35-44.

GARRETT, B. M., ANTHONY, J. & JACKSON, C. 2018. Using mobile augmented reality to enhance health professional practice education. *Current Issues in Emerging eLearning,* 4**,** 10.

GARRETT, J. J. 2010. *The Elements of User Experience: User-Centered Design for the Web and Beyond*, New Riders Publishing.

GATTER, S., HÜTTL-MAACK, V. & RAUSCHNABEL, P. A. 2022. Can augmented reality satisfy consumers' need for touch? *Psychology & Marketing,* 39**,** 508-523.

GEBAUER, J., SHAW, M. J. & GRIBBINS, M. L. 2010. Task-technology fit for mobile information systems. *Journal of Information Technology,* 25**,** 259-272.

GENC-NAYEBI, N. & ABRAN, A. 2017. A systematic literature review: Opinion mining studies from mobile app store user reviews. *Journal of Systems and Software,* 125**,** 207-219.

GIBBS, G. 1988. Learning by Doing : A Guide to Teaching and Learning Methods. *Further Education Unit*.

GIBSON, J. J. 1977. The theory of affordances. R. Shaw and J. Bransford (eds.), Perceiving, Acting and Knowing. Hillsdale, NJ: Erlbaum.

GIBSON, J. J. 1979. The ecological approach to visual perception (17th pr). Psychology Press.

GIDDENS, A. 1984. *Elements of the theory of structuration*.

GLESNE, C. & PESHKIN, A. 1992. *Becoming qualitative researchers : an introduction*, Longman, White Plains, N.Y.

GÖSSLING, S., SCOTT, D. & HALL, C. M. 2021. Pandemics, tourism and global change: a rapid assessment of COVID-19. *Journal of Sustainable Tourism,* 29**,** 1-20.

GRAND VIEW RESEARCH 2022. Augmented Reality Market Size Worth $597.54 Billion By 2030.

GREENBERG, S., CARPENDALE, S., MARQUARDT, N. & BUXTON, B. 2011. *Sketching user experiences: The workbook*, Elsevier.

GRONN, P. 2002. Distributed leadership as a unit of analysis. *The leadership quarterly,* 13**,** 423-451.

GRUSCHKA, N., MAVROEIDIS, V., VISHI, K. & JENSEN, M. Privacy Issues and Data Protection in Big Data: A Case Study Analysis under GDPR. 2018 IEEE International Conference on Big Data (Big Data), 10-13 Dec. 2018 2018. 5027-5033.

GUO, Y. 2014. The Axiomatic Usability Evaluation Method. *In:* BLASHKI, K. & ISAIAS, P. (eds.) *Emerging Research and Trends in Interactivity and the Human-Computer Interface.* Hershey, PA, USA: IGI Global.

GUPTA, A. & DOGRA, N. 2017. Tourist adoption of mapping apps: a UTAUT2 perspective of smart travellers. *Tourism and hospitality management,* 23**,** 145-161.

HAN, D.-I., TOM DIECK, M. C. & JUNG, T. 2018. User experience model for augmented reality applications in urban heritage tourism. *Journal of Heritage Tourism,* 13**,** 46-61.

HAND, M. 2016. *Making digital cultures: Access, interactivity, and authenticity*, Routledge.

HARGREAVES, T. 2011. Practice-ing behaviour change: Applying social practice theory to pro-environmental behaviour change. *Journal of Consumer Culture,* 11**,** 79-99.

HARRINGTON, S. J. & RUPPEL, C. P. 1999. Telecommuting: a test of trust, competing values, and relative advantage. *IEEE Transactions on Professional Communication,* 42**,** 223-239.

HARRISON-WALKER, L. J. & JIANG, Y. 2023. Suspicion of online product reviews as fake: Cues and consequences. *Journal of Business Research,* 160**,** 113780.

HARTSON, R. 2003. Cognitive, physical, sensory, and functional affordances in interaction design. *Behaviour & Information Technology,* 22**,** 315-338.

HASBI, M., TOLLE, H. & SUPIANTO, A. A. 2020. The Development of Augmented Reality Educational Media Using Think-Pair-Share Learning Model For Studying Buginese Language. *Journal of Information Technology and Computer Science,* 5**,** 38-56.

HASSAN, A., EKIZ, E., DADWAL, S. S. & LANCASTER, G. 2018. Augmented Reality Adoption by Tourism Product and Service Consumers: Some Empirical Findings. *In:* JUNG, T. & TOM DIECK, M. C. (eds.) *Augmented Reality and Virtual Reality: Empowering Human, Place and Business.* Cham: Springer International Publishing.

HASSENZAHL, M. & MONK, A. 2010. The Inference of Perceived Usability From Beauty. *Human–Computer Interaction,* 25**,** 235-260.

HEDMAN, J., BØDKER, M., GIMPEL, G. & DAMSGAARD, J. 2019. Translating evolving technology use into user stories: Technology life narratives of consumer technology use. *Information Systems Journal,* 29**,** 1178-1200.

HELLAWELL, D. 2006. Inside–out: analysis of the insider–outsider concept as a heuristic device to develop reflexivity in students doing qualitative research. *Teaching in Higher Education,* 11**,** 483-494.

HELLER, J., CHYLINSKI, M., DE RUYTER, K., MAHR, D. & KEELING, D. I. 2019. Let Me Imagine That for You: Transforming the Retail Frontline Through Augmenting Customer Mental Imagery Ability. *Journal of Retailing,* 95**,** 94-114.

HELLER, P. B. 2012. *Technology and Society Reader: Case Studies*, University Press of America.

HERSKOVIC, V., OCHOA, S. F., PINO, J. A. & NEYEM, H. A. 2011. The Iceberg Effect: Behind the User Interface of Mobile Collaborative Systems. *J. Univers. Comput. Sci.,* 17**,** 183-201.

HERTZUM, M. 2010. Images of Usability. *International Journal of Human–Computer Interaction,* 26**,** 567-600.

HERZ, M. & RAUSCHNABEL, P. A. 2019. Understanding the diffusion of virtual reality glasses: The role of media, fashion and technology. *Technological Forecasting and Social Change,* 138**,** 228-242.

HEVNER, A. & CHATTERJEE, S. 2010. *Design research in information systems theory and practice*, Springer New York, NY.

HILKEN, T., DE RUYTER, K., CHYLINSKI, M., MAHR, D. & KEELING, D. I. 2017. Augmenting the eye of the beholder: exploring the strategic potential of augmented reality to enhance online service experiences. *Journal of the Academy of Marketing Science,* 45**,** 884-905.

HILKEN, T., HELLER, J., CHYLINSKI, M., KEELING, D. I., MAHR, D. & DE RUYTER, K. 2018. Making omnichannel an augmented reality: the current and future state of the art. *Journal of Research in Interactive Marketing,* 12**,** 509-523.

HINSCH, C., FELIX, R. & RAUSCHNABEL, P. A. 2020. Nostalgia beats the wow-effect: Inspiration, awe and meaningful associations in augmented reality marketing. *Journal of Retailing and Consumer Services,* 53**,** 101987.

HOEHLE, H. & VENKATESH, V. 2015. Mobile Application Usability: Conceptualization and Instrument Development. *MIS Quarterly,* 39**,** 435-472.

HOLBROOK, M. B. & HIRSCHMAN, E. C. 1982. The Experiential Aspects of Consumption: Consumer Fantasies, Feelings, and Fun. *Journal of Consumer Research,* 9**,** 132-140.

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**,** 102259.

HOLDEN, H. & RADA, R. 2011. Understanding the Influence of Perceived Usability and Technology Self-Efficacy on Teachers' Technology Acceptance. *Journal of Research on Technology in Education,* 43**,** 343-367.

HÖLLERER, T. & FEINER, S. 2004. Mobile augmented reality. *Telegeoinformatics: Location-based computing and services,* 21.

HOLTZ, G. 2013. Coherence of social practices: the case of meat consumption. *Unpublished working paper, Institute of Environmental Systems Research,* http://www.usf.uos.de.

HSIAO, C.-H., CHANG, J.-J. & TANG, K.-Y. 2016. Exploring the influential factors in continuance usage of mobile social Apps: Satisfaction, habit, and customer value perspectives. *Telematics and Informatics,* 33**,** 342-355.

HU, Y.-H., CHEN, Y.-L. & CHOU, H.-L. 2017. Opinion mining from online hotel reviews – A text summarization approach. *Information Processing & Management,* 53**,** 436-449.

HUANG, R., ZHANG, L., GAO, D., PAN, Y., QIN, S., TANG, P., CAI, Y. & WANG, Y. 2011. Resistive switching of silicon-rich-oxide featuring high compatibility with CMOS technology for 3D stackable and embedded applications. *Applied Physics A,* 102**,** 927-931.

HUANG, T.-L. 2021. Restorative experiences and online tourists' willingness to pay a price premium in an augmented reality environment. *Journal of Retailing and Consumer Services,* 58**,** 102256.

HUANG, T.-L. & LIAO, S. 2015. A model of acceptance of augmented-reality interactive technology: the moderating role of cognitive innovativeness. *Electronic Commerce Research,* 15**,** 269-295.

HUANG, T.-L., MATHEWS, S. & CHOU, C. Y. 2019. Enhancing online rapport experience via augmented reality. *Journal of Services Marketing,* 33**,** 851-865.

HUANG, Z. & BENYOUCEF, M. 2014. Usability and credibility of e-government websites. *Government Information Quarterly,* 31**,** 584-595.

HUANG, Z. & CAPPEL, J. J. 2005. Assessment of a Web-Based Learning Game in an Information Systems Course. *Journal of Computer Information Systems,* 45**,** 42-49.

HUNECKE, C., ENGLER, A., JARA-ROJAS, R. & POORTVLIET, P. M. 2017. Understanding the role of social capital in adoption decisions: An application to irrigation technology. *Agricultural Systems,* 153**,** 221-231.

HUTCHBY, I. 2001. Technologies, Texts and Affordances. *Sociology,* 35**,** 441-456.

HUTCHBY, I. 2003. Affordances and the analysis of technologically mediated interaction: A response to Brian Rappert. *Sociology,* 37**,** 581-589.

HVANNBERG, E. T., LAW, E. L.-C. & LÉRUSDÓTTIR, M. K. 2006. Heuristic evaluation: Comparing ways of finding and reporting usability problems. *Interacting with Computers,* 19**,** 225-240.

IANCU, I. & IANCU, B. 2020. Designing mobile technology for elderly. A theoretical overview. *Technological Forecasting and Social Change,* 155**,** 119977.

IMMONEN, M., SINTONEN, S. & KOIVUNIEMI, J. 2018. The value of human interaction in service channels. *Computers in Human Behavior,* 78**,** 316-325.

ISCHEN, C., ARAUJO, T., VAN NOORT, G., VOORVELD, H. & SMIT, E. 2020. "I Am Here to Assist You Today": The Role of Entity, Interactivity and Experiential Perceptions in Chatbot Persuasion. *Journal of Broadcasting & Electronic Media,* 64**,** 615-639.

ISO, I. O. F. S. 1998. ISO 9241-11. Ergonomic requirements for office work with visual display terminals (VDTs). *Part 11: Guidance on Usability.* Geneva, Switzerland.

ISRAEL, M. & HAY, I. 2006. *Research ethics for social scientists*, Sage.

JACKSON, T. 2005. Motivating sustainable consumption: A review of evidence on consumer behaviour and behavioural change. *Sustainable development research network,* 29**,** 30-40.

JAFARI, S., JANDAGHI, G. & TAGHAVI, H. 2016. Factors influencing the intention to accept advertising in mobile social networks. *Маркетинг і менеджмент інновацій***,** 57-72.

JAIN, P. K., PAMULA, R. & SRIVASTAVA, G. 2021. A systematic literature review on machine learning applications for consumer sentiment analysis using online reviews. *Computer science review,* 41**,** 100413.

JAVORNIK, A. 2016. Augmented reality: Research agenda for studying the impact of its media characteristics on consumer behaviour. *Journal of Retailing and Consumer Services,* 30**,** 252-261.

JAYASHANKAR, P., NILAKANTA, S., JOHNSTON, W. J., GILL, P. & BURRES, R. 2018. IoT adoption in agriculture: the role of trust, perceived value and risk. *Journal of Business & Industrial Marketing,* 33**,** 804-821.

JETTER, J., EIMECKE, J. & RESE, A. 2018. Augmented reality tools for industrial applications: What are potential key performance indicators and who benefits? *Computers in Human Behavior,* 87**,** 18-33.

JIANG, Y., WANG, X. & YUEN, K. F. 2021. Augmented reality shopping application usage: The influence of attitude, value, and characteristics of innovation. *Journal of Retailing and Consumer Services,* 63**,** 102720.

JIGYASU, P. 2018. *Reasons Why Mobile Apps Fail To Make An Impact* [Online]. VAYUZ. Available: https://www.vayuz.com/reasons-mobile-apps-fail-make-impact/ [Accessed].

JIN, H. & CAI, W. 2022. Understanding the smartphone usage of Chinese outbound tourists in their shopping practices. *Current Issues in Tourism,* 25**,** 2955-2968.

JOFFE, H. 2011. Thematic Analysis. *Qualitative Research Methods in Mental Health and Psychotherapy*.

JUNG, J. H., SCHNEIDER, C. & VALACICH, J. 2010. Enhancing the Motivational Affordance of Information Systems: The Effects of Real-Time Performance Feedback and Goal Setting in Group Collaboration Environments. *Management Science,* 56**,** 724-742.

JUNG, T., CHUNG, N. & LEUE, M. C. 2015. The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park. *Tourism Management,* 49**,** 75-86.

JUNG, T. H., BAE, S., MOORHOUSE, N. & KWON, O. 2021. The impact of user perceptions of AR on purchase intention of location-based AR navigation systems. *Journal of Retailing and Consumer Services,* 61**,** 102575.

JUNG, Y. & LYYTINEN, K. 2014. Towards an ecological account of media choice: a case study on pluralistic reasoning while choosing email. *Information Systems Journal,* 24**,** 271-293.

KAPLAN, B. & MAXWELL, J. A. 2005. Qualitative Research Methods for Evaluating Computer Information Systems. *In:* ANDERSON, J. G. & AYDIN, C. E. (eds.) *Evaluating the Organizational Impact of Healthcare Information Systems.* New York, NY: Springer New York.

KARAHANNA, E., AGARWAL, R. & ANGST, C. M. 2006. Reconceptualizing Compatibility Beliefs in Technology Acceptance Research. *MIS Quarterly,* 30**,** 781-804.

KARAHANNA, E., STRAUB, D. W. & CHERVANY, N. L. 1999. Information Technology Adoption Across Time: A Cross-Sectional Comparison of Pre-Adoption and Post-Adoption Beliefs. *MIS Quarterly,* 23**,** 183-213.

KARAHASANOVIĆ, A., BRANDTZÆG, P. B., HEIM, J., LÜDERS, M., VERMEIR, L., PIERSON, J., LIEVENS, B., VANATTENHOVEN, J. & JANS, G. 2009. Co-creation and user-generated content–elderly people's user requirements. *Computers in Human Behavior,* 25**,** 655-678.

KARLSEN, C., HARALDSTAD, K., MOE, C. E. & THYGESEN, E. 2019. Challenges of mainstreaming telecare. Exploring actualization of telecare affordances in home care services. *Scandinavian Journal of Information Systems,* 31**,** 2.

KASAVIN, I. T. 2017. Social Technologies: Between Science and Practice. *Russian Studies in Philosophy,* 55**,** 1-9.

KAUFMANN, H. 2003. Collaborative augmented reality in education. *Institute of Software Technology and Interactive Systems, Vienna University of Technology***,** 2-4.

KESHARWANI, A. & SINGH BISHT, S. 2012. The impact of trust and perceived risk on internet banking adoption in India. *International Journal of Bank Marketing,* 30**,** 303-322.

KIM, J. 2015. *Design for experience: Where technology meets design and strategy*, Springer.

KIM, J. & FORSYTHE, S. 2009. Adoption of sensory enabling technology for online apparel shopping. *European Journal of Marketing,* 43**,** 1101-1120.

KIM, K., KIM, G.-M. & KIL, E. S. 2009. Measuring the Compatibility Factors in Mobile Entertainment Service Adoption. *Journal of Computer Information Systems,* 50**,** 141-148.

KIM, K. J., PARK, E. & SUNDAR, S. S. IPS vs. AMOLED: Effects of Panel Type on Smartphone Users' Viewing and Reading Experience. 2012 Dordrecht. Springer Netherlands, 77-84.

KIM, K. J. & SUNDAR, S. S. 2014. Does screen size matter for smartphones? Utilitarian and hedonic effects of screen size on smartphone adoption. *Cyberpsychology, Behavior, and Social Networking,* 17**,** 466-473.

KIRS, P. & BAGCHI, K. 2012. The impact of trust and changes in trust: A national comparison of individual adoptions of information and communication technologies and related phenomenon. *International Journal of Information Management,* 32**,** 431-441.

KIVIJÄRVI, H. & PÄRNÄNEN, K. 2021. Instrumental Usability and Effective User Experience: Interwoven Drivers and Outcomes of Human-Computer Interaction. *International Journal of Human–Computer Interaction***,** 1-18.

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**,** 119883.

KLEIN, H. K. & MYERS, M. D. 1999. A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly,* 23**,** 67-93.

KOCHEILAS, A. 2018. The ways customers use products have changed—but brands haven't kept up. *Harvard Business Review Digital Articles,* 15**,** 2-5.

KORTUM, P. & SORBER, M. 2015. Measuring the Usability of Mobile Applications for Phones and Tablets. *International Journal of Human–Computer Interaction,* 31**,** 518-529.

KOUNAVIS, C. D., KASIMATI, A. E. & ZAMANI, E. D. 2012. Enhancing the Tourism Experience through Mobile Augmented Reality: Challenges and Prospects. *International Journal of Engineering Business Management,* 4**,** 10.

KOUROUTHANASSIS, P., BOLETSIS, C., BARDAKI, C. & CHASANIDOU, D. 2015. Tourists responses to mobile augmented reality travel guides: The role of emotions on adoption behavior. *Pervasive and Mobile Computing,* 18**,** 71-87.

KOWALCZUK, P., SIEPMANN, C. & ADLER, J. 2021. Cognitive, affective, and behavioral consumer responses to augmented reality in e-commerce: A comparative study. *Journal of Business Research,* 124**,** 357-373.

KRANCHER, O., LUTHER, P. & JOST, M. 2018. Key Affordances of Platform-as-a-Service: Self-Organization and Continuous Feedback. *Journal of Management Information Systems,* 35**,** 776-812.

KRISHNA, A. 2012. An integrative review of sensory marketing: Engaging the senses to affect perception, judgment and behavior. *Journal of Consumer Psychology,* 22**,** 332-351.

KUCIRKOVA, N. 2017. An integrative framework for studying, designing and conceptualising interactivity in children's digital books. *British Educational Research Journal,* 43**,** 1168-1185.

KUJALA, S., MUGGE, R. & MIRON-SHATZ, T. 2017. The role of expectations in service evaluation: A longitudinal study of a proximity mobile payment service. *International Journal of Human-Computer Studies,* 98**,** 51-61.

LABRECQUE, J. 2012. *Adobe Edge Quickstart Guide*, Packt Publishing Ltd.

LABRIE, A. & CHENG, J. Adapting usability heuristics to the context of mobile augmented reality. Adjunct Publication of the 33rd Annual ACM Symposium on User Interface Software and Technology, 2020. 4-6.

LAI, J. & ZHANG, D. 2014. A study of direction's impact on single-handed thumb interaction with touch-screen mobile phones. *CHI '14 Extended Abstracts on Human Factors in Computing Systems.* Toronto, Ontario, Canada: Association for Computing Machinery.

LAITINEN, K. & SIVUNEN, A. 2021. Enablers of and constraints on employees' information sharing on enterprise social media. *Information Technology & People,* 34**,** 642-665.

LAMERS, M. & PASHKEVICH, A. 2018. Short-circuiting cruise tourism practices along the Russian Barents Sea coast? The case of Arkhangelsk. *Current Issues in Tourism,* 21**,** 440-454.

LAVOYE, V., MERO, J. & TARKIAINEN, A. 2021. Consumer behavior with augmented reality in retail: a review and research agenda. *The International Review of Retail, Distribution and Consumer Research,* 31**,** 299-329.

LEE, A. S. & LIEBENAU, J. 1997. Information Systems and Qualitative Research. *In:* LEE, A. S., LIEBENAU, J. & DEGROSS, J. I. (eds.) *Information Systems and Qualitative Research: Proceedings of the IFIP TC8 WG 8.2 International Conference on Information Systems and Qualitative Research, 31st May–3rd June 1997, Philadelphia, Pennsylvania, USA.* Boston, MA: Springer US.

LEE, D., MOON, J., KIM, Y. J. & YI, M. Y. 2015. Antecedents and consequences of mobile phone usability: Linking simplicity and interactivity to satisfaction, trust, and brand loyalty. *Information & Management,* 52**,** 295-304.

LEE, H.-H., KIM, J. & FIORE, A. M. 2010. Affective and Cognitive Online Shopping Experience:Effects of Image Interactivity Technology and Experimenting With Appearance. *Clothing and Textiles Research Journal,* 28**,** 140-154.

LEE, H., XU, Y. & PORTERFIELD, A. 2021. Consumers' adoption of AR-based virtual fitting rooms: from the perspective of theory of interactive media effects. *Journal of Fashion Marketing and Management: An International Journal,* 25**,** 45-62.

LEE, J. H., KIM, H.-I. & PHAAL, R. 2012. An analysis of factors improving technology roadmap credibility: A communications theory assessment of roadmapping processes. *Technological Forecasting and Social Change,* 79**,** 263-280.

LEE, Y. & CHEN, A. N. K. 2011. Usability Design and Psychological Ownership of a Virtual World. *Journal of Management Information Systems,* 28**,** 269-308.

LEE, Y. J., HA, S. & JOHNSON, Z. 2019. Antecedents and consequences of flow state in e-commerce. *Journal of Consumer Marketing,* 36**,** 264-275.

LEHRER, C., WIENEKE, A., VOM BROCKE, J., JUNG, R. & SEIDEL, S. 2018. How Big Data Analytics Enables Service Innovation: Materiality, Affordance, and the Individualization of Service. *Journal of Management Information Systems,* 35**,** 424-460.

LEIDNER, D. E., GONZALEZ, E. & KOCH, H. 2020. An affordance perspective of enterprise social media and organizational socialization. *Strategic Information Management.* Routledge.

LEONARDI, P. M., BAILEY, D. E. & PIERCE, C. S. 2019. The Coevolution of Objects and Boundaries over Time: Materiality, Affordances, and Boundary Salience. *Information Systems Research,* 30**,** 665-686.

LEWIS, J. & RITCHIE, J. 2003. Generalising from qualitative research. *Qualitative research practice: A guide for social science students and researchers.* Sage Publications.

LEWIS, J. R. 2013. Critical Review of 'The Usability Metric for User Experience'. *Interacting with Computers,* 25**,** 320-324.

LEWIS, J. R. 2014. Usability: Lessons Learned … and Yet to Be Learned. *International Journal of Human–Computer Interaction,* 30**,** 663-684.

LEWIS, J. R. 2018. Measuring Perceived Usability: The CSUQ, SUS, and UMUX. *International Journal of Human–Computer Interaction,* 34**,** 1148-1156.

LEWIS, J. R. 2021. Measuring User Experience With 3, 5, 7, or 11 Points:Does It Matter? *Human Factors,* 63**,** 999-1011.

LI, C.-Y. & FANG, Y.-H. 2020. I searched, I collected, I experienced: Exploring how mobile augmented reality makes the players go. *Journal of Retailing and Consumer Services,* 54**,** 102018.

LIGHT, B., BURGESS, J. & DUGUAY, S. 2018. The walkthrough method: An approach to the study of apps. *New Media & Society,* 20**,** 881-900.

LIN, C.-L., LEE, S.-H. & HORNG, D.-J. 2011. The effects of online reviews on purchasing intention: The moderating role of need for cognition. *Social Behavior and Personality: an international journal,* 39**,** 71-81.

LINAZA, M. T., MARIMÓN, D., CARRASCO, P., ÁLVAREZ, R., MONTESA, J., AGUILAR, S. R. & DIEZ, G. Evaluation of mobile augmented reality applications for tourism destinations. Enter, 2012. 260-271.

LITAN, A. 2005. Increased phishing and online attacks cause dip in consumer confidence. *Gartner Study (June 2005)*.

LIU, W. & JI, R. 2018. Examining the Role of Online Reviews in Chinese Online Group Buying Context: The Moderating Effect of Promotional Marketing. *Social Sciences,* 7**,** 141.

LIU, Z. & PARK, S. 2015. What makes a useful online review? Implication for travel product websites. *Tourism Management,* 47**,** 140-151.

LU, J., LIU, C. & WEI, J. 2017. How Important Are Enjoyment and Mobility for Mobile Applications? *Journal of Computer Information Systems,* 57**,** 1-12.

MACLEAN, S. & HATCHER, S. 2019. Constructing the (Healthy) neoliberal citizen: using the walkthrough method "Do" critical health communication research. *Frontiers in Communication,* 4**,** 52.

MAGUIRE, M. & DELAHUNT, B. 2017. Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Higher Education,* 9.

MAHLKE, S. & THÜRING, M. 2007. Studying antecedents of emotional experiences in interactive contexts. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.* San Jose, California, USA: Association for Computing Machinery.

MAJCHRZAK, A. & MARKUS, M. L. 2012. Technology affordances and constraints in management information systems (MIS). *Encyclopedia of Management Theory,(Ed: E. Kessler), Sage Publications, Forthcoming*.

MANOVICH, L. 2006. Interaction as an aesthetic event. *Vodafone, Receiver magazine,* 17.

MARINOVA, D., DE RUYTER, K., HUANG, M.-H., MEUTER, M. L. & CHALLAGALLA, G. 2017. Getting Smart:Learning From Technology-Empowered Frontline Interactions. *Journal of Service Research,* 20**,** 29-42.

MARKUS, M. L. & SILVER, M. S. 2008. A foundation for the study of IT effects: A new look at DeSanctis and Poole's concepts of structural features and spirit. *Journal of the Association for Information systems,* 9**,** 5.

MARWICK, A. E. 2013. *Status update: Celebrity, publicity, and branding in the social media age*, Yale University Press.

MATOR, J. D., LEHMAN, W. E., MCMANUS, W., POWERS, S., TILLER, L., UNVERRICHT, J. R. & STILL, J. D. 2021. Usability: Adoption, Measurement, Value. *Human Factors,* 63**,** 956-973.

MCABEE, S. T., LANDIS, R. S. & BURKE, M. I. 2017. Inductive reasoning: The promise of big data. *Human Resource Management Review,* 27**,** 277-290.

MCGRENERE, J. & HO, W. Affordances: Clarifying and evolving a concept. Graphics interface, 2000. 179-186.

MCKENNA, B. 2020. Creating convivial affordances: A study of virtual world social movements. *Information Systems Journal,* 30**,** 185-214.

MCKENNA, B. & CHUGHTAI, H. 2020. Resistance and sexuality in virtual worlds: An LGBT perspective. *Computers in Human Behavior,* 105**,** 106199.

MCKENNA, B., MYERS, M. & GARDNER, L. Analysing qualitative data from virtual worlds: using images and text mining. European, Mediterranean & Middle Eastern Conference on Information Systems 2015, 2015.

MCKENNA, B., MYERS, M. D. & NEWMAN, M. 2017. Social media in qualitative research: Challenges and recommendations. *Information and Organization,* 27**,** 87-99.

MCLEAN, G., AL-NABHANI, K. & WILSON, A. 2018. Developing a Mobile Applications Customer Experience Model (MACE)- Implications for Retailers. *Journal of Business Research,* 85**,** 325-336.

MCLEAN, G. & WILSON, A. 2016. Evolving the online customer experience … is there a role for online customer support? *Computers in Human Behavior,* 60**,** 602-610.

MCLEAN, G. & WILSON, A. 2019. Shopping in the digital world: Examining customer engagement through augmented reality mobile applications. *Computers in Human Behavior,* 101**,** 210-224.

MCNANEY, R., VINES, J., ROGGEN, D., BALAAM, M., ZHANG, P., POLIAKOV, I. & OLIVIER, P. Exploring the acceptability of google glass as an everyday assistive device for people with parkinson's. Proceedings of the sigchi conference on human factors in computing systems, 2014. 2551-2554.

MCPHERSON, K., HEADRICK, L. & MOSS, F. 2001. Working and learning together: good quality care depends on it, but how can we achieve it? *Quality in Health Care,* 10**,** ii46-ii53.

MEINERT, J. & KRÄMER, N. C. 2022. How the expertise heuristic accelerates decision-making and credibility judgments in social media by means of effort reduction. *Plos one,* 17**,** e0264428.

MICHALCO, J., SIMONSEN, J. G. & HORNBÆK, K. 2015. An Exploration of the Relation Between Expectations and User Experience. *International Journal of Human–Computer Interaction,* 31**,** 603-617.

MILNE, G. R., ROHM, A. & BAHL, S. 2004. Consumers' Protection of Online Privacy and Identity. *Journal of Consumer Affairs,* 38**,** 217-232.

MISHRA, A., SHUKLA, A., RANA, N. P. & DWIVEDI, Y. K. 2021. From "touch" to a "multisensory" experience: The impact of technology interface and product type on consumer responses. *Psychology & Marketing,* 38**,** 385-396.

MIYAZAKI, A. D. 2008. Online privacy and the disclosure of cookie use: Effects on consumer trust and anticipated patronage. *Journal of Public Policy & Marketing,* 27**,** 19-33.

MIYAZAKI, A. D. & FERNANDEZ, A. 2001. Consumer perceptions of privacy and security risks for online shopping. *Journal of Consumer affairs,* 35**,** 27-44.

MOLICH, R. & DUMAS, J. S. 2008. Comparative usability evaluation (CUE-4). *Behaviour & Information Technology,* 27**,** 263-281.

MORTON, C. 2019. *The 10 Most Popular Cities of 2019* [Online]. Available: https://www.cntraveler.com/galleries/2015-06-03/the-10-most-visited-cities-of-2015-london-bangkok-new-york [Accessed].

MYERS, M. D. 2004. Hermeneutics in information systems research. *Social theory and philosophy for information systems,* 32**,** 103.

MYERS, M. D. 2019. *Qualitative research in business and management,* Sage.

MYERS, M. D. & AVISON, D. 2002. *Qualitative research in information systems: a reader*, Sage.

MYERS, M. D. & NEWMAN, M. 2007. The qualitative interview in IS research: Examining the craft. *Information and Organization,* 17**,** 2-26.

NAEEM, M. & OZUEM, W. 2021. Customers' social interactions and panic buying behavior: Insights from social media practices. *Journal of Consumer Behaviour,* 20**,** 1191-1203.

NASCIMENTO, B., OLIVEIRA, T. & TAM, C. 2018. Wearable technology: What explains continuance intention in smartwatches? *Journal of Retailing and Consumer Services,* 43**,** 157-169.

NAYEBI, F., DESHARNAIS, J. M. & ABRAN, A. The state of the art of mobile application usability evaluation. 2012 25th IEEE Canadian Conference on Electrical and Computer Engineering (CCECE), 29 April-2 May 2012 2012. 1-4.

NEUBURGER, L. & EGGER, R. An Afternoon at the Museum: Through the Lens of Augmented Reality. 2017 Cham. Springer International Publishing, 241-254.

NEUHOFER, B., BUHALIS, D. & LADKIN, A. 2015. Smart technologies for personalized experiences: a case study in the hospitality domain. *Electronic Markets,* 25**,** 243-254.

NIELSEN, J. 1994. *Usability engineering*, Morgan Kaufmann.

NIELSEN, J. 2011. *Mobile Usability 2nd Research Study* [Online]. Nielsen Norman Group. Available: https://www.nngroup.com/articles/mobile-usability-2nd-study/ [Accessed 13/05/2022].

NIELSEN, J. 2012. *Usability 101: Introduction to Usability* [Online]. Nielsen Norman Group. Available: https://www.nngroup.com/articles/usability-101-introduction-to-usability/ [Accessed 03/01/2012].

NIELSEN, J. & BUDIU, R. 2013. *Mobile usability*, MITP-Verlags GmbH & Co. KG.

NIKHASHEMI, S. R., KNIGHT, H. H., NUSAIR, K. & LIAT, C. B. 2021. Augmented reality in smart retailing: A (n) (A) Symmetric Approach to continuous intention to use retail brands' mobile AR apps. *Journal of Retailing and Consumer Services,* 60**,** 102464.

NOBLE, J. 2009. *Programming interactivity: a designer's guide to Processing, Arduino, and OpenFrameworks*, " O'Reilly Media, Inc.".

NORMAN, D. A. 1988. *The psychology of everyday things*, Basic books.

NORMAN, D. A. 1999. Affordance, conventions, and design. *interactions,* 6**,** 38–43.

NORTHCRAFT, G. B. & EARLEY, P. C. 1989. Technology, credibility, and feedback use. *Organizational Behavior and Human Decision Processes,* 44**,** 83-96.

OJENIYI, J. A., EDWARD, E. O. & ABDULHAMID, S. M. 2019. Security risk analysis in online banking transactions: Using diamond bank as a case study. *International Journal of Education and Management Engineering,* 9**,** 1-14.

OLSSON, T., LAGERSTAM, E., KÄRKKÄINEN, T. & VÄÄNÄNEN-VAINIO-MATTILA, K. 2013. Expected user experience of mobile augmented reality services: a user study in the context of shopping centres. *Personal and Ubiquitous Computing,* 17**,** 287-304.

OLSSON, T. & SALO, M. Online user survey on current mobile augmented reality applications. 2011 10th IEEE International Symposium on Mixed and Augmented Reality, 26-29 Oct. 2011 2011. 75-84.

OLSSON, T. & SALO, M. 2012. Narratives of satisfying and unsatisfying experiences of current mobile augmented reality applications. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.* Austin, Texas, USA: Association for Computing Machinery.

ONG, C.-S. & LAI, J.-Y. 2006. Gender differences in perceptions and relationships among dominants of e-learning acceptance. *Computers in Human Behavior,* 22**,** 816-829.

ORLIKOWSKI, W. J. & BAROUDI, J. J. 1991. Studying Information Technology in Organizations: Research Approaches and Assumptions. *Information Systems Research,* 2**,** 1-28.

OSATUYI, B., QIN, H., OSATUYI, T. & TUREL, O. 2020. When it comes to Satisfaction … It depends: An empirical examination of social commerce users. *Computers in Human Behavior,* 111**,** 106413.

OUZZANI, M., HAMMADY, H., FEDOROWICZ, Z. & ELMAGARMID, A. 2016. Rayyan—a web and mobile app for systematic reviews. *Systematic reviews,* 5**,** 1-10.

OWEN, H. 2008. *Open space technology: A user's guide*, Berrett-Koehler Publishers.

PANTANO, E., RESE, A. & BAIER, D. 2017. Enhancing the online decision-making process by using augmented reality: A two country comparison of youth markets. *Journal of Retailing and Consumer Services,* 38**,** 81-95.

PANTANO, E. & SERVIDIO, R. 2012. Modeling innovative points of sales through virtual and immersive technologies. *Journal of Retailing and Consumer Services,* 19**,** 279-286.

PAPAGIANNIDIS, S., PANTANO, E., SEE-TO, E. W. K., DENNIS, C. & BOURLAKIS, M. 2017. To immerse or not? Experimenting with two virtual retail environments. *Information Technology & People,* 30**,** 163-188.

PAREKH, P., PATEL, S., PATEL, N. & SHAH, M. 2020. Systematic review and meta-analysis of augmented reality in medicine, retail, and games. *Visual Computing for Industry, Biomedicine, and Art,* 3**,** 21.

PARISE, S., GUINAN, P. J. & KAFKA, R. 2016. Solving the crisis of immediacy: How digital technology can transform the customer experience. *Business Horizons,* 59**,** 411-420.

PARK, M. & YOO, J. 2020. Effects of perceived interactivity of augmented reality on consumer responses: A mental imagery perspective. *Journal of Retailing and Consumer Services,* 52**,** 101912.

PARSONS, T. 1968. On the Concept of Value-Commitments. *Sociological Inquiry,* 38**,** 135-160.

PETIT, O., VELASCO, C. & SPENCE, C. 2019. Digital Sensory Marketing: Integrating New Technologies Into Multisensory Online Experience. *Journal of Interactive Marketing,* 45**,** 42-61.

PETRESCU, M., KITCHEN, P., DOBRE, C., BEN MRAD, S., MILOVAN-CIUTA, A., GOLDRING, D. & FIEDLER, A. 2022. Innocent until proven guilty: suspicion of deception in online reviews. *European Journal of Marketing,* 56**,** 1184-1209.

PLOTKINA, D., DINSMORE, J. & RACAT, M. 2022. Improving service brand personality with augmented reality marketing. *Journal of Services Marketing,* 36**,** 781-799.

PLOTKINA, D. & SAUREL, H. 2019. Me or just like me? The role of virtual try-on and physical appearance in apparel M-retailing. *Journal of Retailing and Consumer Services,* 51**,** 362-377.

PONZOA, J. M., GÓMEZ, A., VILLAVERDE, S. & DÍAZ, V. 2021. Technologically empowered? perception and acceptance of AR glasses and 3D printers in new generations of consumers. *Technological Forecasting and Social Change,* 173**,** 121166.

POPE, H. 2018. Introduction to virtual and augmented reality. *Library Technology Reports,* 54**,** 5-7.

PORTER, M. E. & HEPPELMANN, J. E. 2017. Why every organization needs an augmented reality strategy. *HBR'S 10 MUST,* 85.

POUSHNEH, A. 2018. Augmented reality in retail: A trade-off between user's control of access to personal information and augmentation quality. *Journal of Retailing and Consumer Services,* 41**,** 169-176.

POUSHNEH, A. & VASQUEZ-PARRAGA, A. Z. 2017. Discernible impact of augmented reality on retail customer's experience, satisfaction and willingness to buy. *Journal of Retailing and Consumer Services,* 34**,** 229-234.

PRANAM, A. 2018. The Good, The Bad, and The Unusable. *Product Management Essentials: Tools and Techniques for Becoming an Effective Technical Product Manager.* Berkeley, CA: Apress.

PREWITT, E. & WARE, L. C. 2006. The State of the CIO'06. *Last accessed January,* 24**,** 2008.

PULIJALA, Y., MA, M., JU, X., BENINGTON, P. & AYOUB, A. 2016. Efficacy of three-dimensional visualization in mobile apps for patient education regarding orthognathic surgery. *International Journal of Oral and Maxillofacial Surgery,* 45**,** 1081-1085.

QIN, H., PEAK, D. A. & PRYBUTOK, V. 2021. A virtual market in your pocket: How does mobile augmented reality (MAR) influence consumer decision making? *Journal of Retailing and Consumer Services,* 58**,** 102337.

RAHMI, B., BIRGOREN, B. & AKTEPE, A. 2018. A meta analysis of factors affecting perceived usefulness and perceived ease of use in the adoption of e-learning systems. *Turkish Online Journal of Distance Education,* 19**,** 4-42.

RAMLER, M. E. 2021. Queer Usability. *Technical Communication Quarterly,* 30**,** 345-358.

RAPPERT, B. 2003. Technologies, texts and possibilities: a reply to Hutchby. *Sociology,* 37**,** 565-580.

RASKAR, R., WELCH, G. & FUCHS, H. 1999. Spatially augmented reality. *Augmented Reality: Placing Artificial Objects in Real Scenes.*

RAUSCHNABEL, P. A. 2021. Augmented reality is eating the real-world! The substitution of physical products by holograms. *International Journal of Information Management,* 57**,** 102279.

RAUSCHNABEL, P. A., FELIX, R. & HINSCH, C. 2019. Augmented reality marketing: How mobile AR-apps can improve brands through inspiration. *Journal of Retailing and Consumer Services,* 49**,** 43-53.

RAUSCHNABEL, P. A. & RO, Y. K. 2016. Augmented reality smart glasses: An investigation of technology acceptance drivers. *International Journal of Technology Marketing,* 11**,** 123-148.

RAYMOND, C. M., KYTTÄ, M. & STEDMAN, R. 2017. Sense of place, fast and slow: The potential contributions of affordance theory to sense of place. *Frontiers in psychology,* 8**,** 1674.

RECKWITZ, A. 2002. Toward a Theory of Social Practices:A Development in Culturalist Theorizing. *European Journal of Social Theory,* 5**,** 243-263.

RESE, A., BAIER, D., GEYER-SCHULZ, A. & SCHREIBER, S. 2017. How augmented reality apps are accepted by consumers: A comparative analysis using scales and opinions. *Technological Forecasting and Social Change,* 124**,** 306-319.

RESE, A., SCHREIBER, S. & BAIER, D. 2014. Technology acceptance modeling of augmented reality at the point of sale: Can surveys be replaced by an analysis of online reviews? *Journal of Retailing and Consumer Services,* 21**,** 869-876.

RICE, S., WINTER, S. R., DOHERTY, S. & MILNER, M. 2017. Advantages and disadvantages of using internet-based survey methods in aviation-related research. *Journal of Aviation Technology and Engineering,* 7**,** 5.

RIEGLER, A. & HOLZMANN, C. 2018. Measuring Visual User Interface Complexity of Mobile Applications With Metrics. *Interacting with Computers,* 30**,** 207-223.

RITCHIE, J., SPENCER, L. & O'CONNOR, W. 2003. Carrying out qualitative analysis. *Qualitative research practice: A guide for social science students and researchers.*

ROBEY, D., ANDERSON, C. & RAYMOND, B. 2013. Information technology, materiality, and organizational change: A professional odyssey. *Journal of the Association for Information Systems,* 14**,** 1.

ROGERS, E. 2003. *Diffusion of innovations*, Free Press.

RØPKE, I. 2009. Theories of practice — New inspiration for ecological economic studies on consumption. *Ecological Economics,* 68**,** 2490-2497.

ROSENBERG, D. 2018. The business of UX strategy. *Interactions,* 25**,** 26-32.

RYGHAUG, M. & TOFTAKER, M. 2014. A Transformative Practice? Meaning, Competence, and Material Aspects of Driving Electric Cars in Norway. *Nature and Culture,* 9**,** 146-163.

SALEM, M. A. & NOR, K. M. 2020. The effect of COVID-19 on consumer behaviour in Saudi Arabia: Switching from brick and mortar stores to E-Commerce. *International Journal of Scientific & Technology Research,* 9**,** 15-28.

SARODNICK, F. & BRAU, H. 2006. Methoden der usability evaluation. *Verlag Hans Huber*.

SAUNDERS, B., SIM, J., KINGSTONE, T., BAKER, S., WATERFIELD, J., BARTLAM, B., BURROUGHS, H. & JINKS, C. 2018. Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & Quantity,* 52**,** 1893-1907.

SCAIFE, M. & ROGERS, Y. 1996. External cognition: how do graphical representations work? *International Journal of Human-Computer Studies,* 45**,** 185-213.

SCHATZKI, T. R. 2002. *The Site of the Social: A Philosophical Account of the Constitution of Social Life and Change*, Pennsylvania State University Press.

SCHMIDT, A. & ETCHES, A. 2012. *User experience (UX) design for libraries:(THE TECH SET®# 18)*, American Library Association.

SCHOLZ, J. & DUFFY, K. 2018. We ARe at home: How augmented reality reshapes mobile marketing and consumer-brand relationships. *Journal of Retailing and Consumer Services,* 44**,** 11-23.

SCHOLZ, J. & SMITH, A. N. 2016. Augmented reality: Designing immersive experiences that maximize consumer engagement. *Business Horizons,* 59**,** 149-161.
SCHON, D. A. 1992. *The reflective practitioner,* London, Routledge.
SEARS, A. 1997. Heuristic Walkthroughs: Finding the Problems Without the Noise. *International Journal of Human–Computer Interaction,* 9**,** 213-234.
SELIGMAN, M. E. P. & CSIKSZENTMIHALYI, M. 2014. Positive Psychology: An Introduction. *Flow and the Foundations of Positive Psychology: The Collected Works of Mihaly Csikszentmihalyi.* Dordrecht: Springer Netherlands.
SERANO, P., ANGELONE, L. M., KATNANI, H., ESKANDAR, E. & BONMASSAR, G. 2015. A Novel Brain Stimulation Technology Provides Compatibility with MRI. *Scientific Reports,* 5**,** 9805.
SHACKEL, B. 2009. Usability – Context, framework, definition, design and evaluation. *Interacting with Computers,* 21**,** 339-346.
SHEN, S., XU, K., SOTIRIADIS, M. & WANG, Y. 2022. Exploring the factors influencing the adoption and usage of Augmented Reality and Virtual Reality applications in tourism education within the context of COVID-19 pandemic. *Journal of Hospitality, Leisure, Sport & Tourism Education,* 30**,** 100373.
SHERRY, M., RAVNEBERG, B. & SÖDERSTRÖM, S. 2017. *Disability, society and assistive technology,* Routledge.
SHIH, E. & SCHAU, H. J. 2011. To Justify or Not to Justify: The Role of Anticipated Regret on Consumers' Decisions to Upgrade Technological Innovations. *Journal of Retailing,* 87**,** 242-251.
SHIN, D. 2019. How does immersion work in augmented reality games? A user-centric view of immersion and engagement. *Information, Communication & Society,* 22**,** 1212-1229.
SHIN, D. 2021. Does augmented reality augment user affordance? The effect of technological characteristics on game behaviour. *Behaviour & Information Technology***,** 1-17.
SHOVE, E. & PANTZAR, M. 2005. Consumers, Producers and Practices:Understanding the invention and reinvention of Nordic walking. *Journal of Consumer Culture,* 5**,** 43-64.
SHOVE, E., PANTZAR, M. & WATSON, M. 2012. *The dynamics of social practice: Everyday life and how it changes,* Sage.
SHOVE, E. & WALKER, G. 2010. Governing transitions in the sustainability of everyday life. *Research Policy,* 39**,** 471-476.
SMINK, A. R., VAN REIJMERSDAL, E. A., VAN NOORT, G. & NEIJENS, P. C. 2020. Shopping in augmented reality: The effects of spatial presence, personalization and intrusiveness on app and brand responses. *Journal of Business Research,* 118**,** 474-485.
SÖDERMAN, M. 2005. Virtual reality in product evaluations with potential customers: An exploratory study comparing virtual reality with conventional product representations. *Journal of Engineering Design,* 16**,** 311-328.
SOHN, D. 2011. Anatomy of interaction experience: Distinguishing sensory, semantic, and behavioral dimensions of interactivity. *New Media & Society,* 13**,** 1320-1335.
SONG, J. H. & ZINKHAN, G. M. 2008. Determinants of Perceived Web Site Interactivity. *Journal of Marketing,* 72**,** 99-113.
STANGL, B., UKPABI, D. C. & PARK, S. Augmented Reality Applications: The Impact of Usability and Emotional Perceptions on Tourists' App Experiences. 2020 Cham. Springer International Publishing, 181-191.
STEFFEN, J. H., GASKIN, J. E., MESERVY, T. O., JENKINS, J. L. & WOLMAN, I. 2019. Framework of Affordances for Virtual Reality and Augmented Reality. *Journal of Management Information Systems,* 36**,** 683-729.
STEINBERG, S. L. & STEINBERG, S. J. 2015. *GIS research methods: incorporating spatial perspectives,* Esri Press.
STOFFREGEN, T. A. 2003. Affordances as Properties of the Animal-Environment System. *Ecological Psychology,* 15**,** 115-134.
STOWELL, E., LYSON, M. C., SAKSONO, H., WURTH, R. C., JIMISON, H., PAVEL, M. & PARKER, A. G. Designing and evaluating mHealth interventions for vulnerable populations: A systematic review. Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, 2018. 1-17.

STOYANOV, S. R., HIDES, L., KAVANAGH, D. J., ZELENKO, O., TJONDRONEGORO, D. & MANI, M. 2015. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. *JMIR mHealth and uHealth,* 3**,** e3422.

STRONG, D. M., VOLKOFF, O., JOHNSON, S. A., PELLETIER, L. R., TULU, B., BAR-ON, I., TRUDEL, J. & GARBER, L. 2014. A theory of organization-EHR affordance actualization. *Journal of the association for information systems,* 15**,** 2.

SUH, K.-S. & CHANG, S. 2006. User interfaces and consumer perceptions of online stores: The role of telepresence. *Behaviour & information technology,* 25**,** 99-113.

SUH, K.-S. & LEE, Y. E. 2005. The effects of virtual reality on consumer learning: An empirical investigation. *Mis Quarterly***,** 673-697.

SUN, H. 2013. A Longitudinal Study of Herd Behavior in the Adoption and Continued Use of Technology. *MIS Quarterly,* 37**,** 1013-1041.

SUN, H. & ZHANG, P. 2006. The role of affect in IS research: A Critical Survey and a Research Model. *Human-computer interaction and management information systems: Foundations.*

SUNDAR, S. S., BELLUR, S., OH, J., XU, Q. & JIA, H. 2014. User Experience of On-Screen Interaction Techniques: An Experimental Investigation of Clicking, Sliding, Zooming, Hovering, Dragging, and Flipping. *Human–Computer Interaction,* 29**,** 109-152.

SUNG, E. 2021. The effects of augmented reality mobile app advertising: Viral marketing via shared social experience. *Journal of Business Research,* 122**,** 75-87.

TADROUS, J., ERYILMAZ, A. & SABHARWAL, A. 2019. Action-Based Scheduling: Leveraging App Interactivity for Scheduler Efficiency. *IEEE/ACM Transactions on Networking,* 27**,** 112-125.

TAFESSE, W. 2021. The effect of app store strategy on app rating: The moderating role of hedonic and utilitarian mobile apps. *International Journal of Information Management,* 57**,** 102299.

TAMAS, R., O'BRIEN, W. & QUINTERO, M. S. 2021. Residential thermostat usability: Comparing manual, programmable, and smart devices. *Building and Environment,* 203**,** 108104.

TAN, B. J., BROWN, M. & POPE, N. 2019. The role of respect in the effects of perceived ad interactivity and intrusiveness on brand and site. *Journal of Marketing Communications,* 25**,** 288-306.

TAN, H., SUN, J., WENJIA, W. & ZHU, C. 2021. User Experience & Usability of Driving: A Bibliometric Analysis of 2000-2019. *International Journal of Human–Computer Interaction,* 37**,** 297-307.

TAN, M. L., PRASANNA, R., STOCK, K., DOYLE, E. E. H., LEONARD, G. & JOHNSTON, D. 2020. Usability factors influencing the continuance intention of disaster apps: A mixed-methods study. *International Journal of Disaster Risk Reduction,* 50**,** 101874.

TAVAKOLI, M., ZHAO, L., HEYDARI, A. & NENADIĆ, G. 2018. Extracting useful software development information from mobile application reviews: A survey of intelligent mining techniques and tools. *Expert Systems with Applications,* 113**,** 186-199.

TAYLOR, M. A. 2017. *Information system research: Fundamentals of scientific research for the consumer,* Momentum Press.

TAYLOR, S. & TODD, P. 1995. Assessing IT Usage: The Role of Prior Experience. *MIS Quarterly,* 19**,** 561-570.

THANAKIJSOMBAT, T., BHATIASEVI, V. & SUWANPOSRI, C. 2022. PUBLIC ADOPTION OF TELEHEALTH TECHNOLOGY IN THAILAND. *JOURNAL OF GLOBAL BUSINESS REVIEW,* 24.

THAPA, D. & SEIN, M. K. 2018. Trajectory of Affordances: Insights from a case of telemedicine in Nepal. *Information Systems Journal,* 28**,** 796-817.

THIELSCH, M. T., ENGEL, R. & HIRSCHFELD, G. 2015. Expected usability is not a valid indicator of experienced usability. *PeerJ Computer Science,* 1**,** e19.

THONG, J. Y. L., HONG, S.-J. & TAM, K. Y. 2006. The effects of post-adoption beliefs on the expectation-confirmation model for information technology continuance. *International Journal of Human-Computer Studies,* 64**,** 799-810.

TORNATZKY, L. G. & KLEIN, K. J. 1982. Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. *IEEE Transactions on Engineering Management,* EM-29**,** 28-45.

TRAUTH, E. M. 2001. The choice of qualitative methods in IS research. *Qualitative research in IS: issues and trends.* IGI Global.

TREMOULET, P. D., SHAH, P. D., ACOSTA, A. A., GRANT, C. W., KURTZ, J. T., MOUNAS, P., KIRCHHOFF, M. & WADE, E. 2021. Usability of Electronic Health Record–Generated Discharge Summaries: Heuristic Evaluation. *J Med Internet Res,* 23**,** e25657.

TULI, N. & MANTRI, A. 2021. Evaluating Usability of Mobile-Based Augmented Reality Learning Environments for Early Childhood. *International Journal of Human–Computer Interaction,* 37**,** 815-827.

TURVEY, M. T. 1992. Affordances and Prospective Control: An Outline of the Ontology. *Ecological Psychology,* 4**,** 173-187.

URQUHART, C. & FERNÁNDEZ, W. 2016. Using Grounded Theory Method in Information Systems: The Researcher as Blank Slate and Other Myths. *In:* WILLCOCKS, L. P., SAUER, C. & LACITY, M. C. (eds.) *Enacting Research Methods in Information Systems: Volume 1.* Cham: Springer International Publishing.

VALBØ, B. 2021. The IS-Notion of Affordances:A Mapping of the Application of Affordance Theory in Information Systems Research *Selected Papers of the IRIS, Issue Nr*.

VAN ESCH, P., ARLI, D., GHESHLAGHI, M. H., ANDONOPOULOS, V., VON DER HEIDT, T. & NORTHEY, G. 2019. Anthropomorphism and augmented reality in the retail environment. *Journal of Retailing and Consumer Services,* 49**,** 35-42.

VAN KREVELEN, D. & POELMAN, R. 2010. A survey of augmented reality technologies, applications and limitations. *International journal of virtual reality,* 9**,** 1-20.

VAN RIJNSOEVER, F. J. & CASTALDI, C. 2011. Extending consumer categorization based on innovativeness: Intentions and technology clusters in consumer electronics. *Journal of the American Society for Information Science and Technology,* 62**,** 1604-1613.

VENKATESH, V. & GOYAL, S. 2010. Expectation Disconfirmation and Technology Adoption: Polynomial Modeling and Response Surface Analysis. *MIS Quarterly,* 34**,** 281-303.

VENKATESH, V. & RAMESH, V. 2006. Web and Wireless Site Usability: Understanding Differences and Modeling Use. *MIS Quarterly,* 30**,** 181-206.

VENKATESH, V., THONG, J. Y. L. & XU, X. 2012. Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly,* 36**,** 157-178.

VIGLIALORO, R. M., CONDINO, S., TURINI, G., CARBONE, M., FERRARI, V. & GESI, M. 2019. Review of the augmented reality systems for shoulder rehabilitation. *Information,* 10**,** 154.

VOLKOFF, O. & STRONG, D. M. 2013. Critical Realism and Affordances: Theorizing It-Associated Organizational Change Processes. *MIS Quarterly,* 37**,** 819-834.

VOLKOFF, O. & STRONG, D. M. 2017. Affordance theory and how to use it in IS research. *The Routledge companion to management information systems.* Routledge.

WAIZENEGGER, L., MCKENNA, B., CAI, W. & BENDZ, T. 2020. An affordance perspective of team collaboration and enforced working from home during COVID-19. *European Journal of Information Systems,* 29**,** 429-442.

WALLIMAN, N. 2015. Data collection methods. *Social research methods: The essentials.* Sage.

WALSHAM, G. 1995a. The Emergence of Interpretivism in IS Research. *Information Systems Research,* 6**,** 376-394.

WALSHAM, G. 1995b. Interpretive case studies in IS research: nature and method. *European Journal of Information Systems,* 4**,** 74-81.

WALSHAM, G. 2006. Doing interpretive research. *European Journal of Information Systems,* 15**,** 320-330.

WALTEN, L. & WIEDMANN, K.-P. 2022. How product information and source credibility affect consumer attitudes and intentions towards innovative food products. *Journal of Marketing Communications***,** 1-17.

WANG, T., DUONG, T. D. & CHEN, C. C. 2016. Intention to disclose personal information via mobile applications: A privacy calculus perspective. *International Journal of Information Management,* 36**,** 531-542.

WANG, W., LEI, S., LIU, H., LI, T., QU, J. & QIU, A. Augmented reality in maintenance training for military equipment. Journal of Physics: Conference Series, 2020. IOP Publishing, 012184.

WANG, Y.-S. & LIAO, Y.-W. 2007. The conceptualization and measurement of m-commerce user satisfaction. *Computers in Human Behavior,* 23**,** 381-398.

WARING, T. & WAINWRIGHT, D. 2008. Issues and challenges in the use of template analysis: Two comparative case studies from the field. *Electronic Journal of Business Research Methods,* 6**,** pp85-94-pp85-94.

WEDEL, M., BIGNÉ, E. & ZHANG, J. 2020. Virtual and augmented reality: Advancing research in consumer marketing. *International Journal of Research in Marketing,* 37**,** 443-465.

WEI, W., LI, J., CAO, L., OU, Y. & CHEN, J. 2013. Effective detection of sophisticated online banking fraud on extremely imbalanced data. *World Wide Web,* 16**,** 449-475.

WELLS, J. D., PARBOTEEAH, V. & VALACICH, J. S. 2011. Online impulse buying: understanding the interplay between consumer impulsiveness and website quality. *Journal of the Association for Information Systems,* 12**,** 3.

WIXOM, B. H. & TODD, P. A. 2005. A Theoretical Integration of User Satisfaction and Technology Acceptance. *Information Systems Research,* 16**,** 85-102.

WOLFINBARGER, M. & GILLY, M. C. 2003. eTailQ: dimensionalizing, measuring and predicting etail quality. *Journal of Retailing,* 79**,** 183-198.

WU, I.-L. 2013. The antecedents of customer satisfaction and its link to complaint intentions in online shopping: An integration of justice, technology, and trust. *International Journal of Information Management,* 33**,** 166-176.

XIANGMING, L. & SONG, S. 2018. Mobile technology affordance and its social implications: A case of "Rain Classroom". *British Journal of Educational Technology,* 49**,** 276-291.

XIAO, S., WEI, C.-P. & DONG, M. 2016. Crowd intelligence: Analyzing online product reviews for preference measurement. *Information & Management,* 53**,** 169-182.

XU, H. & GUPTA, S. 2009. The effects of privacy concerns and personal innovativeness on potential and experienced customers' adoption of location-based services. *Electronic Markets,* 19**,** 137-149.

YANG, H.-D., LEE, J., PARK, C. & LEE, K. 2014. The adoption of mobile self-service technologies: Effects of availability in alternative media and trust on the relative importance of perceived usefulness and ease of use. *International Journal of Smart Home,* 8**,** 165-178.

YANG, S., CARLSON, J. R. & CHEN, S. 2020. How augmented reality affects advertising effectiveness: The mediating effects of curiosity and attention toward the ad. *Journal of Retailing and Consumer Services,* 54**,** 102020.

YAVUZ, M., ÇORBACıOĞLU, E., BAŞOĞLU, A. N., DAIM, T. U. & SHAYGAN, A. 2021. Augmented reality technology adoption: Case of a mobile application in Turkey. *Technology in Society,* 66**,** 101598.

YIM, M. Y.-C., CHU, S.-C. & SAUER, P. L. 2017. Is Augmented Reality Technology an Effective Tool for E-commerce? An Interactivity and Vividness Perspective. *Journal of Interactive Marketing,* 39**,** 89-103.

YIM, M. Y.-C. & PARK, S.-Y. 2019. "I am not satisfied with my body, so I like augmented reality (AR)": Consumer responses to AR-based product presentations. *Journal of Business Research,* 100**,** 581-589.

YOO, J. 2020. The Effects of Perceived Quality of Augmented Reality in Mobile Commerce—An Application of the Information Systems Success Model. *Informatics,* 7**,** 14.

YOON, D. & YOUN, S. 2016. Brand Experience on the Website: Its Mediating Role Between Perceived Interactivity and Relationship Quality. *Journal of Interactive Advertising,* 16**,** 1-15.

YOON, S. & OH, J. 2022. A theory-based approach to the usability of augmented reality technology: A cost-benefit perspective. *Technology in Society,* 68**,** 101860.

YOUENS, R. 2011. *7 Habits of Highly Effective Apps* [Online]. GIGAOM. Available: https://www.reuters.com/article/idUS177914094920110715 [Accessed 17/07/2011].

YOVCHEVA, Z., BUHALIS, D. & GATZIDIS, C. 2012. Smartphone augmented reality applications for tourism. *E-review of tourism research (ertr),* 10**,** 63-66.

ZAHABI, M., KABER, D. B. & SWANGNETR, M. 2015. Usability and Safety in Electronic Medical Records Interface Design:A Review of Recent Literature and Guideline Formulation. *Human Factors,* 57**,** 805-834.

ZAHARIAS, P. & POYLYMENAKOU, A. 2009. Developing a Usability Evaluation Method for e-Learning Applications: Beyond Functional Usability. *International Journal of Human–Computer Interaction,* 25**,** 75-98.

ZAMMUTO, R. F., GRIFFITH, T. L., MAJCHRZAK, A., DOUGHERTY, D. J. & FARAJ, S. 2007. Information Technology and the Changing Fabric of Organization. *Organization Science,* 18**,** 749-762.

ZAPATA, B. C., FERNÁNDEZ-ALEMÁN, J. L., IDRI, A. & TOVAL, A. 2015. Empirical Studies on Usability of mHealth Apps: A Systematic Literature Review. *Journal of Medical Systems,* 39**,** 1.

ZHANG, H., LU, Y., WANG, B. & WU, S. 2015. The impacts of technological environments and co-creation experiences on customer participation. *Information & Management,* 52**,** 468-482.

ZHANG, J. & YEOH, B. S. 2016. Harnessing exception: Mobilities, credibility, and the casino. *Environment and Planning A: Economy and Space,* 48**,** 1064-1081.

ZHANG, M., LUO, M., NIE, R. & ZHANG, Y. 2017. Technical attributes, health attribute, consumer attributes and their roles in adoption intention of healthcare wearable technology. *International Journal of Medical Informatics,* 108**,** 97-109.

ZHANG, T., WANG, W. Y. C., CAO, L. & WANG, Y. 2019. The role of virtual try-on technology in online purchase decision from consumers' aspect. *Internet Research,* 29**,** 529-551.

ZHENG, Y. & YU, A. 2016. Affordances of social media in collective action: the case of Free Lunch for Children in China. *Information Systems Journal,* 26**,** 289-313.

ZURAIKAT, L. 2020. Google glass: A case study. *Performance Improvement,* 59**,** 14-20.

Appendices

Appendix A: Data Collection Questions: Phase 1(Gibbs Reflection; Google Maps)

Description

- ✓ Do you have any experience of AR app before?
- ✓ Do you know about AR (live view feature) in Google Map?
- ✓ What would you expect from AR feature to offer to you?

Feelings

- ✓ What is your experience when you were using AR Google Map?
- ✓ How easy or difficult when you started to use the live view through AR Google Map?
- ✓ Which function(s) you most like during using the AR Google Map?
- ✓ How much easy to move around using the AR Google Map?

Analysis and Evaluation

- ✓ What was good about the experience of using AR Google Map live view feature?
- ✓ What was bad about your experience of using AR Google Map?
- ✓ Do you think AR add value to the Google Map App?
- ✓ Do you able to access all the information which you wanted to see in an AR Google Map?
- ✓ What was your anticipation about the AR Google Map? And what it is different in really experience?

Future Action

- ✓ What improvements(s) which you want to see when you will again use this AR Map?
- ✓ Do you think that this AR Map has all ideal features which you expect?
- ✓ Do you want to recommend this AR Map to other, why or why not?
- ✓ Do you think that AR feature be worthy of charge/price for the offered services?
- ✓ Do you think it worth to use it in the future and why?

Appendix B: Data Collection Questions: Phase 2 (Gibbs REFLECTION; Portal to Paradise, Ikea, Gucci)

AR Apps - Expectations

Please answer the following 3 questions BEFORE using the app.

1-Have you ever used or experienced AR-type technologies before? If yes, please elaborate further in terms of what you would EXPECT from an AR app. If no, based on your current understanding of AR, what would you EXPECT from an AR app?

2-In terms of apps you currently use (No AR function or AR-Based), what quality characteristics are most important to you?

- Functionality (How well the app does its 'job')
- Appearance (Aesthetics - appeal, look and feel)
- Reliability (Trustworthiness; Error free; Fast/efficient loading)
- Durability (Longevity of app - few upgrades or patches required)
- Recovery (Resolution of service failure; Automated restore; Automated backup)
- Contact (Customer service; Live chat option)
- Other

3-Please elaborate on why specific quality characteristics are important to you? Any examples? Required to answer.

AR apps - Immersive Experience

4-Which app did you use? Required to answer.

- Portal to Paradise (Tourism app)
- Gucci (On-line shopping app)
- IKEA Place (Home Improvements app)

5-For the app you used, what quality characteristics did you specifically like? (Choose 3!)

- Functionality (How well the app does its 'job')
- Appearance (Aesthetics - appeal, look and feel)
- Reliability (Trustworthiness; Error free; Fast/efficient loading)
- Durability (Longevity of app - few upgrades or patches required)

- Recovery (Resolution of service failure; Automated restore; Automated backup)
- Contact (Customer service; Live chat option)
- Other

6- Please elaborate on why you chose these 3 qualities characteristics. Any specific examples? Required to answer

Analysis phase

7-How does your AR app experience relate to your expectations (as outlined in Q5)?

Future use

8- Would you recommend this AR app to others? Why or why not?

9- If you could design your own AR app, which features would you include?

Appendix C: Reflections Instructions

Questions | Responses 58

Augmented Reality Reflections: Consumer Expectations and Experiences

Dear participant,

Thank you for taking part in this PhD study about Augmented Reality (AR) App usability. This study aims to explore how AR design may be impacted by consumer experience and expectation.

AR is defined as a technology that overlays information or interactive elements on top of the user's physical environment.

This researcher has selected three (free!) AR Apps for iPhones which can easily be used at home to provide you with an immersive experience. You may consider the following:

1- Portal to Paradise (Tourism App)
2- Gucci (On-line shopping App)
3- IKEA Place (Home Improvements App)

Please be aware by submitting your response to this online survey, you are giving consent for us to use your data. All of your responses will be kept confidential and will not be used for any purpose other than this research. Your participation is voluntary.

Please read the instructions carefully and for any enquiries, please contact:
PhD researcher: Arwa Almashyakhi (A.Almashyakhi@uea.ac.uk)
Supervisors: Dr Tomás Harrington and Dr Brad McKenna

Instructions:
SECTION 1: GENERAL INFORMATION (4 Questions)
- Answer general questions (Q1- 4) BEFORE using the App

SECTION 2: AR EXPECTATIONS (3 QUESTIONS)
- Answer Q5-7 on 'AR expectation' BEFORE using the App.

SECTION 3: AR EXPERIENCES (6 QUESTIONS)
- Choose one App (Q8) and download it from the Apple App Store*
- Open your chosen App and follow any instructions.
- Check out the App features. Please take your time to experience it!
- Answer Q9-13 on 'experience' and 'expectation' AFTER using the App.

Thank you!

Notes:
* If you would like to try more than one app, press submit individual responses for each app you use.

Appendix D: Visual representation of Socially Practised Affordance (SPA)

In this study, the researcher defined AR Affordance as the potential actions enabling users to achieve their goals through experiencing the usability of the AR system. Figure D demonstrates the use of an AR app affordance. Prior to its use, the user has a number of expectations related to the credibility of the app, in terms of data privacy and security. Once they commence their interaction, some issues may arise relating to competency of the user, i.e. a lack of the necessary skills. In addition, the user may also realise that the AR app provides incompatible experiences, including social issues caused by the need to hold up the mobile phone when in a public location, which may annoy others as they may feel they are being filmed. This can shape the user's view of AR technology, including writing a negative review.

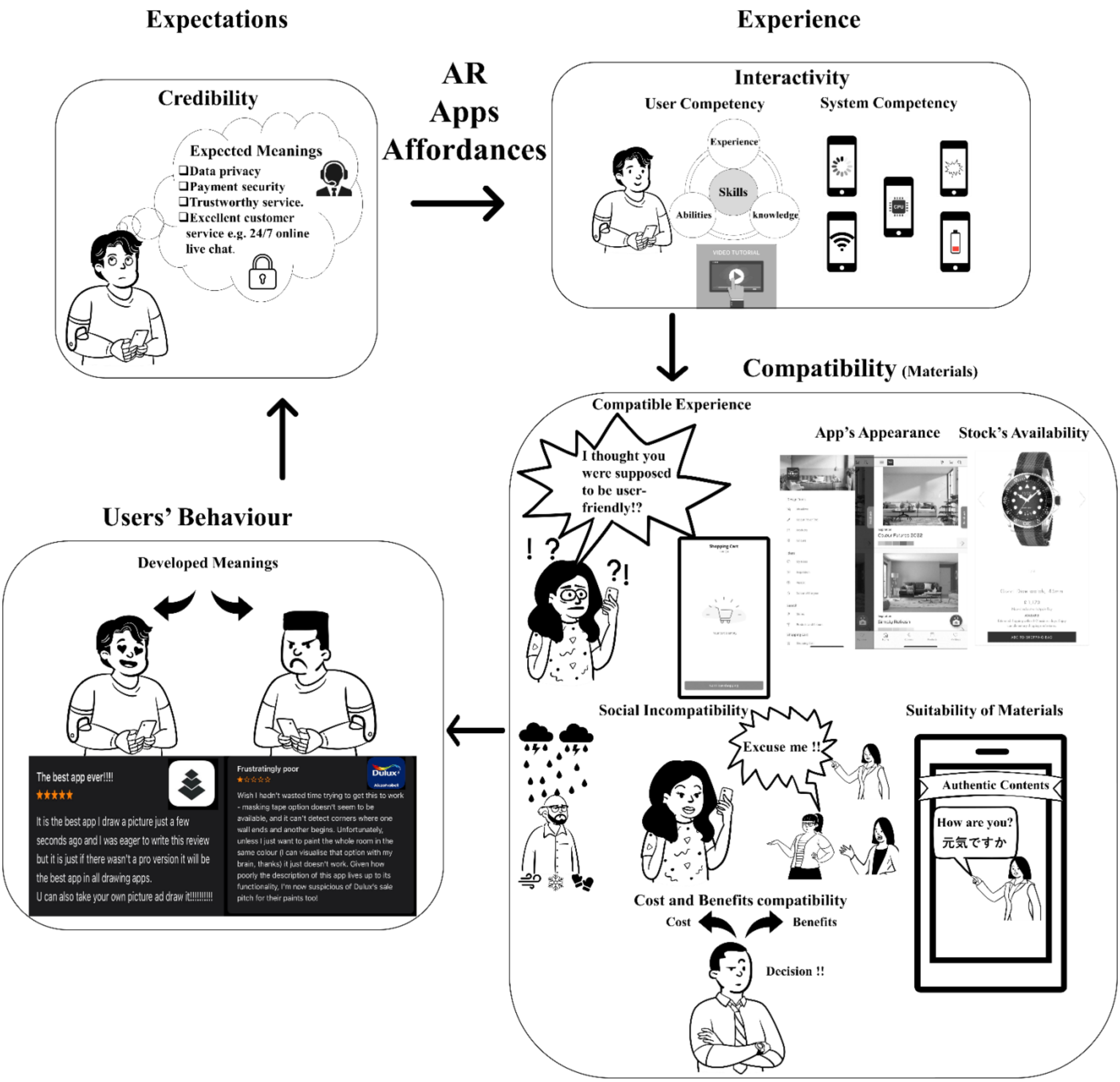

Figure D: Visual representation of Socially Practised Affordance