AUGMENTING SHOPPING REALITIES: STUDIES ON AUGMENTED REALITY (AR) IN RETAIL

Camen Teh

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Abstract

Augmented Reality (AR) is a technology that combines two worlds – the "real" world and the "virtual" world. The unique function of AR of overlaying virtual items into our real world environment blurs the line that separates what was conventionally understood as virtual spaces (e.g. e-commerce platforms) and physical spaces (e.g. brick- and-mortar stores). In the virtual space, product information is abundant, ranging from customer reviews to detailed information about products. In the physical space, on the other hand, information is limited to what we see on product packages and labels. The embedding of virtual information into physical environments is particularly meaningful, as it has the potential to mitigate consumer problems typically associated with conventional brick-and-mortar retail, such as consumer knowledge gaps about products. AR also has the potential to mitigate product uncertainty, through AR-delivered information that allow users to make sense of products and bridge product knowledge gaps.

Despite the potentials of AR in physical stores, retailers have difficulty seeing AR's promises, particularly with the intangible nature of the benefits that AR is speculated to bring. Practitioners remain unsure about how consumers and businesses can maximise the benefits of AR and what context would AR be useful for. In addition, as it currently stands and to the best of the author's knowledge, studies on AR experiences in the context of retail and advertising are limited, and how different AR designs can lead to positive product evaluations and increased purchase remain under-researched. The answer to the question of *"What is so special about AR?"* eludes us still.

In an endeavour to shed light onto the above big question, in Chapter 1, this thesis introduces the research problems of the topic in question and how this thesis is structured, as well as a commentary on the research philosophy of which this thesis is positioned, providing some reflections and background on how the choices of research questions and research designs of this thesis were made. Chapter 2 presents this thesis's literature review, giving a broad view of the current literature on AR technology, and subsequently a narrower view on the extant literature on AR technology in the context of retail. This chapter also critically discusses the themes in current literature and their implications. The research opportunities and gaps that form the motivation of the subsequent two studies in this thesis are also discussed in Chapter 2.

Chapter 3 presents the first study of this thesis, which investigates the properties of AR and its resulting affordances using the means-end chain (MEC) approach that is grounded in the users' perspective. The qualitative laddering technique is used for this study, which resulted in rich findings that allowed this thesis to identify the important AR attributes, and the consequences that these help users achieve in brick-and-mortar retail shopping, as well as the values that these help users gratify. From these findings, AR affordances are derived. The rich data collected from this qualitative study also provided the foundation to the thesis's second study, which is introduced and explained in Chapter 4.

The second study of this thesis is detailed in Chapter 5, and this study focuses on two AR design components that highlight the unique attributes of AR (namely, the virtual items overlaid onto our physical environments and the ability to control these), which were elicited in the first qualitative study. This second study employs a field experiment method to investigate how these two AR design components facilitate the cognitive process of incongruity resolution for an innovative but schema-incongruent product, leading to the purchase behaviour of such products. The context of this study is a juxtaposition of a scenario where product understanding and sensemaking is pivotal, showing how AR can facilitate the sensemaking process in a scenario where individuals' schemas are challenged.

This thesis concludes with a discussion on the implications of this thesis toward the theorising of augmented reality, together with the research and practical implications of the two studies in Chapter 6. The limitations of the thesis and corresponding future research opportunities are also discussed in this chapter.

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Chapter 1 Introduction

"I do think that a significant portion of the population of developed countries, and eventually all countries, will have AR experiences every day, almost like eating three meals a day. It will become that much a part of you." — Tim Cook, CEO of Apple

1.1. Research Background

Augmented reality (AR) is a growing subject of interest for practitioners and scholars alike, owing to the technology's unique properties that can offer unprecedented potential. One of the most-used definitions of AR is the one coined by Azuma (1997) in his seminal work, 'A Survey of Augmented Reality'. Van Krevelen and Poelman (2010, p. 1) highlight the key three aspects of Azuma's definition of AR technology, namely that an AR system:

1. *Combines* real and virtual in *a real environment*;
2. Registers or aligns real and virtual objects with each other and'
3. Runs *interactively*, in three dimensions, and in real time.

While the above has been argued to be the defining features of AR, prior studies have looked at other characteristics of AR too, for instance its media richness (de Amorim et al., 2022), its vividness (Ho et al., 2022; Saleem et al., 2022) and its controllability (Holdack et al., 2022), among others (see Appendix A). However, these can be understood to be derived from the above three basic properties of AR (e.g.

vividness and richness being a quality of the real-virtual integration feature of AR, and controllability as a result of its interactive property that allows for the haptic control of the virtual-real integrative experience).

AR have paved the way for novel technology applications, some of which have attracted much attention. The launch of AR game Pokémon Go in 2016, for example, saw a huge success, garnering 45 million users at its peak – and for some, this was an indication of the optimistic prospects for AR to be adopted by mainstream culture (Javornik, 2016c). In recent years, however, we have seen the potentials of AR manifested through the diverse applications of AR beyond just games and entertainment. For instance, utilitarian AR applications such as the IKEA Place app allows users to scan their rooms and overlay virtual IKEA products on their "real" space via their mobile phones in real to avoid purchasing furniture that may end up not fitting into the space as intended (Marr, 2018). Similarly, the Dulux Visualiser AR application enables a similar "try-before-you-buy" experience where users can try out the different shades of paint by virtually painting their rooms in real time, also on their mobile phones (Marr, 2018). Furthermore, as the opening quote alludes, industry leaders share similar views on AR's optimistic potential. Renowned technology figure, Tim Cook, for instance, suggested that AR will reach a level of ubiquity in the future that we will question "how we ever lived without it" (Leswing, 2016). In addition, there is a promising trend where tech giants, such as IBM, Dell, Google and Microsoft are seen investing millions into AR research and development (Perkins Coie, 2019) . The AR market is also predicted to increase to more than 198 billion USD by 2025 from its size of 3.5 USD in 2017 (Statista, 2018), further indicating AR's optimistic future.

Among its many applications in different domains, AR use in retail is starting to gain momentum in mainstream discussions, especially with applications such as virtual try-ons, in-store navigation and interactive product presentations (inVerita, 2019; Rigby et al., 2019). The unique function of AR of embedding virtual items into our real-world environment blurs the line that separates what was conventionally understood as virtual spaces (e.g. e-commerce platforms) and physical spaces (e.g. brick-and-mortar stores). In the virtual space, product information is abundant, ranging from customer reviews to detailed information about products. In the physical space, on the other hand, information is limited to what we see on product packages and labels. The embedding of virtual information into physical environments (e.g. in-store) is particularly meaningful, as it has the potential to mitigate consumer problems typically associated with conventional brick-and-mortar retail, such as information asymmetry, where there is a pervasive knowledge gap between consumer and retailer about a product. While information asymmetry is an issue that can be addressed by consumers proactively searching for information online through their mobile devices in a physical store, the contextualised information provided by AR that is overlaid onto the real-world product in close proximity, may serve to provide more comfort for consumers in their shopping process, as this would require less cognitive and physical effort for consumers to bridge this knowledge gap. In addition, AR's immersive and interactive format in particular allows for the effective delivery of information to consumers. For instance, brands such as Toyota and Hyundai have leveraged AR to help consumers understand complex processes and mechanisms, which in these brands' cases, involved AR demonstrations of the features and innovative technology in their new car models (Chandukala et al., 2022).

As suggested by Hoffmann et al. (2022), AR opens up an unlimited virtual space of information for retailers that can be creatively optimised to better serve customers in physical stores, while also generating a memorable shopping experience for consumers. Prior literature have indicated the different values that AR can provide to consumers (Caboni, 2019; Scholz & Smith, 2016), which include increasing purchase confidence through the additional information overlaid by AR systems (e.g. in the form of digital and interactive images and videos), while also providing hedonic values to consumers, through the interaction and engagement that are made possible by AR, which allows for the sensitive and intuitive haptic control of the virtual objects that are overlaid into consumers' physical shopping environment. These in turn may provide value to retailers, as it would stimulate consumers to enter their shopping space, increase brand awareness and potentially purchase intention in addition to consumer satisfaction.

1.2. Problem Statement

Despite the potentials of AR in physical stores indicated in the upward trend of research on AR technology[1], as well as investments on the technology stated in market reports, retailers have difficulty seeing AR's promises, particularly with the intangible nature of the benefits that AR is speculated to bring (Rigby et al., 2019). Further, there are apprehensions about what is needed for an AR experience to operate in a stable and reliable manner (Baird, 2019). However, this may well be concerns of the past as not only is the consumers' appetite for a differentiated shopping experience growing, more than 1 billion smartphones and tablet devices can deliver AR experiences today and these are supported by ever-improving network bandwidth (Cook et al., 2020).

[1] This is discussed in detail in Chapter 2 of the thesis.

Nevertheless, practitioners remain unsure about how consumers and businesses can maximise the benefits of AR and what context would AR be useful for. This problem is best highlighted in Kelly (2019), whereby the author argued that a crucial flaw of AR marketing, is that it is used as a gimmick; a shallow, entertainment-based promotion tactic rather than a way to connect the online and offline world. Consumers therefore find it difficult to derive value from AR technology, and as aptly Engine Creative (2022) points out, consumers who have encountered such AR campaigns are left thinking, “What was the point of that?”. Google Glass, for instance, is one exemplary case to indicate this. As Cellan-Jones (2014) describes it, Google Glass is “a fascinating, promising, sometimes brilliant product – but a failure nonetheless ... I think it lacks the sheer *usefulness* that would make it a must-have device for the mass market”. There is still uncertainty about AR technology’s impact on the bottom line, with retailers and brands pondering important questions such as “Does AR get past novelty and entertainment value to provide value to customers and firms?”, “Does AR affect the way customers evaluate brands?” and “Do the sales justify the investment?” (Chandukala et al., 2022). The current state of academic literature indicates a similar direction; as it currently stands, based on the literature reviewed in **Chapter 2** of this thesis, how different AR’s unique attributes and designs can lead to positive product evaluations and increased purchase remain under-researched. The answer to the question of “What is so special about AR?” eludes us still. **Chapter 2** goes into detail with the research motivation behind this question.

In addition, Kelly (2019) suggests that marketers and retailers should instead move beyond shallow implementations of AR and think about the customer pain points that AR can solve. Bringing in functionality through AR executions that satisfy consumer needs would elevate AR's value for consumers, and drive sustainable positive impact for brands and retailers – rather than simply using the technology as fun diversions that are easily forgotten and quickly disposed of (Kelly, 2019). Against this backdrop, this thesis investigates the properties of AR and its resulting affordances from users' means-end perspective. The focus on AR users' motivation in the use of AR in the context of shopping in physical stores (i.e. *why* would consumers use AR in shopping) would give useful insights into the goals that AR can help consumers achieve, thereby provide important values to consumers, and by extension, drive positive impact for retailers.

In addition to the lack of knowledge on how to provide value through AR, retailers also have little knowledge on how to best design and execute AR technologies in their retailing and marketing practices. In a survey cited in Chandukala et al. (2022), 52% of retailers in the US reported that they are not ready to integrate AR into their shopping experiences. The authors suggest that aside from the development and maintenance costs, another factor dissuading brands and retailers from creating AR experiences is the inability to find appropriate use cases (Chandukala et al., 2022). This could be due to the lack of knowledge about how different design features could be configured to create more effective AR experiences. Tan et al. (2021) developed a research agenda for AR marketing following findings of a survey regarding the use of AR in retail and its impact on sales from an international cosmetics retailer who incorporated AR into their mobile app, and it was emphasised that there is a need for clarity and empirical evidence of the factors that affect AR experience, and how these can be delivered on AR interfaces. AR's fidelity (i.e., how closely virtual objects resemble real objects) and embodiment (i.e., the ability to control virtual objects using bodily movements) were two of some suggested design factors that the authors suggested could be investigated in their recommended research agenda (Tan et al., 2021).

This thesis aims to also contribute toward the endeavour to address this point of their suggested research agenda by extending the "*whys*" of AR use in retail, to also examining the "*how*" – *how* consumer goals and values can be achieved through concrete AR attributes; or in other words, *what* are the AR attributes that are important to consumers in relation to their consumer motivation (i.e. goals and values). Orienting the research objectives of this thesis in this way would allow us to obtain tangible design insights for retailers to optimise the design of an AR experience. The first study of this thesis employs a qualitative method to ascertain the *whats* and *whys* of AR use in retail from the consumers' perspective. The second study advances knowledge on optimal AR designs by focusing on two design elements of AR that were elicited in the first study, which also align with the aforementioned AR factors suggested in Tan et al. (2021) – namely, the visual realism of virtual items overlaid onto our physical environments and the ability to control these virtual items, and how these influence cognitive processes and behavior. The two studies of this thesis are sequential, in that the design of the second study is followed by the findings of the first. The following section outlines the overarching framework that has guided the overall direction of this thesis.

1.3. Thesis Structure

This thesis adapts the affordance theory as an overarching framework (Gibson, 1986). This framework allows for the identification of AR affordances and investigation of mechanisms related to AR in the context of retail, as summarised in below **Figure 1**. The figure also shows the general research questions guided by this framework (Pozzi et al., 2014).

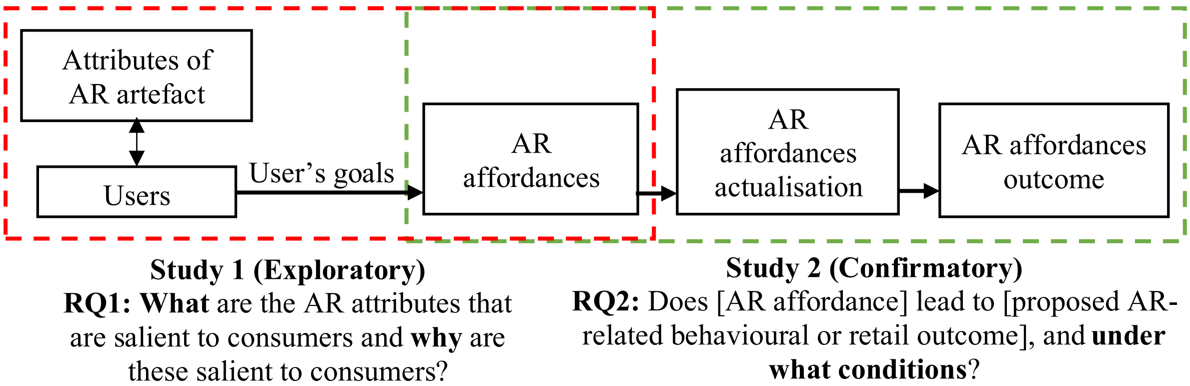

Figure 1 Overarching research framework and research questions – based on the IS affordance framework of (Pozzi et al., 2014)

As mentioned, AR's value remains elusive to stakeholders in retail. To evaluate the potential outcomes of AR use, it is crucial to ascertain these from the perspective of users in the context of retail and their shopping activities. Given the unique and unprecedented properties of AR, there is a need to develop an understanding that can adequately explain how and why AR's properties can lead to certain outcomes in brick-and-mortar retail – in pursuit of answering the question, *"What is so special about AR?"* However, before investigating AR-related outcomes, it is important to ascertain the AR attributes that are salient to consumers in the first place. Examining why the identified

AR attributes are important to consumers can provide us with deeper insights into the potential outcomes that are worthy of studying.

This objective aligns with the IS affordance theory, of which the key tenet is that a "goal-directed actor perceives objects in the environment in terms of how they can be used" (Volkoff & Strong, 2017a, p. 233). In other words, an object is perceived as what it can afford, and its potentials for meeting the actor's goals. The identification of affordances is the focus of the first study (as indicated in the red dashed box of **Figure 1**). The first part of this framework guides Study 1 (**Chapter 3**) in answering the questions of "What are the AR attributes that are salient to consumers" and "Why are these salient to consumers". The goal-directed focus of affordance theory enables the investigation of the latter question. For Study 1, the qualitative laddering method is used to explore and identify means-end linkages between AR attributes and its affordances.

Following the first part of the affordance theory, which focuses on the perception of users, the affordances perceived are subsequently acted upon, leading to the second part of this framework that is the affordance actualisation and its outcome (as indicated in the green dashed box in **Figure 1**). Study 2 (in **Chapter 5**) will zero in on the results found in the first qualitative study and test whether the affordance leads to the outcome proposed, and examine the conditions that influence the outcomes. For Study 2, a field experiment is used to investigate two attributes of AR identified in the qualitative study in the context of schema-incongruent products. This context was selected to emphasise the proposed AR affordance of facilitating product understanding and sensemaking through the mechanism of novelty seeking and perceived control. As

AR is considered a relatively new technology, it is worth noting that this thesis is focused on digital natives as the thesis's studies' sample, as they are representative of the expected user population of AR technology as has been validated in a prior AR user survey study (Olsson & Salo, 2011).

1.4. Research Philosophy: A Reflection

Before describing the research philosophy this thesis subscribes, it is perhaps useful to first mention that this research falls under the marketing and information systems (IS) disciplines, specifically in the area of in IS user/consumer behaviour. In marketing and IS research, scholars have engaged in different modes of inquiry reflecting different research philosophies. A pertinent subject of scholarly debate in social science research is related to the ontological positions of relativism and realism (Deshpande, 1983; Hirschman, 1986; Hunt, 1990).

In the management and marketing discipline, many research seems to implicitly assume a realist perspective (Deshpande, 1983; Hunt, 1990), which can be identified inherently in methodologies that focus on theory verification or hypothesis-testing and causality, as well as replicability and generalisation (Bagozzi, 1984; Churchill, 1979; Hanson & Grimmer, 2007; Hulland et al., 1996), in an endeavour to discover an objective, absolute truth. However, some authors have also advocated the value of relativism in marketing research, and challenged the view of realism by highlighting that human interactions and perceptions are part of science, and play a role in knowledge advancement (Anderson, 1983; Hirschman, 1986; Peter, 1992). In terms of my own research philosophy and beliefs, I find myself in between both stances. My research focus is on user/consumer behaviour, and I find that the pursuit of an absolute truth can be problematic, especially in the attempt to explain human behaviour, which is essentially ever-changing and unpredictable. It may be unconvincing to assume that there is a single, unchanging reality and that we can make predictive statements or generalisations in an area where marketing or technological 'fads' come and go, and the human behaviour associated with them. At the same time, while I believe that the traditional view of realism is implausible, I am not entirely persuaded by relativistic views. In an evaluation of relativism, Hunt (1990) points out that relativism implies nihilism, as a radical relativist view would assume that we can never have genuine knowledge about anything as there are multiple realities and no universal truth. If that is the case and no genuine knowledge of reality can be discovered, what then, would be the point of research?

In reconciling my apprehension for both extreme views, this research project relates most with the philosophy of critical realism (CR). CR does not embrace the naïve view of realism, or that knowledge about external phenomenon is known with certainty (Bhaskar, 2008; Hunt, 1990). An important tenet of CR is that knowledge is always fallible and incomplete (Sayer, 1992), and there are varying degrees of truth in what we know (Proctor, 1998). Nonetheless, from an ontological viewpoint, CR still holds that there exist structures and underlying causal mechanisms that are discoverable via research. Our investigation in uncovering such structures should thus warrant critical checks and questioning. Furthermore, in line with the view that knowledge is always fallible and truth a product of relations and contingent conditions, critical realist Bhaskar (1979) contends that theory can only play an explanatory role in the human sciences, and it is not possible for theory to hold predictive powers (Dobson, 2001). As knowledge is viewed as a social product and is neither permanent nor universal (Easton, 2002; Patomäki & Wight, 2000), the predictive use of theories are limited to simply anticipating likely tendencies (Dobson, 2001). This view translates in the axiological stance of CR, in that researchers should inquire about these 'tendencies', and how these tendencies come to be (Houston, 2010). Thus, the value of our research is reflected by the explanatory power of the theoretical mechanisms we propose in our investigation of a phenomenon (Robert Isaksen, 2016).

The key principles of CR outlined above translates to my research questions and the research methods used, as was briefly outlined in **Section 1.3** on this thesis's structure. The two studies were conducted sequentially, with findings from the first informing the design of the second. The first study is grounded on the users' perspective, employing an inductive approach by collecting qualitative data via interviews to uncover why consumers use AR in their shopping activities, and what are the AR attributes that help consumers achieve their goals. Upon identifying the key elements of AR attributes and corresponding consumer goals elicited from the interviews via content analysis, the following study tests the propositions found in Study 1 using experimental methods in Study 2.

CR also views that phenomenon are conjunctures of mechanisms collectively manifesting in a particular situation (Bhaskar, 1979), which means that the patterns we observe are contingent outcomes co-determined by not only observable factors or variables, but also possible countervailing mechanisms present in specific contexts. It is thus important to identify the contingent variables that operate in different ways at different times (Easton, 2002). Miller and Tsang (2011) have suggested the use of experiments to affirm or falsify the presence of theorised mechanisms, but specifically for Bhaskar (2008), what is more important about experiments in research, is how researchers can identify the experimental conditions that generate observable pattern of events, without which would not yield the same pattern. Drawing from this perspective, Study 2 is based on a field experiment that identifies the design properties of AR and the configuration of these to result in behavioural outcomes.

In summary, this thesis's research questions and methods of inquiry reflect the ontological and epistemic beliefs of the CR philosophy. This research endeavour takes on a multi-method approach in the attempt to shed light on the structure and mechanisms to explain how unique attributes of AR can help users achieve their goals and why they use AR to achieve them. However, I critically consider the context and contingent conditions in the form of the AR designs, which are potential AR conditions identified from the data collected. In a similar axiological vein of CR, the purpose and value of this research's findings is not to predict future patterns or to establish a universal, consistent truth. Rather, it seeks to yield a comprehensive and context-sensitive explanation of the patterns discovered.

Chapter 2 Overarching Literature Review on Augmented Reality: A Critical Overture

"If I have seen further, it is by standing on the shoulders of giants"

– Sir Isaac Newton

This chapter provides an overall picture of the observed trends and themes found in current published works on AR. First, **Section 2.1** presents a broad overview of AR research across disciplines. Second, **Section 2.2** outlines the current state of AR research in the context of retail. Both sections highlight the trends and opportunities for research that provide the impetus of this thesis. Third, **Section 2.3** is a systematic, critical review and analysis of extant literature through which the research themes are identified and the positioning of this thesis in relation to the current academic discourse on the topic is discussed.

2.1. Literature on AR: A Broad Overview

A broad search on the Web of Science Core Collections with the search term *"AR OR Augmented Reality"* garnered a result of 167,717 journal publications ranging from publication years 1970 to 2022. The publication counts according to each year as illustrated in **Figure 2** indicates that there is an upward trend in overall publication of journal articles indicating a growing interest in AR technology.

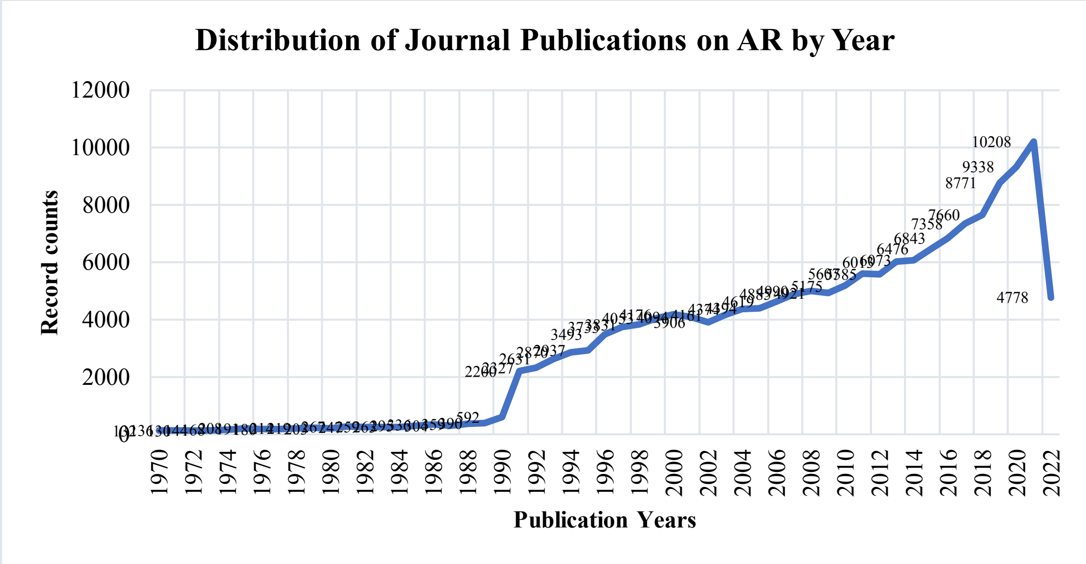

Figure 2 *Distribution of journal publications on AR by year*[2]

While not many journal articles were published prior to year 1990 with less than 400 articles published each year prior to that, there has been a steady increase in publications over the last three decades. There is a stark increase of publication counts in the last decade, in that there were only 5175 journal articles published in year 2010, whereas in year 2020, we observe that the publication count increased almost twofold, to 10,208 journal publications that year – which is also the year with the highest recorded journal publications. It is likely that this rising trend will continue this year and the years to come, particularly with the growing buzz surrounding the Metaverse phenomenon, in which augmented and mixed reality applications are discussed to be core technologies (Anderson & Lee, 2022; Park & Kim, 2022).

[2] The review was conducted in mid 2022. The apparent drop in publication count following 2021 does not imply a decrease in research interest among scholars, as it does not account for works that will be published in the second half of year 2022.

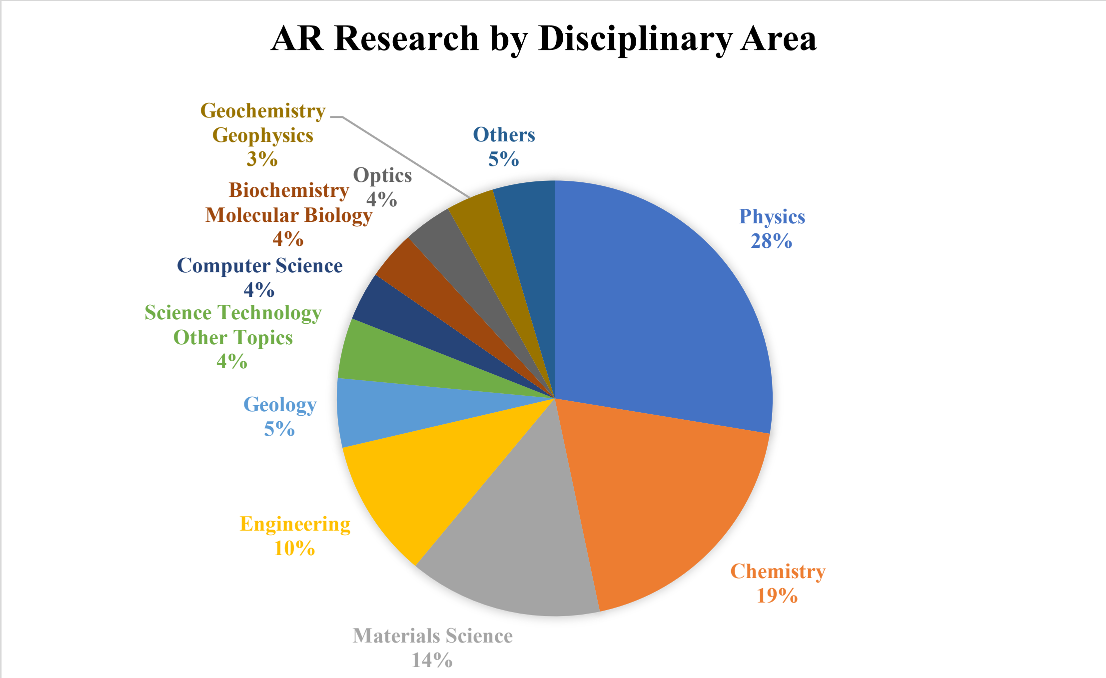

Figure 3 *Distribution of journal articles on AR by Web of Science research areas*

Further analysis of the 167,717 journal articles returned from the broad search revealed that AR research has been published in many disciplines. As shown in **Figure 3**, the three research disciplines with the highest number of AR-related journal articles include Physics (46,273 journal publications), Chemistry (32,019 journal publications) and Material Science (24,097 journal publications). Within "Others (5%)", the category Computer Science wherein Information Systems (IS) journals are indexed, had a share of 6,096 journal publications. Also under "Others (5%)", the category Business Economics wherein Marketing journals are indexed had a share of 1,612 journal publications. Other disciplines also found in this search included medicine and education, and these observations are consistent with the current applications of AR in practice as reported in prior literature reviews (Carmigniani et al., 2011). Although the distribution of journal articles is dominantly centered around disciplines in the hard sciences, there is a substantial growth in research on the business application of AR technology over the recent years, particularly from year 2017 as indicated in **Figure 4**. This coincides with the real-world events in the same year, such as the launch of Apple's ARKit (Matney, 2017), and it was also the onset of the "AR preview app wave", where retailers such as IKEA, Wayfare and Amazon introduced AR apps that allow users to preview products in their own home (Bardi, 2018). Year 2017 was also the year that held big promises for AR technology as AR and VR software revenues grew more than 200% year over year in the previous year of 2016 (Conner, 2016).

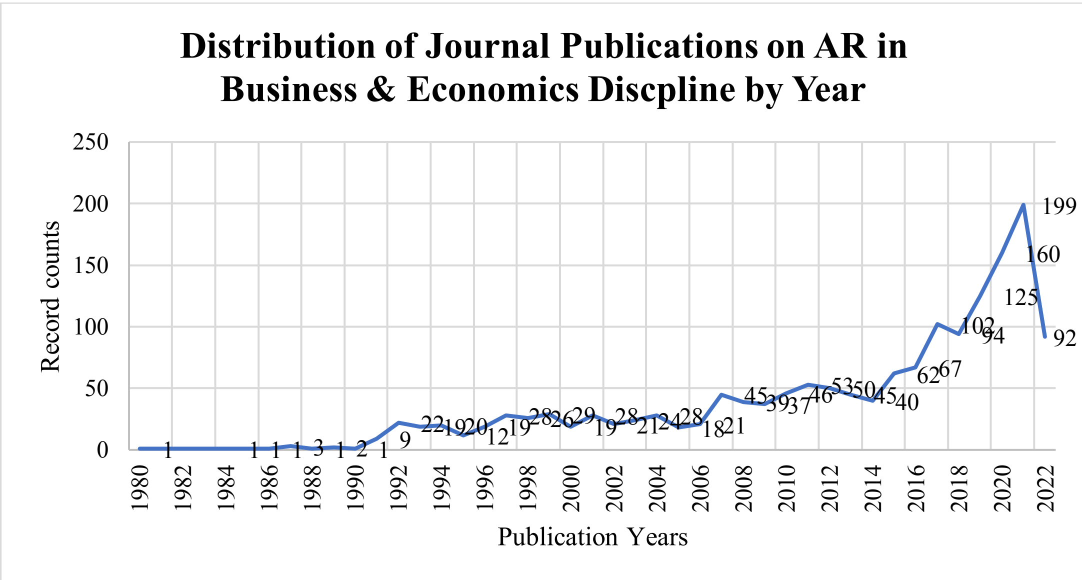

Figure 4 Distribution of journal publications on AR in business and economics discipline by year[3]

Upon closer examination of the journal publications in the computer science category wherein information systems papers are indexed (n= 6,096), specifically when looking at the recurring word frequencies of the abstracts of the journal publications, we can observe that the most frequently used words included data, performance, timing, algorithm, imaging, as seen in **Figure 5**, suggesting that these are the technical foci of

[3] See previous footnote.

AR research that have been studied widely, and also suggest that the research activities gravitate towards hard sciences. “Information” (3,321 counts) and “Users” (3,148 counts) were frequently mentioned words as well, indicating that AR is studied as an information delivery tool and also that users or individuals are also highlighted in relation to AR use in extant research. On this note, it should be highlighted that this thesis pertains to these two keywords in that the thesis takes on a user-centric perspective by examining their motivations and goals in using AR technology and also investigating how users interact with the information delivered by AR applications in retail settings.

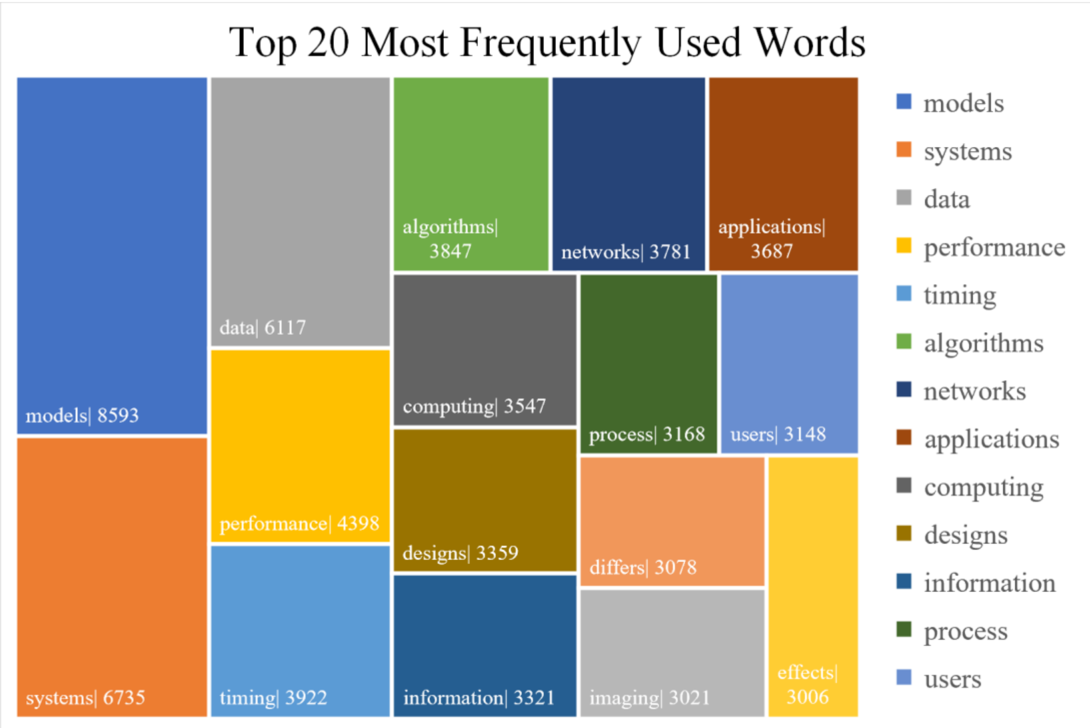

Figure 5 Top 20 most frequently used words in computer science category

The continued increase in the number of journal publications investigating the topic of AR points to a promising trend, and combined with optimistic outlook found in market reports as well as the recent spark in interest in the Metaverse phenomenon that predicates extended technology applications. AR's novelty and distinct attributes provide fertile ground for theory development that can be useful to future research across disciplines. As mentioned, the frequently used words illustrated in **Figure 5** suggests a trend in hard-science approaches, which is unsurprising as the search within the Computer Science category, despite being interdisciplinary and included social science journals, were largely dominated by journals publications from the hard sciences (e.g. electrical and electronic engineering (n = 1,617), software engineering (n = 1,417), telecommunications (n = 866)). This thesis focuses on a social science perspective but synthesises prior works on technical AR attributes and technology advances (e.g. in imaging and photorealism) from the hard sciences into our focus on user application experiences and perspectives. While contributions to this thesis would largely be to the social science domains, it is also expected that the findings of this thesis would aid researchers in the hard computer sciences in identifying the salient aspects of AR that may be important to users, and would impact behaviour and business performances.

2.2. Research on AR in Retail

As this thesis is concerned with the context of retail, I refined the search terms to *("AR" OR "Augmented Reality") AND "retail"*. This query returned only 253 publications, wherein only 148 are journal articles. Similar to the overall publication of AR research in general, this search query that refined the search results to also include "retail" in their title, topic and/or abstract also saw an increase in publication over the years, as illustrated in **Figure 6**.

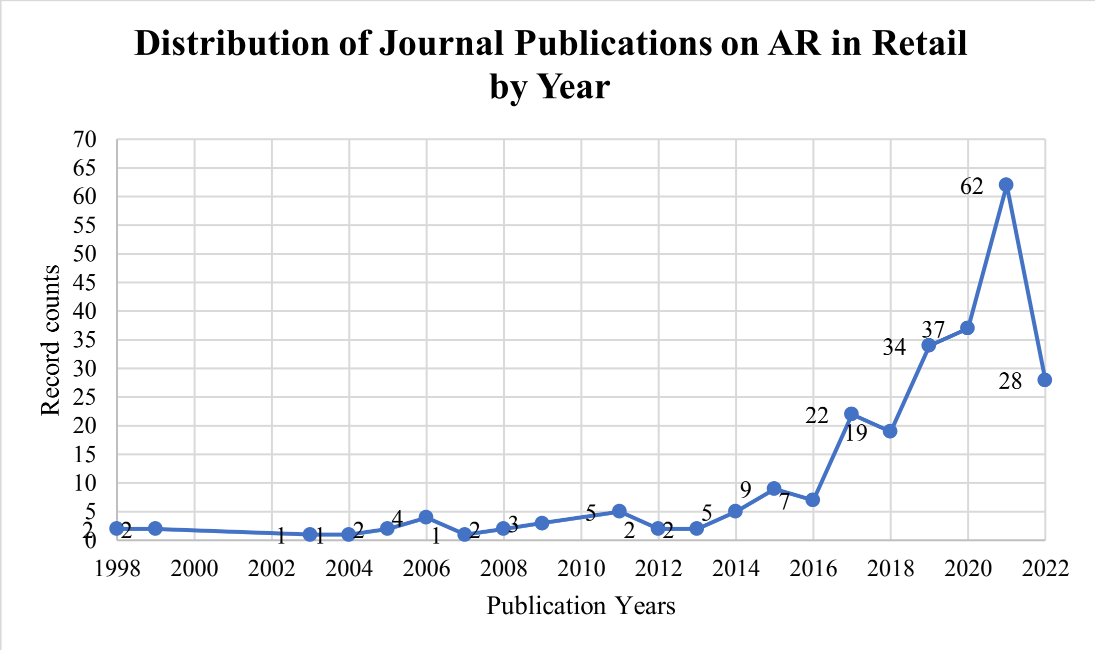

Figure 6 Distribution of journal publications on AR in retail by year [4]

Compared to the previously analysed trends, research on AR in specifically retail is a relatively new focus, as there were no recorded publications dated before year 1998. As can be seen in **Figure 6**, there is a stark increase in publications in year 2017; a similar trend discussed in **Section 2.1**, also illustrated in **Figure 4**. This observation, again, may be attributed to retailers' interest in AR applications for consumer engagement and to provide them with an elevated customer experience. While this growth trend is forecasted to continue, the number of publications is still relatively small (under 100 publication across publication years), providing much room for research opportunities.

[4] See previous Footnote 1.

Figure 7 Distribution of journal sources of papers on AR in retail [5]

As can be seen in above **Figure 7**, the sources of journal publications on AR in retail are dominantly from the marketing and information systems domain. The source with the largest share of journal publications is the Journal of Retailing and Consumer Services (*n*=18), which is an ABS Level 2 journal in the field of marketing [6]. Other marketing journals with papers on AR in retail include the International Journal of Retail Distribution Management (*n*=12; ABS Level 2), Journal of Retailing (*n*=4; ABS

[5] Journals listed in the chart are sources with >1 publication with the keywords returned from the search query *("AR" OR "Augmented Reality") AND "retail"*. For brevity, journal sources with just 1 publication were not included in the chart (*n*=74).

[6] All references to ABS academic journal ranking follows the ABS Academic Journal Guide 2021. Available at: https://charteredabs.org/academic-journal-guide-2021/

Level 4), Journal of Research in Interactive Marketing (*n*=3; ABS Level 1), Journal of the Academy of Marketing Science *(n*=2; ABS Level 4*) and Psychology and Marketing (*n*=12; ABS Level 2). On the other hand, information systems sources with journal publications on AR in retail include Technological Forecasting and Social Change (*n*=6; ABS Level 3), Computers in Human Behaviour (*n*=4; ABS Level 2), Information Technology and People (*n*=2; ABS Level 3), International Journal of Information Management (*n*=2; ABS Level 2) and Journal of Internet Commerce (*n*=2; ABS Level 1). Following the assumption that journal ranking indicates quality of publications, the observations from **Figure 7** would suggest that the current stage of literature of AR in retail is still largely still of average quality, with a large proportion of papers that has found home in journals with ABS ranking of Level 3 and below. However, it is found that the 6 journal papers from the ABS Level 4 and 4* academic journals were published between year 2019 to 2022. This is a positive indication, as it shows that AR in the domain of retail is increasingly getting the attention and acknowledgement of higher-ranking journals. At the same time, the low numbers of publication in high-ranking journals also indicate that there is a need for higher-level research and understanding of AR applications in the context of retail. It is also the aim of this thesis to contribute to the stream of literature by having at least one of the studies targeted to a journal that is ranked 4 and/or 4*.

A word frequency analysis of the indexed keywords of these 148 journal publications is illustrated in **Figure 8** below**.** The keywords “experience”, “consumer”, “service”, “customer”, “user” and “engagement” are indicative of the consumer- or user-centric focus of extant literature. This thesis similarly puts individual users of AR technology at the center. The keywords “satisfaction”, “intention”, “behaviour”, "purchase" suggest that these may be the dominant variables that are being studied. Furthermore, the keywords "acceptance", "adoption" and "resistance" also suggest that these are outcomes that were frequently examined in the context of AR in retail, and also indicates a density in acceptance studies for AR technology in the domain of retail.

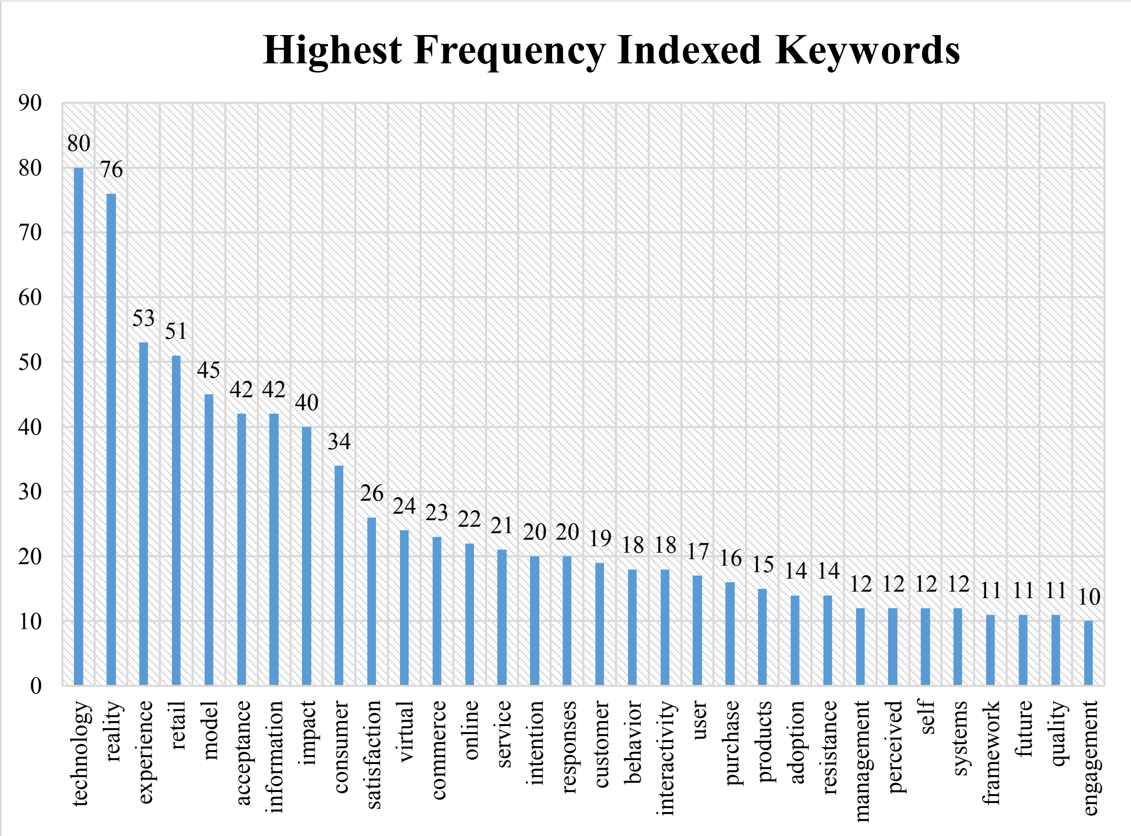

Figure 8 Highest frequency indexed keywords of journal publications on AR in retail

A noteworthy finding from this keyword analysis is that "online" is a dominant keyword, providing support to prior observations that AR-related studies in the context of retail have primarily focused on online retail and e-commerce (Hilken, 2018). While this would be discussed in more detail in the later section, there is a gap in knowledge on the value of AR in offline/physical retail settings, and the processes related to it. This thesis aims to contribute to the limited literature on the use of AR in brick-and-mortar retail settings – the impetus being that the functions of AR are different in salience with regard to online vs. offline settings.

In addition, as seen in **Figure 8**, "virtual" and "interactivity" are also frequently indexed keywords. These pertain to the unique properties of AR; first, that it is a system that overlays *virtual* objects into physical environments and second, it is a system that users can *interact* with, whereby it allows users to control and manipulate the virtual elements that are embedded in the AR experience. The importance of these two AR attributes are elicited alongside other key AR attributes in this thesis's first study that explores the salient AR attributes that lead to meaningful consequences in physical retail settings, which were found to gratify personal values. It is also these two properties of AR that the second study of this thesis dives deeper into, by experimentally testing how the design variations of these two key AR properties would lead to different cognitive outcomes and behaviour.

Another observation that can be gathered from the analysis visualised in **Figure 8** is the frequent keyword "model" suggests that extant studies may be predominantly employing quantitative approaches whereby models are tested as the main research method. A deeper examination of these 148 journal publications in the subsequent section confirms this. I argue that because AR technology is a relatively new technology in retail, particularly in physical, brick-and-mortar retail, it is important to develop insights from ground up, qualitatively before these are tested through quantitative means. The following section provides a deeper look into these 148 studies on AR in retail to identify the academic discourse surrounding the technology in this domain, and discusses how this thesis positions itself within this discourse as well as how it can provide added insights and possibilities for the theorising of augmented reality.

2.3. A Critical Literature Review of AR in Retail

The above sections have provided a birds-eye view of research on AR, first by reporting some trends on AR research in general, and second by discussing similar patterns but in the narrowed scope of research on AR in retail. Refining this further, this section will go deeper to take on a more critical review of the literature in this area and discuss the implications of the observed trends, particularly with regards to the motivation of this thesis and how this thesis can contribute to the existing scholarly discourse. The following sections will: first, go into the review approach; second, describe the observed themes that were found in the literature review and discuss these critically; and third, present the knowledge gaps that this thesis seeks to address.

2.3.1 Review approach

Figure 9 below illustrates the literature search and selection process for a more systematic examination of the analysis of the relevant literature before moving into critically evaluating the literature and drawing conclusions from the trends and themes observed. First, to ensure that all relevant publications are included, I employed the broad search query *("AR" OR "Augmented Reality") AND "retail"* on Web of Science Core Collections, which returned 253 overall publications, including proceedings, book chapters, review articles and so forth. The second step involved scope refinement, where the 253 search results were later refined only to include journal publications to ensure source credibility, which resulted in 148 journal papers.

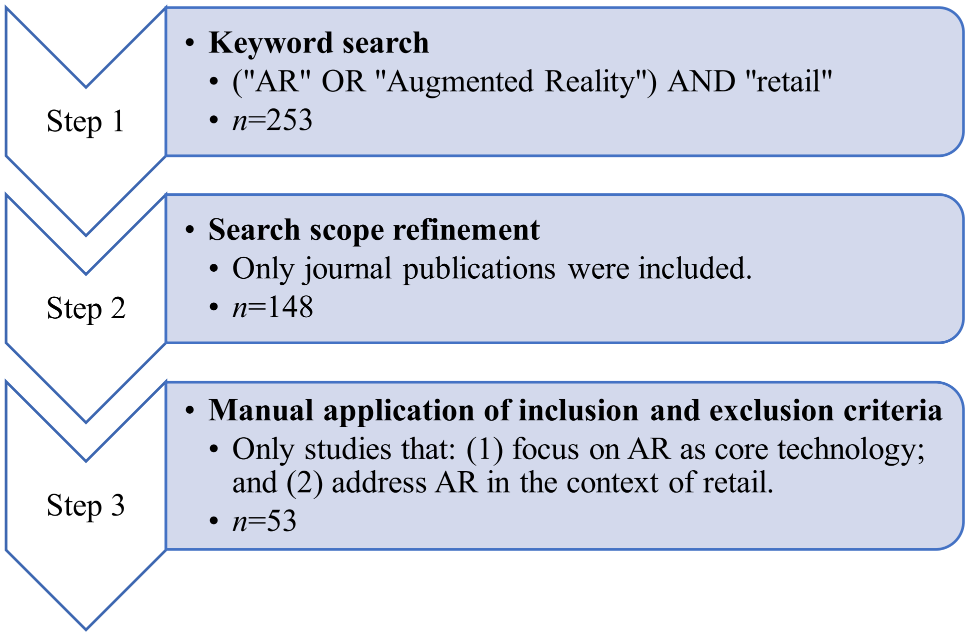

Figure 9 Literature selection process

Following that, I manually reviewed the relevance of the abstract and applied two inclusion criteria, such that: (1) only studies that had AR as the core focus (i.e. studies that used AR as an example of general retailing technology were excluded, e.g. Rajagopal (2022)); and (2) only studies that addressed AR in the context of retail, were included. Taking a focused view on AR technology, its key properties and the investigated effects on business processes can help us avoid reducing AR as a generic technology and develop a better understanding on AR's uniqueness and the research opportunities we can undertake. This third and final step of refinement resulted in a final sample of 53 journal publications, as papers that did not meet the aforementioned two criteria were excluded.

The final sample of 53 journal publications were reviewed with special attention paid to the context of AR use, the AR characteristics and variables investigated, as well as the conceptual or theoretical foundations explaining mechanisms related to AR use. The following sections will discuss some observations gathered from this review based on the aforementioned foci, and describe how this thesis situates itself in the current scholarly discourse.

2.3.2 Synthesis of literature

Drawing from prior literature reviews that have been done on AR technology use in retail (e.g. Caboni and Hagberg (2019); Hilken (2018); Lavoye et al. (2021)), this review focus on four central themes that were similarly discussed in these review papers, but more importantly, these themes are also relevant to this thesis. The discussed themes include: (1) the context of AR use in retail; (2), the AR characteristics or variables investigated; (3) research approach and foci in current literature on AR in retail; and (4) AR-specific mechanisms and theorisation. This section closes with an overall discussion that summarises the key takeaways from this critical review based on the four themes. **Appendix A** summarises the 53 journal publications this review is based on.

Theme 1: Context of AR use. Among the 53 papers reviewed, 33 were focused on the online retail use of AR (e.g. Park and Kim (2021)) and investigated web-based AR technology in relation to purchase intentions), whereas only 12 were focused on the offline use of AR (i.e. in physical, brick-and-mortar stores – e.g. de Amorim et al. (2022) examined the use of AR HoloLens in supermarkets). The remaining papers did not make explicit offline-online distinctions on the AR use setting. For instance, Rese et al. (2017) employed a lab experiment to compare user acceptance on two types of AR use, namely the marker-based AR and marker-less AR. In marker-based AR applications, the tracked "reality" are predefined objects that are recognised by image recognition (e.g. via mobile cameras) that are assisted by markers such as barcodes and QR codes found on physical objects. The AR system would then recognise the marker and would follow by superimposing a virtual 3D object relative to the marker's position. On the other hand, the marker-less AR takes on a different tracking approach, in that the marker is inexplicit and tracks a vague definition on the real environment that will later be overlaid with virtual objects. A typical example of this second category of AR include virtual try-ons where virtual objects (e.g. clothes and sunglasses) are superimposed onto our mirrored self on a device (e.g. mirror, mobile phones). Although Rese et al. (2017) compared these two types of markers in terms of usage intentions using lab experiments, the authors did not clarify whether the online-offline difference in setting would lead to different outcomes. In fact, the authors highlight that AR technology can be used at home through an installed software or application on a device with camera (e.g. mobile phone for AR apps or laptops with a camera for web-based AR) or in retail outlets. In both cases, AR can support the superimposition virtual content in the users' immediate, physical or "real" environment, whether it is the users' home or in a retail store.

While it is true that AR can be used in both online and offline settings with marker-based and marker-less AR in either settings, how AR can be valuable in offline and online retail contexts are meaningfully different. Hoffmann et al. (2022) address the difference in AR's relevance in the online vs. offline retail settings by highlighting that AR in e-commerce offers three-dimensional visualisations of products that are not accessible to consumers in their immediate (physical) environment and without which consumers would be unable to imagine the product or product fit. In the offline or physical stores on the other hand, the appeal of AR is vice versa, in that consumers need not imagine products as these are physically there, but product information is limited to typically what is available on the product packaging or labels. As Hoffmann et al. (2022, p. 745) aptly summarise it, "as a bridge between the digital world and the physical world, AR technology can open up a virtually unlimited space for product presentations". As shown in the descriptive above, majority of the investigations are focused on the online use of AR. This is also supported by literature review by Hilken (2018), where it was pointed out that in comparison to the applications of AR in online retail environments, scholarly research exploring the effects of AR in offline retail environments are limited. Although it is not the aim of this thesis to compare the performance of AR in the two settings, this thesis echoes Hoffmann et al. (2022), in sharing the view that AR can provide meaningful value as an information "amplifier", which is not a value that is particularly salient in the online setting, where information is already abundant. It is thus timely to explore how consumers can benefit from AR use in the context of brick-and-mortar retail shopping.

As this is a relatively understudied focus, it may be a fruitful pursuit to study how AR can be of value to users, specifically in the context of physical retail stores.

Albeit limited, a few studies have investigated the use of AR in physical stores (e.g. Chiu et al. (2021); Holdack et al. (2022); Zimmermann et al. (2022)). However, these are largely investigated using deductive approaches, testing AR-related variables that were not grounded in the context of offline retail use. The following discussion on the two themes, namely the AR characteristics investigated in prior literature and methodologies used highlights the knowledge gaps and research opportunities that may be worth pursuing.

Theme 2: AR characteristics and variables. As mentioned above, the AR characteristics that were investigated in prior literature are often deductively assumed and were not grounded in the context of AR's use in offline retail. A reasonable consideration of why having a grounded approach is important that is specific to the offline retail context is due to the finding from this literature review analysis, that most studies tend to employ an a priori approach in testing AR variables that were drawn from prior literature on other digital technologies (e.g. Silva and Bonetti (2021) and Rajagopal (2022)), and adjacent technologies, such as virtual reality and other extended reality technologies (e.g. Park and Kim (2021) and Xi et al. (2022)). Some studies take an even broader view on AR and investigate the generic Technology Acceptance Model (TAM) variables (Davis, 1989), such as perceived ease of use and perceived usefulness to predict user's intention to use AR technologies (e.g. Huang and Liao (2015); Kim and Forsythe (2008); Pantano et al. (2017); Spreer and Kallweit (2014)). While these studies pave a useful start to indicate the positive potential for AR to be well-received by users, these studies reveal little about what is unique about AR and what are the AR-specific characteristics that lead to the users' perceptions.

On the other hand, some studies albeit similarly adopted broad variables from prior models, have narrowed down their investigation to more specific AR-related variables. For instance, de Amorim et al. (2022); Hsu et al. (2021); Nikhashemi et al. (2021); Sengupta and Cao (2022) have used the Stimulus-Organism-Response (SOR) model (Mehrabian & Russell, 1974) as a broad framework to explain user behavior that is typically the ‘response’ part of the model. The model generally describes the linkages between stimuli, such as external or environmental factors that affects organisms, which pertains to the cognition and emotion of individuals, and consequently the responses or behaviors of these individuals. Some of the aforementioned AR studies employing this model identified AR itself as a ‘stimulus’ itself (e.g. Sengupta and Cao (2022)), whereas some selected AR-specific characteristics as the stimulus to be investigated, namely AR’s media richness (de Amorim et al., 2022); AR’s informative, personalisation and interactivity features (Hsu et al., 2021); as well as AR’s quality, novelty, interactivity, and vividness (Nikhashemi et al., 2021). Without employing the SOR model, similar AR properties were also investigated in Yim et al. (2017), where the authors also examined interactivity and vividness, which were found to lead to purchase intentions, through the mediating role of immersion. Nevertheless, these features can easily be said to be offered by other adjacent technologies, such as virtual reality, that can also offer users interactive and vivid experiences. Table 1 summarises the AR variables investigated in past literature and its limitations, and what this thesis seeks to address.

Table 1 Summary of AR variables investigated in prior literature

<table>
<tr><th>Example studies</th><th>AR variables investigated</th><th>Summary</th></tr>
<tr><td>Kim and Forsythe (2008); Rese et al. (2017); McLean and Wilson (2019), Cuomo et al. (2020); Castillo and Bignes (2021)</td><td>Perceived ease of use, perceived usefulness, perceived enjoyment (i.e. TAM variables)</td><td>These studies indicate general perceptions towards AR. However, these studies do not advance our knowledge on the specific AR attributes that lead to such perceptions.</td></tr>
<tr><td>Kang et al. (2022); Saleem et al. (2022); Nikhashemi et al. (2021)</td><td>Novelty</td><td rowspan="3">Novelty, vividness and informativeness are variables that are not uniquely pertaining to AR. Novelty is a generic factor that is applicable to all new technologies, and is also an unstable construct that may not be relevant after the technology has achieved mass adoption. Vividness, is a feature relevant to many media technologies (e.g. videos, VR technology), whereas informativeness is also a characteristic that can be relevant to other information technologies.</td></tr>
<tr><td>Ho et al. (2022); Nikhashemi et al. (2021)</td><td>Vividness</td></tr>
<tr><td>Sun et al. (2022); Kowalczuk et al. (2021)</td><td>Informativeness</td></tr>
<tr><td>Ho et al. (2022); Hsu et al. (2021); Kowalczuk et al. (2021); Park and Yoo (2020); McLean and Wilson (2019); Pantano et al. (2017)</td><td>Interactivity</td><td>While interactivity is a common feature that is shared by many information technologies (e.g. social media platforms, mobile applications, VR), it is a defining quality of AR as the virtual objects that are overlaid onto the users' physical environment are controllable by users, thereby allowing for users to interact with the virtual content.</td></tr>
<tr><td>This thesis</td><td colspan="2">Identify and explore AR attributes that are grounded from the users' perspective, and investigate the meaningfully unique AR attributes that fulfil consumer values in the context of physical stores.</td></tr>
</table>

Albeit limited, there are studies that have addressed the unique attributes of AR. For instance, Hilken et al. (2017) drew from the situated cognition perspective to conceptualise AR's unique ability to provide environmental embedding and simulated physical control of a product in the context of AR-based online shopping service augmentation. Essentially, the context focuses on how the traditional, in-store shopping experience can be brought into the online environment using AR as an innovative service strategy, which can lead to purchase and word-of-mouth intentions.

In spite of such examinations, while these could be salient qualities of AR, we have no knowledge of whether these AR characteristics are the most relevant to users, grounded in their context of online or offline shopping, and whether the outcomes are important to users as consumers in the retail context to begin with, as these investigated AR properties are selected through a priori means and are assumed from prior literature that were not inductively grounded from actual users' perspectives. As described in the above paragraphs, most investigations of AR are set in the online context, while few are in the offline context. We remain unsure if the AR characteristics studied in prior investigations are relevant to the offline setting, for instance. A question we could ponder, for example, is whether simulated control of a product as examined in Hilken et al. (2017) be a relevant feature of AR to users in offline retail settings, when consumers are able to inspect a product physically in store. Similarly, other properties of AR may become salient that would not be in the online or e-commerce setting. The lack of grounded knowledge on AR characteristics that are salient from the users' perspective may explain why there seems to be no consensus on what are the defining features of AR that is worthy of studying and also *why* are these worthy of studying.

On this note, the answer to *why* a specific AR variable is worthy of studying would require a purposeful line of investigation that is grounded in the motivations of users as well as the setting of AR use. By unravelling the motivations of AR use, we may have a better idea about which AR features would be most relevant to users, particularly if the setting (i.e. whether it is online or offline) aligns with the users' goal and motivation. As it currently stands, findings from extant studies have hinted towards the benefits and values AR can bring forth. For instance, Poushneh and Vasquez-Parraga (2017) and Pantano et al. (2017) have looked at the hedonic and aesthetic qualities of AR, whereas some have looked at the intrinsic and extrinsic experiential values of AR (Dacko, 2017), as well as the perceived store atmosphere with the presence of AR (Poncin & Mimoun, 2014). However, they did not delve into the specific attributes that lead to user's perception of AR's hedonic and aesthetic characteristics. Although all the aforementioned studies have contributed greatly to our knowledge of AR use in retail in the initial stages of AR research in this area, in most of these studies, AR is still treated as a black box, and the constructs or variables examined do not pertain to the properties of AR specifically, or are not explicitly grounded in the uniqueness of AR from the user's perspective and their context of use. In other words, there is a disconnect between the properties of the AR artefact and the investigated outcome variables or dependent variables. I argue that it is likely that the AR artefact and its unique attributes lead to certain outcomes in the context of its use (specifically, online retail ***or*** offline retail), which is why it is important for AR's special properties to be highlighted and investigated in AR research. More importantly, a focus on the technology's unique properties may provide some insights into the building blocks of potentially novel mechanisms that explain ***why*** AR can lead to certain effects. From a research point of view, this can be an opportunity for the theorisation of AR, whereas from a practical point of view, knowledge of the specific properties of AR and the resulting outcomes can help inform the designs of AR experiences to achieve specific business goals.

Theme 3: Research approach and foci in current literature on AR in retail. The above have briefly mentioned that majority of the studies have taken on deductive approaches to studying AR, using prior literature on other technologies to make assumptions of the AR features worthy of studying.[7] Although these are educated assumptions drawn from prior literature, the danger in doing so is that the uniqueness of AR becomes lost and we do not advance our knowledge on what AR can uniquely bring to consumers that other technologies may not be able to achieve.

A systematic investigation that consolidates the AR properties that are unique and salient to users is still lacking, in addition to the outcomes that these user-salient AR properties would bring forth. A unifying, holistic account on what are the AR properties that are salient to consumers and the underlying user motivations behind AR use can give credence to subsequent AR studies on the kinds of AR properties are relevant of investigating, in a given context, research or business problem – rather than what would seem like an arbitrary selection of features to investigate. Of particular relevance to user motivations, one study in the reviewed papers that indicates the importance of user motivations is the study by Park and Kim (2021). In this study, the role of shopping goals was highlighted as two distinct shopping modes that moderate the impact of AR and VR. AR's specific properties were not investigated in this study,

[7] In the review of the 53 journal papers in the final sample of analysis, only 4 studies employed qualitative research method (i.e. Caboni & Pizzichini, 2022; Ogunjimi et al., 2021; Romano et al., 2020; Scholz & Duffy, 2018.

as the study only compared the use of AR and VR rather than zooming into either technology's specific properties. Despite this limitation, this study showed evidence for the importance of user goals, as it was found that user preference for AR vs. VR vs. static pictures of products as well as user behavior (i.e. purchase intention) varied based on the different user goals.

On the other hand, some studies have looked at the utilitarian and hedonic values of AR (e.g. Bonnin, 2020; Gatter et al., 2022; Hsu et al., 2021; Nikhashemi et al., 2021), also indicating that users with goals that align with these (e.g. utilitarian goals: to seek additional information to determine product fit; hedonic goals: to have an enjoyable shopping experience, etc.) may have varying outcomes, such as AR usage intention or purchasing behaviour. However, in these studies, the AR properties again, are treated as a blackbox (e.g. in the study by Park and Kim (2021), there is no indication of the specific AR features that differentiated it from VR and static pictures) or that the individual AR use goals are quite broad – for instance, utilitarian purposes could range from ascertaining product fit on self to making comparisons between products. Furthermore, these studies took on a deductive approach on the AR characteristics and user motivations in the retail context, assumed from prior literature.

Albeit limited, there has been studies that have employed inductive approaches to explore AR features. For example, Romano et al. (2020) conducted semi-structured interviews to identify AR contributions across the customer journey, namely pre-purchase, point of purchase and post-purchase. In this study, the authors used the specific context of an AR virtual try-on application of an Australian online fashion retailer, whereby respondents were asked to describe their perceptions and experiences of the application that allowed them to virtually try on the retailer's products, which were shoes. The main findings of this study were based on consumers' decision-making process through the engagement of the virtual version of the product and salient themes were identified at different stages of the customer journey. The merits of this study lie in the takeaway that at different points of the customer journey, AR's role and salience can be different – supporting again, the argument that the subjective relevance of AR is context-bound and it is hence important to tease out and answer the questions of what are the AR features that are important to users in what context and for what purpose. The limitation of this study however, is that the virtual try-on application is merely one of many applications of AR. It is claimed that the aim of this study is to understand the "promises and perils associated with AR" (Romano et al., 2020, p. 359) – yet, exploring these with just one type of AR application creates tunnel vision and overlooks other features that may be prominent through other types of applications, for instance, how virtual, textual information (e.g. customer reviews) rather than virtual, pictorial objects (e.g. the virtual shoes like in the aforementioned context of study). Some AR "promises and perils" may be unobserved.

As for other studies that have employed inductive approaches, Caboni and Pizzichini (2022) narrowed in on the accelerated adoption of AR due to the COVID-19 pandemic. This study explored the factors related to the pandemic that have shifted consumers' shopping habits and investigated AR is used to overcome retailing crises driven by environmental factors like COVID-19. It was found that people's need to re-establish a new everyday life that is similar to that of pre-pandemic led to the users' adoption of AR. Specifically, people appreciated the ability to experience shopping using AR and also to do so safely while avoiding social contact. Furthermore, the interactive nature of AR afforded users a proactive approach of finding other ways to shop. This, again, highlights the need to acknowledge that different features and functions of AR that comes to light in investigations that are based on unique contexts. Another inductive study is one by Scholz and Duffy (2018), where the authors conducted an ethnographic study to investigate how consumers use make up retailer Sephora's mobile AR shopping app in their own homes. The authors found that the branded AR app is embedded into consumers' intimate space and their sense of self. Similar to that of Romano et al. (2020), investigations based on a single app can provide insights into AR's possibilities that provide the same function (i.e. try-ons), but it does not provide us with a holistic understanding of other potentials that AR's unique features could bring through other types of functions and with different user goals.

Theme 4: AR-specific mechanisms and theorisation. Perhaps the most critical point to be discussed here in this review is the theorisation of the AR phenomena based on the retail context. Linking this back to the previous discussion about the gap of knowledge on AR's unique qualities due to the use of a priori knowledge that were based on adjacent technologies of AR (e.g. virtual reality), there is also a lack of theorisation that is unique to the phenomena that centers around AR technology. However, there are studies that have looked at the unique properties of AR, such as environmental embedding and simulated physical control in Hilken et al. (2017), to explain the AR experience and in decision making, grounding these in situated cognition theory. In this study (Hilken et al., 2017) and a conceptual paper (Hilken, 2018), the authors sheds light on the ability for AR to contextualise products and services by embedding digital content into the customer's physical environment and interactively that allows for information processing. According to Hilken (2018), the situated cognition theory suggests that customer experiences would seem most realistic when information about product or services within the immediate decision context (i.e. embedded), allow for physical interaction of product or service (i.e. embodied) and communication with other individuals (i.e. extended). Embedded, embodied and extended cognition (EEC) are the three pillars to situated cognition, which highlights that behaviour emerges from the interplay between brain, body and world. Coincidentally, these three pillars are the criteria that are satisfied by AR technology, making this a unique quality about AR.

The above perspective highlights AR's uniqueness based on a pre-established theory of situated cognition. On the other hand, Javornik (2016b) looked at perceived augmentation as a crucial and driving mechanism related to AR. Augmentation, according to Javornik (2016b), refers to the visual annotations of AR technology and this is argued to represent AR's most salient and well-developed feature. Perceived augmentation, however, is the psychological correlate of this feature. Javornik (2016b) self-developed a scale to measure perceived augmentation with five items – namely: (1) I felt I could enrich X; (2) After I stopped using the site, I could still imagine Y; (3) The virtual objects seemed completely real; (4) I felt that the virtual objects did not add anything to X and; (5) Reality seemed richer *(where X is the element that is being augmented and Y is the virtual element depicted in the application).* From this scale, we can see that there is a positive assumption about the augmentation concept – in that augmentation corresponds to reality enrichment, enhancement and making virtual objects real. However, augmentation, could also be conceptualised in a more neutral meaning of the word, in that to augment reality is simply to change or alter reality, as some AR experiences have virtual objects that are designed in varying levels of realism (e.g. cartoonish virtual dragons overlaid in-store to realistic virtual clothes overlaid on consumers' body); whereas some diminishes reality rather than enhances, for instance some AR apps digitally removes objects from users' physical environment to get a realistic view of how potential purchases will fit within the users' immediate context. On this note, there is still untapped potential in the theorising of the augmentation of reality itself that is brought about by this technology and its unique feature of unifying the virtual and the real to create a changed and modified reality that could be through the enhancing and diminishing of reality.

2.3.3 Overall discussion

A critical review on the current literature based on the four themes can be synthesised into several takeaways that are pertinent to this thesis. Firstly, AR use in offline retail environments requires attention. As reviewed, the context of AR applications studied in previous literature are predominantly in the online context – and understandably so, as AR-powered virtual try-ons is one of the mainstream AR applications that has garnered public attention (Marr, 2018), that is most appropriately studied in the online or e-commerce context to replicate shopping activities that are crucial to making purchase decision, such as being able to inspect a product and trying it on (e.g. in Kim & Forsythe, 2008; Song et al., 2020; Tawira & Ivanov, 2022). However, AR's value is not unidirectional in just injecting "offline" experiences into the "online" setting, it can also provide online elements into the offline setting as well. *How the bringing of virtual, digital and online elements into physical stores affects users remains understudied, and requires inductive approaches to investigate the context-bound salient AR properties*, rather than using a priori knowledge based on other technologies as AR has unique qualities of its own and have a unique combination of different properties (e.g. interactive, real-time superimposition of 3D, virtual objects etc.).

Secondly, similar to the argument of online-offline context sensitivity, AR use motivation is also something that requires attention. The previous section has shown that extant literature examined the hedonic and utilitarian benefits of AR, indicating that the technology can gratify functional and/or emotional needs (e.g. in Gatter et al., 2022; Nikhashemi et al., 2021). However, these are classified very broadly into utilitarian or hedonic categories, and *there is little knowledge about the more specific goals within these broad goal categories and values and the AR properties as well as the corresponding designs that would lead to the fulfilment of these*. Current literature has provided strong findings that developed general frameworks for further research. However, for nuanced perspectives that can inform practitioners on the design elements to incorporate that are focused on aiding consumers in their context-specific goals, it is important to be comprehensive but also more fine-grained in terms of *what* properties of AR can fulfil *what* consumer goals. On this note, the third takeaway to be highlighted from this literature review is that the connection between AR properties and the goals or values that these can gratify should be systematically explored and investigated.

Going in detail about this third takeaway – discovering the linkages and exploring the nature of the connections between AR properties and the user values that these gratify not only allows for practitioners to effectively design marketing agendas to better serve consumers through the technological features, but it also provide us researchers *the nuances that is required to better theorise, particularly with the specific*

AR properties that can bring to light the unique AR artefacts – and this is something that is particularly important within the IS discipline. In the 1990s to the early 2000s, a few of the notable researchers in the IS discipline expressed that there is a dilemma about IS as a research discipline. However, there is a split in perspective; on one spectrum is the technology determinism point of view, and on the other spectrum, the social constructivist point of view. In an influential commentary by Benbasat and Zmud (2003) embodying the former spectrum, it is argued that the IS discipline is facing an identity crisis. Benbasat and Zmud (2003) claimed that IS researchers are developing their theories and research with too much focus on the context and too little focus on the IT artefact. The authors pointed out that researchers who claim to study an IT or IS tend to treat the technology as a blackbox, often substituting technologies with generic terms like "digitalization" or "innovation". In other words, the very properties of the IT itself is not the priority in such research investigations. The main reason why this was a concern, according to those who share this view, is that IS as a research discipline would not have a core, in that it would be no different from different from other disciplines in social science. This coincidentally supports what was found in the broad literature review, where as indicated in **Figure 7,** the highest frequency of journal papers on AR in retail were published in marketing journals rather than in IS journals.

On the other spectrum are those who share social constructivist values, who counter-argued that such a view that focuses only on IT properties is problematic. For instance, Galliers (2003) contended that it is not possible to separate social systems from IS studies because IT and IS are designed for social use, and IS researchers should study the context because it frames the meaning of what the IT is, and cannot be isolated from its users who are situated in a social setting. Although data itself is a raw material and can be treated as context-free, information is a collection of data by which meanings are attributed to and so, it is the human interpretation of IT that makes IT what it is. Following these two polarized arguments, Orlikowski and Iacono (2006a) wrote a commentary that bridges the gap between the two disparate views on the opposite ends of the spectrum. The authors emphasise that the IS artefact should take a central role, but also highlight that IT artefacts are not just made up of material properties of hardware and software – but also human, social, economic and historical elements. Technology artefacts are not only embedded in the social world, but social worlds are also embedded into artefacts – or in other words; technology affects the social world and the social world affects technology. Connecting these views from the debate on IS research and its identity as a research discipline, together with the takeaways that were discussed thus far from this literature review, *investigating the concrete AR properties and situating these in the context of use, grounded from the users' goals aligns well in highlighting the central role of the AR technological artefact but through social and human standpoints of users*. To this end, I argue that the AR blackbox needs to be "filled in" through an inductive approach to explore such AR features, in order to systematically ground these from the users' perspective. As discussed in Theme 3 in the previous section on research approaches, prior studies on AR in retail have mainly adopted a priori assumptions, and teasing out the unique qualities of AR through a goal-directed lens can help advance our understanding of the AR technological artefact.

Fourth takeaway from this literature review that is also related to the importance of an inductive investigation of the AR technological artefact, is the theorisation of AR and its related phenomena. By unravelling the AR properties and users' relations to these, we open up opportunities for developing theories that are focused on the AR core properties. Theme 4 in the previous section have discussed and indicated that there is indeed an opportunity for grounded theorising of the AR artefact, but also theorising that hits the head on the nail of explaining the *augmentation of reality,* that does not assume an a priori position to whether it is a positive augmentation or a negative one. There is still untapped potential in the theorising of the phenomena brought about by AR's unique properties.

2.4. Revisiting Research Questions and Thesis Structure

The above four takeaway points from the scholarly perspective adds to the former discussion in **Chapter 1** that has mostly outlined the problem statements that were more focused on a managerial and practitioner point of view. In addition to being able to provide business value to marketers on how AR can be used to provide a differentiated customer experience to consumers, exploring the first research question of what are the AR attributes that are salient to consumers and why these are salient in the context of shopping in physical stores not only allows for practitioners to have actionable knowledge on what features of AR to prioritise and for what specific purposes, but also allows for researchers to have a holistic understanding of the users' relationship with specific AR properties from a goal-directed perspective. Investigating these research questions bring AR technological attributes to the forefront without disregarding the human and social elements that make these important – advancing our knowledge on the AR artefact. An IT artefact is defined as "bundles of material and cultural properties packaged in some socially recognisable form such as hardware and/or software" (Orlikowski & Iacono, 2001, p. 121), and is characterised as "the application of IT to enable or support some task(s) embedded within structure(s) that itself is embedded within context(s). Here, the hardware/software design of the IT artefact encapsulates the structures, routines, norms and values implicit in the rich contexts within which the artefact is embedded" (Benbasat & Zmud, 2003, p. 186). Following these descriptions of what an IT artefact is, this thesis seeks to advance understanding on what could be the AR artefact from a technical viewpoint without compromising the social nature of the artefact by grounding our investigations from the users' perspective. To this end, this thesis's first study in **Chapter 3** takes on an inductive approach and employs a qualitative research design to identify salient AR attributes based on the different user goals that form AR affordances.

Ascertaining these properties of AR and their potential outcomes is a step towards identifying the building blocks of a theory or theorisation. An inductive approach would allow us to derive the linkages between these blocks to develop propositions that explain the underlying causal mechanisms within the AR phenomenon (Locke, 2007). To take the findings of this inductive investigation a step further is to test these mechanism propositions using deductive means. This is also an essential part to theory building and theorising. Theories explain. As discussed in **Chapter 1** on the critical realist philosophy that this thesis subscribes to, what we observe are conjunctures of mechanisms collectively manifesting in a particular situation (Bhaskar, 1979). Theories explaining a phenomenon requires unearthing causal mechanisms and their interplay with different contexts (Smith, 2018). To develop a nuanced theory, falsification of propositions is a crucial scientific activity that critical realists are advocates of (Barnhart, 1996). Falsification, a concept popularised by philosopher Karl Popper, is about finding evidence to refute a proposed theory, rather than to support it (Miller & Tsang, 2011). Experimental testing is a favoured method used to find the weaknesses and flaws of a hypothesis, and critical realists encourage such an activity in our endeavour to generate knowledge as researchers, and to generate *better* theories; theories that can stand against rigorous criticism and are sensitive to contingencies that are co-determined by other factors and mechanisms. In the discussion on takeaways from the literature review, attempts in theorising of AR-related phenomena are still relatively few in the current nascent stage of AR research. The depth and breadth of a research project afforded by a PhD thesis is the perfect opportunity for the endeavour of theorisation.

Hence, after the inductive study, this thesis tests the proposed causal mechanisms found in the first inductive study of this thesis, specifically conditions or contingencies that would affirm or falsify the patterns proposed in **Chapter 3**. Study 2, introduced in **Chapter 4** and **Chapter 5**, takes several findings inferred from Study 1 (in Chapter 3) and scrutinises the AR designs that are representative of the salient AR attributes found to be relevant to users in the context of brick-and-mortar shopping, and treat these as possible factors that give rise to contingent outcomes. In other words, Study 2 tests the AR design factors that were proposed to cause important outcomes to consumers. This experimental testing provides credence to the proposed causal mechanisms found in Study 1, and provide knowledge of contingencies, such as technical or human boundary conditions, that will allow researchers to develop a richer and rigorous theory of AR.

In summary, both Chapter 1 describing the research background, practical problem statements, as well as the research philosophy of this thesis; and Chapter 2 detailing the research landscape and literature review of research on AR in retail that highlighted the research gaps and opportunities –outlined the motivations for the development of the two studies that make up this thesis. The following Chapters 3 to Chapter 5 will detail Study 1 and Study 2 that have taken the course of three years of the PhD programme to develop and complete. Chapter 6 concludes this thesis with a discussion on the implications and limitations of this thesis, which also pave the potential directions for future research.

Chapter 3 Study 1: Exploring User Means and Ends of AR Technology in Physical Stores with an Affordance Perspective

"What new technology does is create new opportunities to do a job that customers want done." – Tim O'Reilly

3.1. Introduction

Research exploring the potentials that AR attributes can offer to users in brick-and-mortar retail, as well as why these are important to users using an inductive approach is limited. As previously discussed, an inductive approach to ascertaining the unique AR attributes that are salient to users can help us unravel the blackbox of what is it about AR specifically that can provide value to users when shopping in brick-and-mortar stores – and this is particularly important in identifying potential causal mechanisms as our first step to theorisation. The previous literature review section has shown that AR research in brick-and-mortar retail has received little scholarly attention, and most studies were focused on the online context. In this study, I argue that AR's value manifests in distinct ways in online and offline contexts. In the virtual space (online), product information is abundant. On the other hand, when it comes to the physical space, information is very much restricted to what customers can see on product packages and labels.

The unique function of AR of embedding virtual items into our real world environment opens up a new space that combines both the real and the virtual, and this is something that is especially evident in AR use in physical retail – making this context of study particularly relevant to our objective of theorising the AR phenomena as the use of AR in the physical or "real" world settings is a close juxtaposition of the "augmentation of reality" phenomena. Unravelling the process of augmenting the real with our context of study that is situated in the "real", physical stores may provide us insights into the mechanisms that are noteworthy not just for this thesis, but also for future researchers to examine. In addition to how examining AR use in the offline retail context aligns with the objective of AR theorising, the ability for AR to break the confines of reality is particularly meaningful, as it opens up consumers to an integrated space that combines real and virtual elements, thereby allowing retailers to maximise this new space creatively for positive consumer outcomes – such as to educate consumers about their products, which may in turn mitigate product uncertainty, as the vivid and interactive AR-delivered information allow users to make connections and bridge product knowledge gaps.

However, as highlighted in the problem statement section of this thesis in **Chapter 1's Section 1.2**, there is still a need to advance knowledge about the consumers' pain points that AR can resolve, in order to establish AR's usefulness and have a clearer understanding on how the use of AR may impact the bottom line for brands and retailers (Kelly, 2019). Identifying the attributes of AR for this endeavour allows us to concretely ascertain what it is about AR (i.e. what separates AR from other technologies, hence unravelling its unique usefulness) that can lead to positive outcomes that are *important* or *salient* to consumers. Furthermore, the identification of these would allow us to obtain insights that would allow for further testing in the later part of this thesis. On this note, this chapter details the first study of this thesis that investigates the users perspective of AR use in physical stores, addressing the research questions of "*What are the AR attributes that are salient to consumers*" and "*Why are these salient to consumers*".

This study integrates the means-end chain (MEC) theory (Gutman, 1982), with the affordance theory (Gibson, 1986), to derive affordances of AR in the retail context, focusing on the interaction between goal-oriented users and material properties of AR. I employed the laddering technique, a common method used in MEC studies, to collect and analyse data from a sample of 45 participants. Based on the findings, I gain insights into the important AR attribute-consequence-value chains that show how goal-oriented users interact with material properties of AR, thereby allowing me to derive the affordances of AR in the context offline shopping. The following sections detail the theoretical background of this study, its research methodology, the findings and the discussion of these.

3.2. Theoretical Background

This thesis adopts the affordance theory as an overarching framework to identify the affordances of AR and generative mechanisms related to AR (Bygstad et al., 2016). As the first study of this thesis is exploratory in nature with the pursuit of identifying mechanisms, employing the affordance theory as a broad theoretical framework is deemed particularly appropriate and useful. This is discussed in below **Section 3.2.1.** This study integrates the affordance theory and the MEC theory as a novel theoretical perspective that follows an integrated research method, allowing for a richer understanding of AR affordances. On its own, the affordance theory explains that IT affordances emerge through the interaction between goal-directed actors with an IT artefact (Gibson, 1986). However, by integrating the MEC theory, we can deconstruct this interaction to understand more clearly *how* and *why* affordances arise by zooming into the goal-orientation aspect of actors.

Drawing from the MEC theory (Gutman, 1982), this thesis argues that users interact with technologies as a goal-directed action to satisfy underlying personal values. In other words, the actors' interaction with material properties of IT are essentially guided by their personal values. The focus of MEC theory on the linkages between technology attributes, the consequences these provide and the personal values fulfilled, enables us to unearth AR user motivations, thereby allowing us to interpret AR affordances from a goal-directed lens. While the potential mechanisms and linkages identified may be AR-specific for subsequent testing in this thesis, I argue that this study contributes to the broader field of the IS discipline as this study is the first to integrate the affordance theory (Gibson, 1986) with the MEC perspective (Gutman, 1982), to the best of my knowledge. This integration can be adopted for future IS researchers who are looking to explore new technologies. Both theories will be explained in more detail in the following sections.

3.2.1 Affordance theory

The affordance theory draws from ecological psychology, focusing on the interaction between an actor with the environment (Gibson, 1986). A key tenet of this theory is that a goal-oriented actor perceives objects in the actor's surrounding in terms of how they can be used (Volkoff & Strong, 2017b). In other words, an object is perceived as what it can afford, and its potentials for meeting the actor's goals. According to Gibson (1986), these potentials arise from both the properties of the actor and the object – thus, affordances are the potentials of the interaction between actor and object, rather than a set of attributes inherent to the object and separable from the actor. We can understand affordances as "action possibilities".

The affordance theory has been used in IS research, both in studies on the organisational level (Leonardi, 2011), as well as on the individual level (Grgecic et al., 2015). Several literature review papers that have systematically reviewed the use of this theory in IS literature introduced a synthesised framework to explicate the intertwining of the properties of the IT artefact and goal-directed actors, which gives rise to affordances (see **Figure 10**). These affordances are then perceived by the actors and subsequently acted upon (actualisation of the potentials or affordances). This is essentially a goal-directed behaviour, reflecting the actor's volition of taking action on the affordance, which consequently produces outcomes (Pozzi et al., 2014).

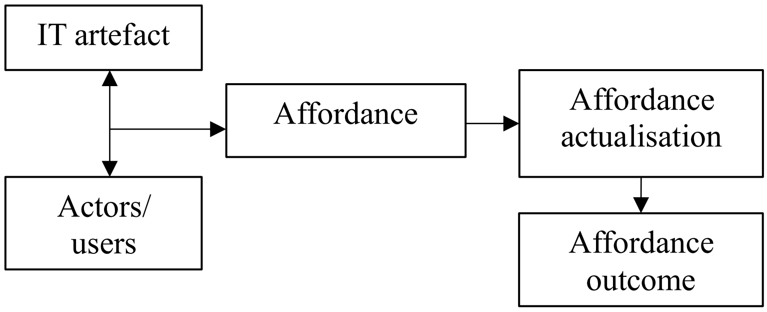

Figure 10 Affordance theoretical framework (Pozzi et al., 2014; Wang et al., 2018)

Bringing this back to the prior discussion on the debate regarding IS as a research discipline, the affordance theory aligns itself in between the two arguments on the spectrum that spans from one end that subscribes to technological determinism, and social constructivism on the other end. The affordance theory is situated in the middle of the spectrum by looking at the interaction between technological characteristics of an IT and individuals with the potential of using it and actualising its affordances, thereby giving meanings to the IT artefact. In addition, the affordance theory also shares philosophical undertones that critical realism holds. In Bygstad et al. (2016, p. 83), the authors shared their insights about what a critical realist understanding of the affordance theory can offer, particularly in the search for "generative mechanisms", whereby a mechanism is defined to be "a causal structure that explains an empirical outcome". Notably, these said outcomes are argued to be probablistic and contingent to other mechanisms rather than deterministic (Bhaskar, 2008; Bygstad et al., 2016), and this is something that aligns particularly well with the objective of this thesis in identifying noteworthy mechanisms and testing these in order to better theorise the AR phenomena.

Of particular relevance to the affordance theory, is that critical realism holds a realist ontology, in that mechanisms are viewed as arising from a reality that is external to the observer (Bhaskar, 1979). Drawing from the interpretation of the affordance theory that has gained the acknowledgement of the IS community (Bygstad et al., 2016; Volkoff & Strong, 2013, 2017b), an affordance arise from the relation between technology and an actor, whereby the goal-oriented actor perceives the potential for behaviours associated with achieving outcomes through an object. Perception of the actor here thus plays an important role. Without such awareness of potential actions, knowledge of affordances may not exist. However, many have debated whether or not an affordance exists if an actor does not perceive it. For instance, Norman (1988), a scholar who is often cited in the human-computer interaction (HCI) research community, characterises an affordance as the design aspect of an object which suggest how the object should be used. In other words, an affordance is a visual clue to its function and use. Such an understanding of affordance puts into question whether affordances can still exist without the role of human perception. However, when Gibson (1979) first coined the concept of affordance, there was considerable ambiguity regarding the nature of it, that "an affordance is neither an objective property nor a subjective property; or it is both if you like" (Gibson, 1979, p. 129).

At this juncture of defining the term affordance for the purpose of this thesis, I return to the principles of critical realism as IS scholars subscribing to the same school of thought had (e.g. Bygstad et al., 2016; Volkoff & Strong, 2013). The ontological position of critical realism views that reality exists external to the actor. Hence, regardless of whether a potential for action is perceived by an actor, the said potential still exists – and this is the stance taken in this thesis. However, the relativist epistemological standpoint of critical realism would suggest that the relation between actors and features of the object (or technology) is subjective. In other words, affordances can be perceived differently by different actors, and sometimes even not perceived at all – but at the same time, this does not mean that the affordance does not exist.

Norman's emphasis on actor perception carries merit within the realist-relativist principles of critical realism, in that actor perception – albeit relative, is key to understanding to the potential outcomes of material properties of an object. Users subscribe meanings to material properties, giving rise to affordances. Relating this back to the different interpretations and definitions of an affordance that has been discussed so far (e.g. Bygstad et al., 2016; Volkoff & Strong, 2017), one significant facet of the human element in the object-actor interaction described, is the role of goals. In Bygstad et al. (2016) and Volkoff and Strong (2017b), actors are directly referred to as goal-oriented, whereas in seminal commentaries following Gibson's concept of affordance, the goal orientation of actors, though not directly indicated, is strongly implied. Turner (2005) aptly exemplified the role of goals with the case of an orangutan that found a claw hammer that was left in its enclosure. Despite not having the knowledge that we have as human actors (i.e. the knowledge of it as a tool to purposefully hammer and claw), the animal actor was still able to use the claw end to scratch at the walls of its confines and the face end to hit at different surfaces. From this example, we can see how the orangutan as an actor perceived the hammer for its affordance to potentially break out of its enclosure, potentially fulfilling its *goal* of attaining freedom. This view is also shared by Hutchby (2001) who emphasised the relational aspect of an object, in the way that affordances of an object may be different for one species than for another. To exemplify this, the author used the case of water surfaces and how these do not have the affordance of walk-on-ability for some species, such as us humans or for a lion or a crocodile. However, water surfaces have the affordance of walk-on-ability for water boatman, the insect. The *range* of afffordances of an object, as Hutchby (2001) fittingly puts it, is thus not fully and immediately available to perception. In the example given, the surfaces's affordance of walk-on ability becomes manifest or apparent *when* the insect walks on it, and has the *goal* of walking on it. Actors' goals are therefore quite insightful in revealing the affordances of objects.

If we scrutinise the central argument here that explicates the realist point of view that affordances of objects are objective and real, and it is the perception of these that are relative to actors, it would stand to reason that the key to identifying the affordances is through the understanding of the actors. More specifically, focusing on the goal orientation aspect of actors can be an effective and systematic lens into the potential range of an object's affordances. For our topic on AR affordances, we will clearly only be looking at a single species; that is us, human users – however, the relativity of affordances and the perceptions of these are varied across the different goals we have as users. It is thus useful to unravel the goals of user actors when interacting with the material (or technical) properties of AR to identify the affordances of AR technology, which can later be examined for generative mechanisms that will involve the material attributes of AR and human actors – fitting into the overall objective of this thesis that is AR theorising.

The subsequent section explains the MEC theory developed by Gutman (1982). The MEC theory's goal-focused lens is used to give the affordance theory more layer and structure, thereby also informing a systematic method of exploring affordances through the elicitation of technical attributes of AR that are salient to users, in relation to their goals and values.

3.2.2 Means-end chain (MEC) theory

The MEC theory is developed by Gutman (1982) and is used often in marketing literature with the objective of understanding consumer decision-making process. A key assumption that the MEC theory makes is that products are collections of attributes, whereas consumers are holders of values (Gutman, 1982). Attributes of products lead to consequences (or benefits) derived from using the products, which in turn gratify the consumer's values (see **Figure 11**). Using the MEC approach, the cognitive linkages between attributes, consequences and values are mapped to identify the attributes that make products personally relevant to consumers, in addition to ascertaining the values that are important to consumers. Although the MEC theory is more commonly used in marketing research, it has also been used in IS research to study user behaviour (Chiu, 2005; Jung & Pawlowski, 2014). In these studies, the MEC theory is used to examine how users engage technologies that possess tangible attributes, which can similarly lead to consequences that fulfil their personal values.

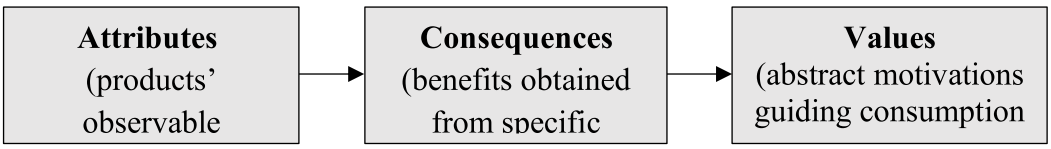

Figure 11 MEC model (Gutman, 1982)

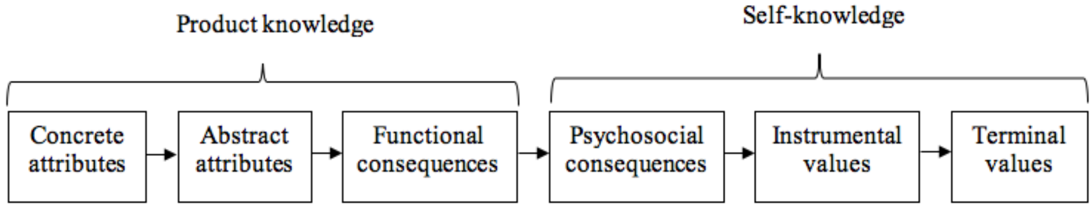

Figure 12 Modified MEC model in six layers (Walker & Olson, 1991)

While most studies have adopted MEC as a theoretical approach to study a variety of phenomena in different disciplines, one notable work has sought to modify the original model introduced by Gutman (1982). Olson and Reynolds (1983) proposed a more complex MEC model that distinguishes finer gradations of attributes and values with respect to their level's abstraction, as shown in **Figure 12**. According to this model, attributes are divided into two – concrete and abstract attributes. Concrete attributes are referred to as physical or concrete features of a product or service, which can be directly measured (e.g. shape of the product and location of a store). Abstract attributes, on the other hand, are typically more subjective and are commonly *perceived* qualities of a product or service – for instance, information credibility of a website or quality of customer service at a store. While both types of attributes vary in levels of abstractness, both represent operational methods to attain subsequent benefits or consequences (Olson & Reynolds, 1983). Consequences are also broken down to two levels; functional and psychosocial. Functional consequences are defined as the practical benefits and outcomes acquired by consumers upon consumption or usage of the product or service in question (e.g., good for health, look attractive), whereas psychosocial consequences are more affective and pertain to individual feelings as well as social considerations (e.g., feel good about oneself, to fit into a social circle). In addition, the model splits values into instrumental and terminal values (Olson &

Reynolds, 1983). The former type of values is concerned with preferred ways of behaving (e.g. be trendy, be loyal to the brand), while the latter refers to the desired end-state of being (e.g. sense of belonging, improved self-esteem). In essence, the *self* is the *ends* in means-end relationships, where the means are the aspects of product knowledge and the ends are that of consumer self-knowledge (Lin et al., 2017; Olson & Reynolds, 1983).

Although this model is a more refined modification of the original (Gutman, 1982), Olson and Reynolds (1983) have pointed out that the additional layers are not always necessary or applicable. Moreover, the authors highlighted that not all links proposed in the six-layered model would be present in every situation because consumers may not always be able to elaborate on the abstract meanings of the products they use (Olson & Reynolds, 1983). The authors explained that this is due to the inactivation of self-relevant knowledge in the consumer's working (or short-term) memory during the decision situation (Olson & Reynolds, 1983). According to Walker and Olson (1991), while our personal values (or core 'self') are relatively stable, different aspects of self-knowledge may be activated in different situations. Individuals take on different social roles that develop over time, and corresponding identities are activated in situations that call for specific social roles (Walker & Olson, 1991). For instance, an individual can be both a parent and an employee. Corresponding identities (the "parent" self and "employee" self) are activated in different situations, such as being at home with the kids, or working at the office. Based on the authors' theory of the self (Walker & Olson, 1991), different identities or 'selves' possess self-knowledge that is unique to particular social roles, and is activated by specific situations. However, as indicated earlier, activated self-knowledge can be limited in working memory at a given time – but it is this activated self-meanings that influence consumers' cognition and behaviour (Walker & Olson, 1991).

This argument that emphasises the decision situation as an important determinant of the activation of self-knowledge aligns with the emphasis of contexts in this thesis. Previous studies on AR technology adoption in retail have been conducted without considering the possible distinctions in consumers' decision-making process between AR use in online and offline retail settings (Heller et al., 2019; Hilken, 2018). This study considers the specificity of individuals' decision situation by focusing specifically on the context of offline retail. Furthermore, the underlying assumption of the MEC framework is that consumers are goal-directed decision-makers, selecting products or services that lead to desired outcomes, which are relevant to the individual self. Instead of products, this study employs this approach as a lens to map out the AR attribute-consequences and values chain. Drawing from previous IS studies that have employed the MEC approach to investigate technologies, this study investigates the tangible attributes that AR technology possesses, that are perceived by users, and scrutinise the motivations behind why these perceived attributes are relevant to them, thereby aiding our objective of answering our research questions of "*What are the AR attributes that are salient to consumers*" and "*Why are these salient to consumers*", while also holistically interpreting these into affordances that AR technology can provide within the context of brick-and-mortar retail.

3.2.3 Integration of perspectives

The MEC theory complements the affordance theory in significant ways. The main motivation for integrating these two perspectives is the MEC framework gives the affordance theory more structure, aiding us in a more systematic investigation of the motivations behind the goal-oriented perception and action of AR use. The MEC theory guides us in identifying not only *what* are the tangible attributes that are salient to users, but also *why* these are salient. Firstly, as detailed in **Section 3.2.1** on the affordance theory, the two sides that play into the emergence of affordances are the material properties of the IT artefact and the goal-oriented actors. The MEC theory that is centered on the goal-directed use of material products by consumers with agency very much supports the affordance theory. For one, it highlights the observable characteristics of the product(s) investigated [8], which is also the central argument of the affordance theory that is based on the ecological approach to visual perception, and how these are perceived by actors as potential actions. Again, in this thesis, one of the objectives of this research project is to “fill in” the blackbox of AR technology and to advance knowledge on the AR artefact, investigating the role of the AR artefact in the context of brick-and-mortar retail in a manner that is faithful to the IS discipline, while contributing to IS literature despite being based on a marketing context.

Another highlight is that the MEC theory emphasises the goal orientation of users, which I have argued in the discussion on affordance theory, provides a useful insight into the range of affordances AR technology can offer. To reiterate, based on the development and the refinement of the affordance theory as well as what has been

[8] In our case, it is the technology investigated.

characterised as an affordance, I contend that actors (or users) with different goals would perceive different affordances of AR when interacting with the material attributes of the technology. This thesis views the material properties of the IT artefact in the affordance framework as synonymous to the attributes construct of the MEC. **Figure 13** illustrates the integration of the two theories, showing how users interact with AR attributes thereby perceiving AR affordances in this interaction, how these perceptions of affordances are derived from the consequences driven by AR and in turn, the users' values that these fulfil. Disentangling the links between AR attributes, consequences and values allow us to better interpret AR affordances, as the motivations of goal-directed actors that shape the perception of affordances are elicited. It is also worth noting that the affordance theory's focus on the user and how one interacts with the AR artefact that consists technical attributes supports this thesis's position in grounding this study from the users' perspective, obtaining an understanding of the attributes that are important or salient to consumers and why these are salient from the point of view of the users themselves.

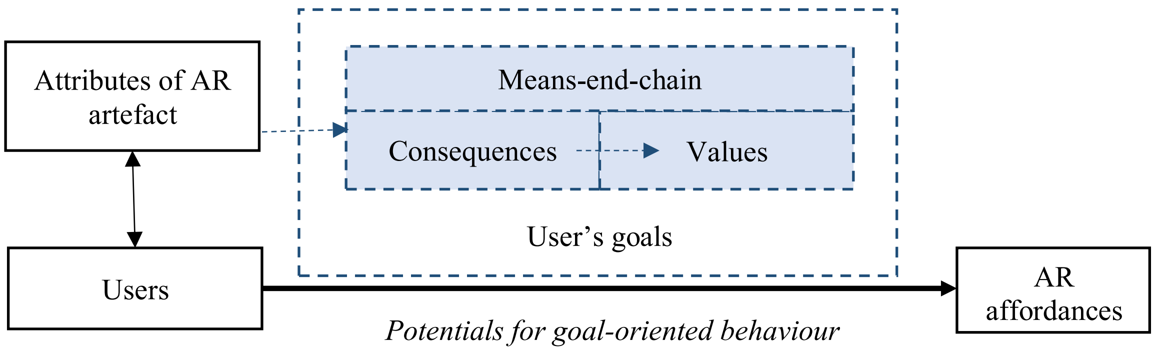

Figure 13 Integrated conceptual framework (synthesised from Pozzi et al. (2014) and Gutman (1982))

Secondly, for the development of this thesis, the MEC linkages uncovered in this investigation of AR affordances can give us the granularity and nuance required for us to identify interesting mechanisms that can add insight into our goal of theorising the AR phenomenon. The inclusion of human factors that are context-sensitive from the goal-directed perspective can give us insights into the "contingencies" within mechanisms that can influence an outcome (i.e. the outcome of an affordance). For example, some goals may facilitate or discourage the actualisation of an affordance (i.e. behaviour of acting on the potentials that AR can bring), subsequently leading to different outcomes. Or some variation in the material properties uncovered early in the attribute-consequence-value chain may lead to variation in actualisation and eventually outcome. The qualitative nature of the laddering research method that is used in MEC studies to elicit concrete attributes of objects and how these lead to the fulfilment of goals and personal values allow us to have rich insights into such possibilities. The laddering method is underpinned by the MEC theoretical assumptions, and is compatible with this study's objective of uncovering the salient AR attributes and the reasons behind the salience of these, providing us with a systematic means to explore AR affordances. The next section discusses the laddering technique in detail.

3.3. Methodology

As mentioned above, this study employs the laddering technique. The laddering technique consists of in-depth, one-on-one interviews with the goal of developing an understanding of how consumers translate tangible, observable attributes of products into meaningful linkages that relate to the self (Reynolds & Gutman, 1988). The laddering technique coherently follows the logic of MEC, allowing researchers to probe beyond respondents' surface knowledge about the perceived products' attributes and benefits, and to uncover how these are connected to the implicit personal values and beliefs that drive behaviour. As the MEC theory originated from the marketing discipline (Gutman, 1982), this method is typically focused on product attributes in marketing and consumption contexts. However, instead of product attributes, this study adapts the laddering method to identify the attributes of AR and the related goals, and subsequently the personal values these fulfil. The laddering method employed for this study comprises of three main parts: (1) elicitation of AR attributes that are salient to the respondents; (2) in-depth laddering interviews; and (3) analysis of the results to generate a hierarchical value map (HVM) that visually depicts the attributes-consequences-values linkages.

3.3.1 Laddering technique

The laddering method coherently follows the logic of MEC, allowing researchers to probe beyond respondents' surface knowledge about the perceived product or service attributes and benefits, and to uncover how these are connected to the implicit personal values and beliefs that drive behaviour. Authors ter Hofstede et al. (1998) summarised the laddering procedure by breaking the procedure down into three main steps: (1) elicitation of product/service attributes that are salient to the respondents; (2) in-depth interviews; and (3) analysis of the results. **Figure 14** shows the main steps for data collection and analysis as outlined by Reynolds and Gutman (1988).

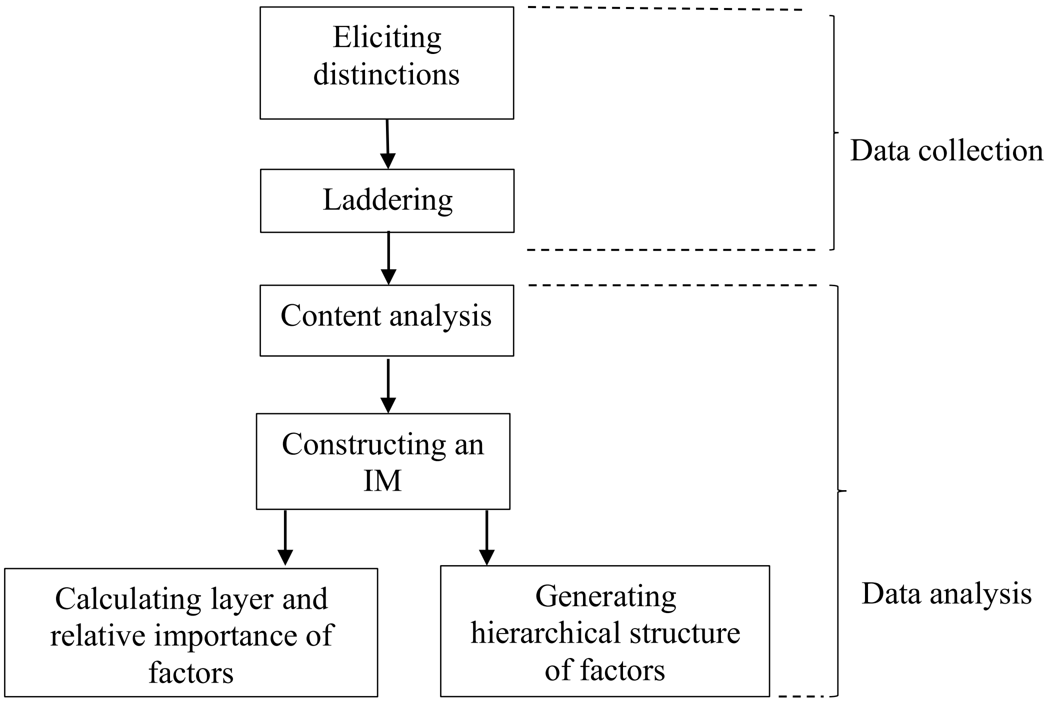

Figure 14 Laddering technique

The first phase of elicitation is crucial as it provides the base for further inquiry into respondents' higher-level values. Typically, this phase begins with asking individual respondents to make distinctions, or in other words, point out meaningful differences between products. After the first phase of elicitation is completed and distinctions are obtained, the data collection process continues with laddering interviews, which involves a tailored interviewing format consisting of continuous probes with a series of questions that take some form of the key question "Why is that important to you?" (Reynolds & Gutman, 1988). This way of questioning nudges interviewees up the ladder of abstraction, making them think critically and stimulate their memory (ter Hofstede et al., 1998). The result of this line of questioning is that key perceptual elements will be sequentially elicited, revealing attributes (A), consequences (C) and values (V) that form association networks or ladders. **Figure 15** below shows an example of a (one) ladder given by Reynolds and Gutman (1988), starting with a basic distinction between types of snack chips. This example was taken from a single respondent data in a salty snack study. During the interviews, interviewees freely describe their thoughts and experiences while the interviewer keeps questions open-ended and maintains the breadth of the interview until interviewees are unable to go further.

(V) self-esteem
|
(C) better figure
|
(C) do not get fat
|
(C) eat less
|
(A) strong taste
|
(A) flavoured chip

Figure 15 Example of a ladder from Reynolds and Gutman (1988)

Figure 16 illustrates the data collection procedure conducted for this study. To elicit AR attributes, we asked participants to watch 10 videos of different AR applications used in offline stores and shopping malls (see **Table 2**). These 10 videos were selected from a search result on YouTube using the keywords "augmented reality in retail". To ensure that we have a representative list of diverse AR applications in order to elicit a variety of attributes, while also maintaining parsimony to avoid overloading our participants with too many videos, these videos were selected carefully as described as follows. The AR videos that shared similar functions and uses were grouped together. When there was an AR app that did not share any similarities with the ones in the groups formed, a new group was created. This grouping process was a reiterative one, which ended after saturation was achieved, and no new groups appeared. One video from each of the 10 groups formed in this process was chosen for the final list of 10 videos.

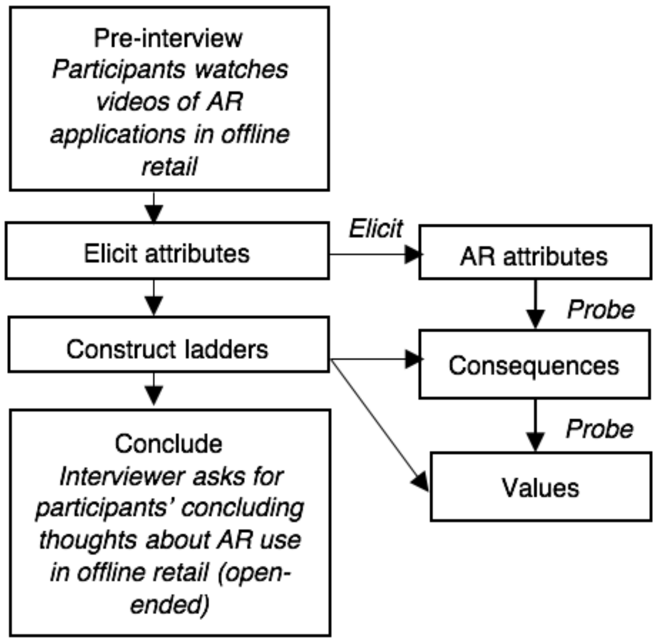

Figure 16 Data collection procedure

Table 2 Videos on AR application in brick-and-mortar stores

AR application	Brief description
Supermarket shopping AR (Acquia Labs)	Features of AR app include: in-store navigations, customer ratings, nutritional information and personalised recommendations.
AR product packaging (SIG-W-in-a-Box)	Interactive content on packaging allowing users to tap on information to view narratives of water's health benefits.
AR product packaging (Shazam-Bombay Sapphire)	Users can scan the label on the beverage to watch animated content. Content includes three different videos showcasing different recipes.
AR in apparel store (American Apparel)	AR app features include: showing customer reviews of products, slideshow of pictures of modelled clothing,

	video of modelled clothing, sharing function and colour assortment of product.
Supermarket shopping AR (Hansel)	AR app features include: in-store navigation, product discount information and personalised recommendations.
AR magic mirror in apparel store (UNIQLO)	Magic mirror displaying virtual clothing of different colour selections onto customer's camera view. Contains sharing function.
LEGO store AR	Displays a 3D animated version of LEGO kit when customers hold up boxed products in front of a display screen.
AR guidebot in furniture store	Voice recognition AI chatbot that guides customers with AR navigation. Also provides seller recommendation.
Treasure hunt AR in shopping mall	Gamified AR that involves a virtual bird navigating users around the mall to "unlock" discounts provided by stores in the mall.
AR store window (VyuAR)	Displays camera view of the store interior that creates a "transparent screen" effect, allowing both passer-bys and in-store customers to view virtual content such as 3D dragons and promotional information.

During the pre-interview stage, individual interviewees were briefed that they will watch all 10 videos selected that featured AR applications and will later be asked to rank the AR applications based on their preference and were thus encouraged to take notes. For this study, the ranking strategy was employed to elicit distinctions from our participants. Ranking is an attribute elicitation technique commonly used in laddering studies (Bech-Larsen & Nielsen, 1999). When the ranking was completed, I asked why the participant ranked the AR applications the way they did – specifically why he or she preferred one AR application over another. The participant then compared the AR applications to provide reasons, and from his or her response, the attributes that are used to distinguish the different AR applications are elicited.

This elicitation process resulted in a list of concrete attributes, which are treated as analogous to the properties of the AR artefact in the affordance framework. I then proceeded with constructing the ladders that link the elicited attributes to their consequences, and consequences to their related values. To achieve this, I focused on each attribute that was elicited from a participant's response (e.g. amplified product information) to ask a series of probes that takes some form of the question "Why is that important to you?" for interviewees to achieve higher levels of abstraction in their responses. Upon getting the participant's response, the same questioning (i.e. why is that factor important to him or her) continued until he or she had nothing further to add. Below is an example taken from my interview with P14:

> *Interviewer: Why is having information on customer's favourite important to you?*
>
> *P14: If I have to compare with other products, especially if it is something I have not purchased before, having the star value, which is the number of times customers have picked it up, would be helpful.*
>
> *Interviewer: Why is comparing between products important to you?*
>
> *P14: If it's something that I've never bought before, I want to make sure I get the best one out of the other products.*
>
> *Interviewer: And why is making sure you get the best product important to you?*
>
> *P14: So I know I didn't waste my time and money on something that I could've spent on a better product.*

From this section of the interview, one ladder is constructed to show the linkages between attribute, consequence and value: amplified product information (attribute) → facilitate product evaluation (consequence) → avoid wastefulness (value). As illustrated in the above example, participants are encouraged to think more abstractly with relevance to the self, resulting in linkages that lead to personal values. However, this is only one ladder (of many) achieved from a single attribute elicited (e.g. amplified product information), and from one participant. Each and every attribute elicited by every participant during the elicitation stage were followed by such probes to create new ladders.

3.3.2 Sample selection

When it comes to collecting qualitative data via interviews, the conventions of sample selection are different from that of quantitative studies. According to Polkinghorne (2005), a key distinction between quantitative and qualitative studies in terms of sampling, is that participants for qualitative study are selected based on the substantial contributions they can offer in filling out the structure and character of the experience that researchers are trying to investigate, rather than to meet the representative requirements of statistical inference. In this regard, it is therefore important to select participants who have the relevant experience for this study. However, as AR is relatively new and uncommon, it may not be feasible to restrict the sample selection to only individuals who have had experience in using AR prior to this study. In consideration of this limitation, I broadened this study's sample selection scope by choosing participants who are familiar with mobile applications. This is deemed to be an appropriate criterion because some AR applications for offline retail are only accessible via user mobile devices (Caboni, 2019). As this study is focused on the use of AR in retail, it is also relevant to select participants who frequently shop. Hence, this study selected its participants based on two criteria: (1) familiarity with mobile applications, and (2) frequency in shopping activity.

According to Vriens and Hofstede (2000), a sample size of about 30 laddering interviews is recommended because as number of interviews increase, new factors (e.g. goals, attributes and values) elicited become fewer and fewer until it reaches a point where no new concepts are elicited. This is consistent with the assumption of theoretical saturation (typically associated with grounded theory), in that sampling and data collection should continue until there are no new concepts generated (Strauss & Corbin, 1998). However, past literature using the laddering method have had varying sample sizes, ranging from 7 (Yang & Gao, 2017), 20 (Bianchi et al., 2020), to 1000 respondents (Brunsø et al., 2004). MEC studies with large sample sizes typically employ the 'hard' laddering approach whereby data is collected using questionnaires instead of in-depth interviews. However, the hard laddering approach has been critiqued for its lack of flexibility and consideration for respondents who may find it challenging to recall abstract values on their own without the probing of an interviewer (Phillips & Reynolds, 2009). Additionally, the time required to complete a laddering interview beginning with the elicitation of attributes to final laddering usually takes about 60 to 75 minutes (Reynolds & Gutman, 1988). As there is no consensus on what is the required sample size for the laddering method, I followed the logic of theoretical saturation that the adequacy of sample size should depend on the possible constructs elicited. I started data collection with 15 interviewees (deemed to be a suitable size for subsequent analysis as indicated in existing MEC literature), but increased the sample size to 45 until there were no new attributes or constructs elicited during the basic elicitation stage. Hence, data review and analysis were done in conjunction with data collection, making sampling and analyses an iterative process.

The first round of data collection with 15 participants were recruited using purposive, snowball sampling. I started by identifying and subsequently interviewing two PhD students from the University of Nottingham Ningbo China, who were deemed to be sufficiently acquainted with AR technology as they both had direct experience with AR applications. Following the interviews, they provided me with referrals who were identified to have basic knowledge of AR. All 15 participants confirmed that they understood the basic features of AR as defined by Azuma (1997). As it is the research objective of this study to identify what AR can afford users and the personal values that AR attributes can help satisfy, it is important that I collect data from participants who possess the knowledge or experience that can help me in this investigation. Additionally, to avoid gender biases, I ensured that there was an appropriate mix of male and female participants. 6 of the participants were male and 9 were female. The second round of data collection involved an additional 30 participants who were through a recruitment agency based in Ningbo city where the university is located. The agency were in charge of remunerating the participants for their participation. The participants were recruited based on the aforementioned two criteria: (1) familiarity with mobile applications, and (2) frequency in shopping activity. All participants were given a participation information sheet and signed a consent form before conducting the interviews [9]. These were also approved by the university's Ethics Committee [10]. The interviews were conducted at an office space provided by the agency.

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[9] Samples of participation information sheet and consent forms can be found in Appendix B and Appendix C respectively.
[10] Ethics committee approval form is provided in Appendix D.

The first round of data collection consisted of a total interview data of 806 minutes, with 58 minutes and 16 seconds as the average duration for a single interview. The second round of data collection consisted of total interview data of 1455 minutes, with 48 minutes and 31 seconds as the average duration for a single interview. In total, we had 2,261 minutes of interview data collected and recorded. Below **Table 3** lists the demographic details of participants for this study.

Table 3 Demographic details of Study 1 participants

Participant	Age	Sex	Occupation	Interview duration (h:mm:ss)
P1	26	Male	PhD student	0:49:38
P2	26	Female	PhD student	0:55:04
P3	27	Female	Writer	0:49:56
P4	24	Female	Master’s student	0:42:07
P5	29	Male	PhD student	0:56:54
P6	34	Female	Marketing executive	0:46:15
P7	26	Female	Paralegal	0:36:52
P8	23	Male	PhD student	0:44:30
P9	27	Male	Teaching assistant	0:39:33
P10	26	Female	PhD student	0:56:44
P11	27	Male	Business development executive	1:06:35
P12	28	Female	PhD student	0:55:57
P13	31	Male	Postdoctoral fellow	0:38:24
P14	29	Female	Marketing executive	0:45:50
P15	23	Female	PhD student	0:47:44
P16	27	Female	Consultant	0:42:15
P17	26	Female	Consultant	0:50:01
P18	29	Female	Senior consultant	0:54:37
P19	32	Female	Administrative staff	0:47:05
P20	37	Female	General manager	0:56:00
P21	26	Male	Entrepreneur	0:31:40

P22	30	Female	Administrative staff	0:54:19
P23	40	Female	Human resources staff	0:53:06
P24	30	Male	Administrative staff	0:46:31
P25	24	Male	Finance staff	1:07:25
P26	37	Female	Logistics staff	0:39:08
P27	32	Female	Purchasing staff	0:35:12
P28	38	Female	Property management staff	0:45:55
P29	28	Female	Purchasing staff (trading)	0:52:01
P30	27	Male	Supplier quality management staff	0:48:17
P31	24	Female	University student	1:20:41
P32	31	Female	Manager	0:52:10
P33	28	Female	Teacher	0:51:32
P34	35	Female	Assistant general manager	0:49:20
P35	34	Male	Personnel organisation management staff	1:29:11
P36	40	Male	General manager	0:57:38
P37	26	Female	Teacher	1:00:13
P38	40	Male	Teacher	0:57:03
P39	37	Male	Accountant	1:10:56
P40	33	Male	Education consultant	0:45:33
P41	25	Male	Business trader	0:44:45
P42	21	Female	Student intern	0:58:30
P43	31	Male	Warehouse manager	0:51:55
P44	23	Female	Quality assurance staff	0:46:20
P45	24	Female	Quality assurance staff	0:38:18

3.3.3 Qualitative coding

The first part of this study's data analysis was to analyse the content of all the factors from the ladders. The interview audio recordings were transcribed within 72 hours from when the interview took place. Following the content analysis recommendations by Reynolds and Gutman (1988), I first loosely classified all responses into the basic three categories: attributes, consequences and values. Then, the content was assigned individual codes with the NVivo software, as per the open coding technique commonly used in qualitative analysis (Strauss & Corbin, 1998).

I read the transcript and assigned codes to the pieces of text that were relevant to this investigation (hereafter referred to as reference texts), that answers the research questions of what are the AR attributes salient to users and why are these salient to them. The codes used to label the content from the transcript are called raw constructs. Following the coding and content analysis procedure described by Lin et al. (2017), the raw constructs that are expressions of the same underlying meaning were grouped together to form one unique construct. The data were further reduced into broader-level consequence categories, via categorisation per content analysis guidelines presented by Lin et al. (2017), adapted from Jankowicz (2004). The guidelines are summarised below:

1. If one unique construct is similar to the second, both are put together under a single category.
2. If a unique construct is different from the first one, they are placed into separate categories.
3. The researcher compares the remaining constructs with each of the categories and places it to the appropriate one, if the appropriate one existed.
4. If no appropriate category exists, a new category is created. However, during the creation of the new category, the researcher needs to consider redefining

existing categories by possibly combining or breaking them up further and repositioning the unique constructs accordingly if necessary.

The 2,261 minutes of interview data were coded and reduced from 36 raw codes into 28 aggregated codes. The data structure can be found in **Table 4.** The left most column in **Table 4** shows the attribute (A), consequence (C) and value (V) categories of the codes that were loosely assigned based on prior MEC studies in the IS discipline (Lin et al., 2017). Alphanumeric codes are assigned to each of the aggregated codes for the convenience of the following step, which is the implication matrix analysis (see **Section 3.3.4**). To ensure reliability of the coding procedure, I created a codebook and a coding scheme following the first round of my data reduction for a second coder to check against [11].

Table 4 Data structure of attributes, consequence and value categories

Category	Code	Aggregated codes and summary (with sample citations)	Raw codes
Attribute	**A01**	**Virtual-real integration** Virtual items (e.g. virtual clothes, virtual animations, virtual version of boxed products) presented onto the real environment or real objects (e.g. consumers' body, store, real products). *e.g. "... so I can see what I'll look like in the clothes with the virtual clothes on my own body.."*	
	A02	**3-Dimensional (3D)** Three-dimensionality of the AR content. *e.g. "It was 3D, and the 3D presentation really catches our attention."*	
	A03	**Recommendation** AR applications' recommending system elements.	

[11] Codebook and sample of coding scheme can be found in Appendix E and F respectively.

		e.g. "It's a lot like Siri, when I have a request or when I am unsure about what to buy, it will give me some appropriate recommendations"	
	A04	**Navigation** Virtual signals provided by AR app for consumer navigation and identification of product location. *e.g. "It helps you find the corresponding products and bring you to the corresponding location. I think this is very convenient, yes, first, because sometimes go there, especially with big shopping malls, you want to find products that you need, but there are just too many, making it difficult to find and choose."*	
	A05	**Amplified product information** Additional and more detailed information about products presented through AR app. *e.g. "It provides a lot of rich information... that you did not know about the products."*	**Discount information**
			Product feature information
			Product guide
	A06	**Integrated resources** The "one-stop" characteristic of AR apps allowing users to quickly access multiple types of information all in one app. *e.g. "Without apps like this, I would have to physically go to each and every store one by one, look through discount information on billboards outside their store or even go into the store to get information one by one. If I use this app, I can just see everything at a glance."*	
	A07	**Customer reviews** Reviews or information about the product from other individuals who have bought and used the product. *e.g. "... with customer reviews, I'm able to get other people's opinion about the quality of the product after buying it."*	
	A08	**Interactivity** Three-dimensionality and animation of virtual items that facilitate consumer interaction. *e.g. "... it has a lot of interactions, like the dragons and promotional messages. I would feel like touching it. This... helps me remember the information."*	**Dynamic content**
			User-content interaction

<table>
<tr><td></td><td>A09</td><td colspan="2">Assortment
Users have access to an extended variety of product options.
e.g. “I have more variety, and I can see if the colour I want that looks good on me exists.”</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">A10</td><td rowspan="2">Realism
The ability for AR to produce a sensorially rich environment, allowing for the perceptual fidelity of the “real”.
e.g. “... it's more convincing than just a picture because pictures can be edited, but with AR, it just looks more real.”</td><td>Vividness</td></tr>
<tr><td>Fidelity to the real</td></tr>
<tr><td rowspan="6">Consequence</td><td rowspan="2">C01</td><td rowspan="2">Autonomy
User has control over information displayed and shopping experience with minimal assistance from services staff
e.g. “..., it can introduce me products and it’s very detailed. When I get the info I need, and I don’t need it anymore, I can put it away. I choose what I want to see, I can save others from bothering me and I don’t need to ask the salespeople.”</td><td>Control</td></tr>
<tr><td>Self-service</td></tr>
<tr><td>C02</td><td colspan="2">Product impression
Consumers have a deeper and stronger impression of the product with AR experience, making it more memorable.
e.g. “... I can say the product presentation makes it feel very direct and intuitive. And I will remember this product and feel good about the product.</td></tr>
<tr><td>C03</td><td colspan="2">Immersiveness
Consumers are engaged and engrossed in an environment embedded with virtual elements.
e.g. “It’s hard to explain... so for example, some books have pictures and illustrations but with AR you can create a whole scene you know, and it transports me into this scene, into the plot.”</td></tr>
<tr><td>C04</td><td>Ability to visualise
The ability for users to have a vivid visualisation of a product, of its</td><td>Visualise product outcomes of product</td></tr>
</table>

		potential use scenarios, and of its ownership. *e.g. “With just a picture, I don’t really know what the product would look like. But with this, you can really see its real size. You see the 3D model, with a 360 angle view. I will have a more concrete idea about what the product looks like.”*	**Visualise product use experience** **Vivid and concrete visualisation**
	C05	**Cost saving** Users can save money. *e.g. “By making a good judgment and good choice, I don’t have to buy another product. It saves my money.”*	
	C06	**Efficiency** Ability for consumers to achieve maximum productivity with minimal time as well as cognitive and physical effort. *e.g. “I won’t need to make so much effort to guess how it will turn out in real life.”*	**Convenience** **Efficient shopping** **Save effort**
	C07	**Time saving** Users can save time. *e.g. “If this app tells me where to go, it’s not as time consuming as trying to find it myself.”*	
	C08	**Product knowledge** Users have more in-depth and clearer knowledge of the products, including its uses and potentials as well as an understanding of what to expect of the product. *e.g. “From the information, I’ll know the correct way of using it. It’s directly from the producer of the product. That way I know how to use it the way I’m supposed to.”*	**Product uses** **Product potentials** **Product expectations** **Product understanding**
	C09	**Product evaluation** AR facilitates the process of users evaluating a product by making choices easier to make, providing assurance through product credibility, product comparison, product fit and perceived	**Choice optimisation** **Product credibility** **Product comparison** **Product fit**

		product worth and overall reduced uncertainty. *e.g. "After seeing this, I have more confidence in the product. I feel secure in my heart. I can make the decision ...whether this product is worth buying"*	**Product worth** **Reduced product uncertainty**
	C10	**Positive customer experience** Experiential retail shopping where users are offered a different shopping experience beyond traditional ones through the elicitation of hedonic elements such as novelty, comfort and curiosity. *e.g. "It's such a fun experience... when you find something like this, you remember it. It's different."*	**Novelty** **Good experience** **Comfortable shopping** **Curiosity**
	C11	**Purchase intention** Users' intent to make a purchase. *e.g. "Actually that was one of the things that would probably make me buy it, because I'll be able to see how it looks like and how you can play with it."*	
	C12	**Retailer appeal** Users are attracted to the store or mall. *e.g. "I will go into the store to try the AR app. And perhaps I will look around the store too... why not shop around to see if there are any shoes I'm interested in."*	
Values	**V01**	**Negative emotion avoidance** Users want to avoid negative emotions such as feelings of regret or guilt. *e.g. "So like maybe I buy the clothes I thought would fit me well, but once I put it on, it's not what I thought it would look like. So I feel bad and disappointed. My mood gets ruined and I don't want that."*	
	V02	**Avoid wastefulness** Users values avoiding wasting precious money, time and effort. *e.g. "If I buy something I will never wear, I will feel like it's a waste of money."*	
	V03	**Maximise resources** Users can allocate their time and money on other priorities in their lives.	**Maximise money** **Maximise time**

		e.g. "Time saving is important because leaves you time to do other stuff."	
	V04	**Happiness and satisfaction** Feelings of joy and satisfaction derived from product and experience. *e.g. "It affects how I feel. If I see something cool and interesting, it just makes me enjoy my shopping experience and it makes me feel happy."*	**Happy or satisfied with product** **Happy or satisfied with experience**
	V05	**Improve life quality** Life is better for users. *e.g. "Living comfortably is very important to me."*	
	V06	**Enhancement of self-esteem** Users feel good about themselves, through self- confidence and the ability to accomplish something and develop themselves (e.g. knowledge). *e.g. "When I learn about something new, I am very happy and I feel proud of myself."*	**Self-confidence** **Self-development** **Sense of accomplishment**

3.3.4 Constructing the implication matrix (IM)

Upon completion of coding, the next step was to record the interrelationships between and across codes. This is performed using the implication matrix (IM). The IM is a matrix that displays the number of times each element leads to another element (Reynolds & Gutman, 1988). In the case of this study, the elements are the attribute, consequence and values categories that were aggregated from the coding process. There are two types of relations represented in the IM; direct relations and indirect relations. More detailed and sample descriptions about these relations and how the IM was generated for this study is found in **Section 3.4.2**.

The strength of constructing the IM is that it transfers qualitative data into quantitative data. The IM is a summary of all the linkages among codes thereby making it easy for us to identify how often a code leads to another code. The IM also allows us to deduce which pairs of codes have the strongest linkages and also how often a code is the destination of another code (Reynolds & Gutman, 1988). In addition to giving us a bird's eye view of the rich qualitative data obtained, the construction of the IM allows us to confirm the categorisation of the attribute-consequence-value groups. The former categorising process as shown in the left most column of **Table 4** is based on a priori knowledge of the coder with no objective method for classification. However, with the IM, we are able to objectively classify these into hierarchical layers according to the abstractness index of the factors, and to objectively identify the salience of factors according to the centrality index of the factors. This approach is discussed in the section below.

3.3.5 Determining the hierarchical layers of attribute-consequence-value (A-C-V) chain

The approach employed in this study to determine the hierarchy of the three elements of the A-C-V chain and how to classify the elements found in our qualitative data into the three categories is drawn from Pieters et al. (1995). This approach stems from identifying the hierarchy of goals, which Pieters et al. (1995) argued is composed of three main layers: (1) sub-ordinate goals; (2) focal goal; and (3) super-ordinate goals. According to Pieters et al. (1995), sub-ordinate goals involves the "*how*" of a goal, in that these goals operationalise the attainment of focal-level goal, which answers the question of "*what*" is the goal (Bagozzi & Dholakia, 1999; Pieters et al., 1995). For instance, if an easy product evaluation process (i.e. consequence C09 Product evaluation) is *what* an individual is striving for (i.e. the focal goal), then attaining additional product information (i.e. attribute A05 Amplified product information) would be the sub-ordinate goal as this represents *how* the individual is going to attain the focal-level goal. Finally, drawing from the approach by Pieters et al. (1995) on hierarchy of goals, the highest, most abstract level of goals would reflect the primary motivation in attaining the focal goal – answering the "why" of a goal. For example, the reason *why* an individual wants to be able to evaluate a product well (focal goal) could be to avoid wasting their resources on a purchase they end up not liking (i.e. value V02 Avoid wastefulness). From this perspective, a goal hierarchy can also be viewed as a means-end hierarchy made up of chains of sub-ordinate and super-ordinate goals (Pieters et al., 1995). The means can be considered sub-ordinate goals, consequences as focal goals and ends the super-ordinate goals.

Treating the hierarchy of goals as analogous to the A-C-V hierarchy chain, I draw from Pieters et al. (1995) to determine the hierarchy of A-C-V factors based on their levels of abstraction, ranging from concrete to abstract levels. This is determined through what is termed "abstractness", which is calculated as the number of times each factor (or code) is mentioned as the means versus the ends. Factors weighing higher on the abstractness index are considered ends or values, while those weighing less are considered means or attributes. In addition to the abstractness of factors, Pieters et al. (1995) also suggested an index of centrality that can also be calculated using the information tabulated in the IM. The centrality index represents the degree to which a code or a factor occupies a central role in the overall structure of the A-C-V chains. High values on the centrality index indicates that a particular factor or code is frequently involved in the linkages with other factors. This means that this factor or code is an important one. The following results section provide the abstractness and centrality values of each codes following the formulas proposed by Pieters et al. (1995). With these, a hierarchical map is constructed that can act as a framework for further testing.

3.4. Results

The data analysis procedure as discussed in above **Section 3.3.3** to **Section 3.3.5** have yielded results which are presented in the below sections. First, **Section 3.4.1** provides an overview of the codes aggregated and reduced as a result of the qualitative coding analysis, summarised in the data structure presented in **Table 4.** Second, **Section 3.4.2** presents the IM results that gives us a holistic view of the interrelationships between the aggregated codes obtained from the qualitative coding. **Section 3.4.3** draws from the IM results to reorganise the aggregated codes into factors arranged in hierarchical order. **Section 3.4.4** provides the hierarchical structure presented in a visual map for the interpretation of AR affordances, which are discussed in this study's discussion section (**Section 3.4**).

3.4.1 AR factors identified in qualitative coding

As explained in **Section 3.4.1,** the 1,199 reference texts transcribed from the interviews with 45 participants were coded by a single coder and these codes were checked against by a second coder. Of all the codes assigned to the 1,199 reference texts by the first coder, only 112 of these codings were disagreed by the second coder

– indicating a 91% agreement between coders. All coding disagreements between the two coders were resolved after discussion. The 1,199 reference texts produced a total of 37 raw codes. As some of these raw codes were found to have considerable overlap with other raw codes, whereby we saw that one code was often mentioned alongside another, we further reduced the data to consolidate similar factors under an "umbrella" factor of the same theme. I take two reference texts from the transcript for participants P18 and P25 to illustrate this:

P18: *I really like the AR app in Video 6 because when we buy clothes, if we see a piece of clothing that comes in different colours, of course you'd want to try the different colours on. But trying on clothes and taking it off takes a lot of effort. But here, you just try on one and you can see the different colours. No need to keep changing* **[coded as "Save effort"]**. *It's so convenient* **[coded as "Convenience"].**

P25: *I always feel confused going to the supermarket because supermarkets are very large and there are many products. It is very troublesome to find things and takes a lot of effort* **[coded as "Save effort"]**. *especially if I'm there for the first time. So like with this fifth app it'll make my shopping a lot more efficient* **[coded as "Efficient shopping"]**.

The above reference texts are two instances illustrating how the raw codes "save effort", "convenience" and "efficient shopping" coincide with each other. These adjacent codes appeared often alongside each other. Although these raw codes have nuanced differences, they share a unifying meaning of our aggregated code "Efficiency", which describes how AR offers users the ability to achieve maximum shopping productivity with minimal time as well as cognitive and physical effort. Such aggregations or reductions were performed, where 12 aggregated codes, namely codes A05, A08, A10, C01, C04, C06, C08, C09, C10, V03, V04, and V06, were a result of the consolidation of 2 raw constructs or more. This reduction process brought the total of 36 raw codes down to 28 aggregated codes or factors. When the codes were combined, the relationship frequencies were combined and adjusted accordingly.

Using a priori knowledge and preliminary observation of the relationships indicated from how each interview ladder started and ended, the coders agreed that out of the 28 aggregated codes, 10 were AR attributes that were perceived with immediacy by participants; 12 were consequences that the AR attributes were reported to bring forth, and 6 were values that these consequences gratify. During the analysis, it was found that within the three attribute, consequence and value categories to which the codes were loosely assigned to, there were connections between the codes within the same category. For example, there were many instances where C08 Product knowledge was found to lead to C09 Product evaluation, despite both elements being in the same category. This indicates that even within categories, there are sub-layers, affirming the model suggested by Walker and Olson (1991) that introduced finer gradations of attributes, consequences and values with respect to their levels of abstraction, as depicted in **Figure 12** in **Section 3.2.2.** In this model, attributes are divided into two – concrete and abstract attributes; consequences are also broken down to two levels – functional and psychosocial; and values into instrumental and terminal values (Olson & Reynolds, 1983). This model is used as a guide to name the finer layers found in our results. We determine which factors belong to which layers following the IM results below.

3.4.2 IM results

Table 5 shows the IM generated from the recording of interrelationships between factors and the frequencies of the connections that were mentioned in the laddering interviews. The IM comprehensively shows the direction of relationships between factors identified and reduced from our qualitative interviews as well as the frequencies of the number of times the relationships were mentioned, hereafter referred to as frequencies of linkages. The top most row and left most column represent the code labels that are assigned to each factor (see **Table 4**). There are therefore 28 code labels as heads of the IM, making this a 28 x 28 matrix. The input value in each cell of the matrix represents the number of times each "row" code leads to each "column" code (Reynolds & Gutman, 1988).

It can be seen that the diagonal of the IM is empty because it is not possible for a particular goal to lead to itself. As briefly discussed in **Section 3.3.4**, there are two types of relations in the IM; direct relations and indirect relations. As seen in **Table 5,** there are two numbers in each cell – one on the left of the colon one on the right. The number on the left of the colon indicates the direct relations between factors whereas the number on the right of the colon represents the indirect relations between them, so for instance, the number between A05 (amplified product information) and C08 (product knowledge) in the IM means that there were 20 instances that participants mentioned that A05 can lead to C08 directly, while there were 10 instances that participants mentioned that A05 can lead to C08 through other goals.

Table 5 IM of AR factors

	A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	C11	C12	V01	V02	V03	V04	V05	V06	OD
A01								1:0	1:0	6:1		0:1	1:0	5:3	0:1	5:2	4:8	1:2	7:11	6:7	1:3	1:4	0:2	0:2	0:4	0:9		0:4	**103**
A02					1:0					3:0				9:2		1:0	0:1	0:4	1:5	1:1	0:3	0:1		0:4		0:2		0:1	**40**
A03															1:0	2:1	4:2	1:0	3:1	1:1				0:1	0:1	0:1			**20**
A04											7:0					11:6	12:7			1:3	0:1		0:1	1:6	1:9	1:3	0:1		**71**
A05						1:0	1:0		1:0		3:1	0:1		5:1	11:2	4:7	5:3	**20:10**	**21:19**	4:3	1:2		0:3	3:8	2:9	0:9	0:2	1:5	**168**
A06				1:0			1:0		1:0		2:1				0:1	7:2	6:1	1:1	3:3	1:2	0:1			0:3	1:1	0:4	0:1	0:1	**46**
A07					2:0											1:1		4:1	15:4	1:0	0:3		0:1	1:9	0:3	0:2		1:1	**50**
A08					2:0					3:0	3:0	3:2	2:0	6:2		1:2	2:3	1:4	1:3	10:9		3:2		0:2	0:2	0:6		0:2	**76**
A09											0:1					1:0		3:2	13:2	1:0	0:1		0:2	0:3		0:4	0:2	1:2	**38**
A10												1:0	3:0	6:0	0:1	2:0	1:1	3:2	6:5	1:3	1:1		1:2	0:3	0:2	0:2		0:3	**50**
C01																6:3	2:1		2:0	6:0	0:1		1:0	0:2	0:1	2:3			**30**
C02																										1:0	1:0		**2**
C03																		1:1		3:0						0:1		2:1	**9**
C04											1:0	1:0	3:2			3:1	5:2	7:7	12:4	3:2	3:3		0:4	2:7	0:1	1:3		0:5	**82**
C05																							1:0	1:0	6:0	3:0			**11**
C06											1:0						15:1	1:0	4:0	5:1			2:2	10:2	6:6	1:0	0:1	0:1	**59**
C07															1:0	5:0			2:0	1:0			0:1	5:3	12:1	3:0	1:0		**35**
C08														3:1			1:0		10:13	3:0	5:3		1:1	6:12	1:1	2:3	1:0	6:1	**74**
C09											2:1	1:0		1:0	4:1	5:2	6:2	10:0		0:1	6:3		6:5	19:7	2:2	10:8	0:2	9:1	**116**
C10														1:0				2:0	1:1	2:1	12:0			1:0		12:4	3:0	4:5	**49**
C11														1:0					2:0					1:2	0:1	1:0			**8**
C12																				3:0						3:0		0:1	**7**
V01																								1:0					**1**
V02																							1:0		2:0	1:0			**4**
V03																								1:0					**1**
V04																								1:0				1:0	**2**
V05																													**0**
V06																										1:0	2:0		**3**
ID	**0**	**0**	**0**	**1**	**5**	**1**	**2**	**1**	**3**	**13**	**23**	**10**	**11**	**46**	**23**	**81**	**95**	**89**	**174**	**87**	**54**	**11**	**37**	**129**	**77**	**106**	**17**	**59**	

Note: ID: in-degree; OD: out-degree.

Based on the guidelines provided by Reynolds and Gutman (1988), direct relations refer to the implicative relations among adjacent factors. For instance, based on a ladder taken from the laddering interview with Participant P41 (A07 Assortment → C08 Product knowledge → C09 Product evaluation (Raw code: Product fit) → C11 Purchase intention → V04 Happiness and satisfaction (Raw code: Happy or satisfied with experience)), the relation of A07 to C08 is a direct one, as is C08 to C09, and C09 to C11 so forth. However, within this given ladder, there exists indirect relations as well – for instance, the indirect relation of A07 to C09, or that of A07 to C11, A07 to V04, C08 to C11 and so forth. In other words, a direct relation between two factors is when one factor is mentioned directly after the other within the same ladder. An indirect relation between two factors is when both are mentioned within the same ladder but are separated by one or more intermediary factor(s). When using laddering analysis, researchers have to make a decision whether to consider only direct relations or both direct and indirect relations. For Reynolds and Gutman (1988), because there are typically more indirect relations than direct ones, excluding indirect relations may lead to a scenario where there are many paths by which two goals (through different intermediary goals) are indirectly related, but none of these paths are included enough times to show a significant connection. For this reason, the indirect relations are also included in our results to obtain a comprehensive picture of the connections among the AR-related factors. Thus, from what can be gathered from just a cursory look at the IM, we can see that the highest values belong to C08 (product knowledge) and C09 (product evaluation), two of the most frequently-mentioned consequence factors in relation to attribute A05 (amplified information). Following the formulas provided by Pieters et al. (1995), I am able to extract information that can give us an objective method to classify the finer layers within each A-C-V category and also to identify the most salient factor interrelationships.

As seen in **Table 5**, the out-degree (OD) values on the right-most column and the in-degree (ID) values on the bottom-most row are recorded. The OD of a single goal is the frequency that the goal is the *origin* of a connection with other goals, aggregated across all subjects and ladders. The OD is thus represented by the row sum of a goal in the IM. The ID, on the other hand, is the number of times that the goal is the *destination* of a relation with other goals, also aggregated across all subjects and ladders. Hence, the ID is represented by the column sum of the goal in the IM. These two values allow us to more objectively classify the finer layers within the A-C-V categories, while also confirming whether the factors belong to the larger A-C-V categories. For instance, the OD of V02 (avoid wastefulness) is a low score of 1. What this mean is that "avoid wastefulness" is not often mentioned as the source of the connection, implying that it is unlikely for it to be an attribute. On the other hand, "avoid wastefulness" has an ID score of 129. Compared to other factors with lower ID scores, "avoid wastefulness" is relatively higher in ID score. "Avoid wastefulness" is thus estimated to be higher up in the A-C-V structure, implying that it is likely a more abstract consequence or a value. As mentioned in **Section 3.3.5,** the abstractness and centrality of factors are the two indices that can help us determine the hierarchical position of the factors and the importance of the factors respectively, and these are calculated using the OD and ID information obtained from the IM illustrated in **Table 5**. The following section provides the abstractness and centrality scores of each factor and the hierarchical arrangement of the factors according to these scores.

3.4.3 Layer of factors and importance of factors

With the OD and ID values of each factor, we are able to determine the abstractness and centrality of factors that will inform us of the hierarchical positioning of the factors and its relative importance respectively. First, abstractness of a factor is defined as ratio of ID over the sum of IDs and ODs (Pieters et al., 1995). The higher a factor's abstractness score, the larger the proportion of the factor's relations with other goals, where the said factor is the destination rather than the source (Pieters et al., 1995). Typically, factors with high abstractness scores represent ends or terminal values, whereas those with low scores are usually means or concrete attributes. The second index is the centrality of a factor, which Pieters et al. (1995) define as the ratio of IDs plus ODs of a particular factor over the sum of all cell-entries in the IM. The higher the centrality index of a factor would mean the more frequently the particular factor is involved in relations with other factors in the overall structure (Pieters et al., 1995). Overall, the centrality index essentially indicates the relative importance of a particular factor, whereas the abstractness index shows the position or level (low to high) in the general factor structure. Following the formulas described above, below **Table 6** shows the factors with their corresponding abstractness values in ascending order.

Table 6 Abstractness of factors in ascending order

Code label	Factors	Abstractness
A01	Virtual-real integration	**0.000**
A02	3-Dimensional (3D)	**0.000**
A03	Recommendation	**0.000**
A08	Interactivity	**0.013**
A04	Navigation	**0.014**
A06	Integrated resources	**0.021**
A05	Amplified product information	**0.029**
A07	Customer reviews	**0.038**
A09	Assortment	**0.073**
A10	Realism	**0.206**
C04	Ability to visualise	**0.359**
C01	Autonomy	**0.434**
C08	Product knowledge	**0.546**
C03	Immersiveness	**0.550**
C06	Efficiency	**0.579**
C09	Product evaluation	**0.600**
C12	Retailer appeal	**0.611**
C10	Positive customer experience	**0.640**
C05	Cost saving	**0.676**
C07	Time saving	**0.731**
C02	Product impression	**0.833**
C11	Purchase intention	**0.871**
V06	Enhancement of self-esteem	**0.952**
V02	Avoid wastefulness	**0.970**
V01	Negative emotion avoidance	**0.974**
V04	Happiness and satisfaction	**0.981**
V03	Maximise resources	**0.987**
V05	Improve life quality	**1.000**

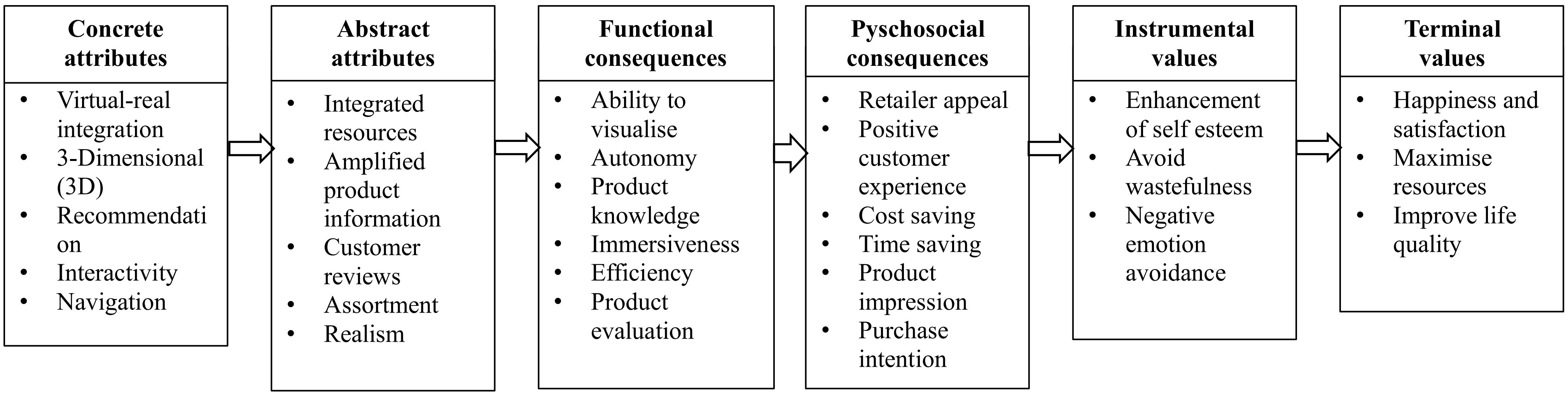


Figure 17 AR factors categorised and positioned according to abstractness index

The overall abstractness values computed for each of the factors confirm that the preliminary broad categorising of the attribute, consequences and values group that was based on our a priori knowledge corresponded to the expected abstractness of each categories, with factors in the attribute scoring lowest in abstractness, consequences with mid-range abstractness scores and values scoring the highest. Using the definitions provided by Olson and Reynolds (1983) and Walker and Olson (1991) of the finer six layers within the A-C-V chain, namely concrete attributes, abstract attributes, functional consequences, psychosocial consequences, instrumental values and terminal values – together with the abstractness value computed as shown in **Table 6**, the factors were classified into these finer layers as illustrated in **Figure 17.**

5 concrete attributes which had little to no connection *from* other factors and are almost always an origin rather than a destination factor were identified. These include “virtual-real integration”, “3D”, “recommendation”, “interactivity” and “navigation” – representing the most basic properties of AR. The virtual-real integration attribute, in particular, has a high OD value of 103, indicating that it is a high frequency mention, which means that this is the source for many other related factors in the A-C-V chain. Another 5 other attributes were deemed to fall under the abstract attributes layer, which is the layer above the concrete attributes. These include “integrated resources”, “amplified product information”, “customer reviews”, “assortment” and “realism”. These rank higher in abstractness and some are indeed outcomes from the more material properties of AR in the concrete attributes layer. For instance, integrated resources, amplified product information and customer reviews are three attributes that result from the superimposition of virtual or digital information onto users’ real-world settings. Among the 5 abstract attributes, we observe that “amplified product information” has

the highest OD value among all the factors across categories, indicating that it is an important factor in the A-C-V chain, but also one that trumps all concrete attributes in terms of its frequency of being mentioned as the origin of other factors and it being the starting point of many elicited ladders.

Following the two attributes layer is the consequence layers. Within these, 6 functional consequences and another 6 psychosocial consequences were identified. The functional consequences identified include “ability to visualise”, “autonomy”, “product knowledge”, “immersiveness”, “efficiency” and “product evaluation”. Among these, “ability to visualise” and “product evaluation” were two of the most frequently mentioned consequences that led to other factors with 82 and 116 OD values respectively. Further up in abstractness hierarchy is the psychosocial consequences, which were identified to be “retailer appeal”, “positive customer experience”, “cost saving”, “time saving”, “product impression” and “purchase intention”. As expected, due to these being higher in abstraction, the OD values for psychosocial consequences are significantly lower compared to the functional attributes. Based on the descriptions provided by Olson and Reynolds (1983) on the hierarchical layers, functional consequences can be understood practical benefits obtain through the usage of AR. Psychosocial consequences, on the other hand, are more about affect and social considerations. Although the factors in this study identified as psychosocial consequences may not seem directly affective or pertaining to social considerations, the self-reports from participants speaks to the affective nature of these factors. The following are quotes from our participants that were coded as factors considered to be psychosocial consequences to illustrate the social and affective undertones of these factors that points to the emotion element within these factors.

Retailer appeal

P13: *This one's very cool, yes, it may not be as practical as the previous one but I think it is very cool. It attracts me to the store and attracts a lot of people to watch it. I think it is very interesting.*

Positive customer experience

P34: *I think this is kind of like the icing on the cake, you know what I mean? For me, it can only attract me to go into the store to have a look, but I don't know I guess others will buy your products. I guess you can convert visitors to be buyers. But one thing's for sure I will feel like this is a special experience that they [retailers] put a lot of effort on.*

Cost saving

P22**:** *Knowing I bought something that was on sale... I think to some extent I feel like I gained something you know.. it's a cheeky feeling. And I feel happy knowing I bought something cheaper than the original price and saved money.*

Time saving

P45: *It's a very direct thing you know what I mean. Like I don't have to read from the beginning til the end. It presents what I need to know very quickly and I save time learning about the product ... reading product descriptions one by one will take a really long time and that annoys me.*

Product impression

P30: *Yeah so like I remember the product better but also like it affects my understanding about this product and the team behind the product, whether or not they are serious about the product. And this is something you feel in the whole experience with the product when you shop.*

Purchase intention

P34: *Because quite often some toys ... many of them are packaged ... unless the vendor has a display, many of them we cannot see. There may be a lot of building box for example but what does it pile up to. But with this [the AR], I can see the possibilities and I instantly feel that I can also pile it up like this and I want to play it. You can better understand the products [with AR] and arouse their [consumers'] interest and desire to buy. And it makes me feel happy that I bought the right thing.*

Based on these quotes, we can see how these psychosocial consequences involve individual feelings and emotions, such as enjoyment and feeling special for "retailer appeal" and "positive customer experience", happiness and avoiding negative emotions for "cost saving" and "time saving" respectively, and we also see how *feeling* some kind of emotion (i.e. feeling assured that retailers made an effort with advertising the product or feeling happy about a purchase) with the final two pyschosocial consequences, that is product impression and purchase intention. These consequences are also *closer* connected to the values that were mentioned by the participants (e.g. happiness and negative emotion avoidance), which were frequently mentioned by other participants as well.

As for the values category, there are three values identified to be in the instrumental value layer, namely “enhancement of self-esteem”, “avoid wastefulness” and “negative emotion avoidance”; and another three values in the terminal value layer, namely “happiness and satisfaction”, “maximise resources” and “improve life quality”. Among the values category, the “avoid wastefulness” value has the highest ID value of 129 indicating that it is most frequent destination for other factors. “Happiness and satisfaction”, on the other hand, was the second-most frequent value destination for other factors, with 106 as its ID value. Instrumental values, as defined by Olson and Reynolds (1983), refer to broad, preferred ways of behaviour. The instrumental values identified align with this characterisation, as having higher self-esteem, avoiding wasting behaviour and avoiding negative emotions are all aspirations that participants mentioned that they would like to achieve through the consequences acquired by tapping onto specific attributes of AR. These are also relatively less abstract compared to the terminal factors that were identified. For the terminal values, Olson and Reynolds (1983) describe these as desired end-state of being that are highest in abstractness and hierarchy. The terminal values identified in our analysis also support this description as fulfilling the instrumental values can gratify terminal values, such as making them feel happy or satisfied, helping them achieve resource maximisation and enhance their life quality.

The above described the results pertaining to the abstractness of factors that helped confirmed and corrected the hierarchical layers among the factors we have identified and grouped into the A-C-V with our existing knowledge. In the results, there were some indication of what were some of the more frequently mentioned factors among participants. In the analysis, the centrality of factors is calculated to determine more objectively the relative importance of factors. Using the formula proposed by Pieters et al. (1995), the centrality of factors are computed as the ratio of IDs plus ODs of a particular factor over the sum of all cell-entries in the IM. **Table 7** lists the results of the factor centrality formula in descending order, with the factor with the highest centrality score to the lowest. The higher the centrality score of a factor, the larger the proportion of connections in the A-C-V structure that run through the particular factor. Hence, the higher the value, the more important is the particular factor relative to other factors.

As seen in **Table 7,** among all the factors, the functional consequence factor “product evaluation” ranks highest in centrality, followed by abstract attribute factor “amplified product information” and functional consequence “product knowledge”. Among the factors in the attribute category, abstract attribute factor “amplified product information” as well as concrete attributes “virtual-real integration” and “interactivity” are the three factors with the highest centrality indicating these as important attributes to users. On the other hand, functional consequences “product evaluation”, “product knowledge” and “efficiency” have the highest centrality values among the factors in the consequence category. In the values category, instrumental value “avoid wastefulness” as well as terminal values “happiness and satisfaction” and “maximise resources” are three of the most important values as indicated by their centrality scores.

Table 7 Centrality of factors in descending order

Code label	Factors	Centrality
C09	Product evaluation	**0.251**
A05	Amplified product information	**0.150**
C08	Product knowledge	**0.141**
C06	Efficiency	**0.121**
C10	Positive customer experience	**0.118**
V02	Avoid wastefulness	**0.115**
C07	Time saving	**0.113**
C04	Ability to visualise	**0.111**
V04	Happiness and satisfaction	**0.094**
A01	Virtual-real integration	**0.089**
V03	Maximise resources	**0.068**
A08	Interactivity	**0.067**
A04	Navigation	**0.062**
A10	Realism	**0.055**
C11	Purchase intention	**0.054**
V06	Enhancement of self-esteem	**0.054**
C01	Autonomy	**0.046**
A07	Customer reviews	**0.045**
A06	Integrated resources	**0.041**
A09	Assortment	**0.035**
A02	3-Dimensional (3D)	**0.035**
V01	Negative emotion avoidance	**0.033**
C05	Cost saving	**0.029**
A03	Recommendation	**0.017**
C03	Immersiveness	**0.017**
C12	Retailer appeal	**0.016**
V05	Improve life quality	**0.015**
C02	Product impression	**0.010**

3.4.4 Hierarchical value map

Based on the information acquired with the centrality index and abstractness index together with the quantified frequencies of the connections between factors provided through the construction of the IM, a hierarchical value map (HVM) can be generated. Prior MEC studies construct a hierarchical map to better present the "chains" or interrelations between the A-C-V factors as well as to uncover the dominant paths to value fulfilment (Gutman, 1997; Olson & Reynolds, 1983). It is through this HVM that the affordances will be interpreted and discussed in the following discussion section in **Section 3.5**.

Unlike the IM where there is a breadth of comprehensive information provided by each non-zero cells corresponding to the relations between factors, the HVM is more parsimonious as it takes out and presents only key or dominant orientations of the A-C-V hierarchical structures. This study's HVM therefore uses a cutoff level of connections to avoid a cluttered map which can be difficult to interpret as there are many cells in the IM that are non-zero, thereby only connections between factors above some cutoff level are considered. This also aligns with the objective of this study to identify AR affordances, which should represent the dominant goal orientations found in this study [12]. Determining an appropriate cutoff level is important to ensure the balance between the comprehensiveness and interpretability of the map, and the interpretability is particularly important in our endeavour to infer the AR affordances from the extensive data collected.

[12] Although the information in the IM is reduced further for the HVM, further research can still draw from the IM and the less dominant relations between factors to investigate the less "obvious" elements of AR, which could also yield interesting knowledge about AR.

Prior literature using the MEC approach that have also constructed a HVM had varying cutoff levels. For instance, Pieters et al. (1995) and Jung and Pawlowski (2014) used a cutoff level of 4 (meaning only keeping linkages that appears at least 4 times in the IM), Lin et al. (2017) used a cutoff level of 5, and Wagner (2007) used a cutoff level of 3. To determine the cutoff level, this study employed the sensitivity analysis proposed by Pieters et al. (1995) to ensure the balance of informativeness and interpretability. **Table 8** presents the information necessary to decide on the cutoff level value for this study's HVM. The first row of **Table 8** shows the information of the current IM as the cutoff level of one, which simply means all cells with non-zero values. Column 1 is number of active cells, which means the count of cells that are non-zero. For example, in the second row in **Table 8**, if the cutoff level is determined at 2, all cells that sums up to less than the value 2 will be deleted and taken out of consideration. In this case, cells A01 to A08, A01 to A09 and A02 to A05 in the IM illustrated in **Table 5**, for instance, will be ignored. As all analyses thus far have considered both direct and indirect relations, this cutoff consideration involves the sum of both. Hence, to illustrate this in an example, A05 to C01 in the IM in **Table 5** that records 3 direct relations and 1 indirect relations would equate to 4 relations in total, and hence would be deleted in the cutoff level of 5. Thus, Column 1 represents the number of active cells after all cells that did not make it to the cutoff values are deleted (i.e. number of cells with aggregated values of both direct and indirect relations of $\geqslant 2$ if the cutoff is determined to 2, is 169; 136 cells with aggregated values of both direct and indirect relations of $\geqslant 3$ if the cutoff is determined to 3; and so forth).

Column 2 of **Table 8** are the number of active cells as a proportion of all cells. Our IM of 28 x 28 factors result in 784 number of total cells. Column 2 represents the values in Column 1 divided by 784 to represent the number of active cells according to the different cutoff level in proportion to all cells. Column 3 of **Table 8** is the number of active cells as a proportion of cells mentioned at least once. All cells mentioned at least once is the same as the number of active cells in the original IM as it records all non-zero values in the matrix – hence why it is 100% for the first row that has the cutoff value of 1. Computing the values for Column 3 hence follows the number of active cells for each cutoff divided by 244, which is the number of active cells mentioned at least once in the IM.

Column 4 of **Table 8** is the number of active linkages after the cells that did not meet the cutoff values are deleted. Linkages here are synonymous to relations, the frequency of which are represented by the values in the cells (i.e. direct relations + indirect relations). The number of linkages can hence be understood as the total sum of values in the IM. The original IM with the cutoff value of 1 would have 1155 linkages (also the sum of all ODs and IDs respectively). Upon the deletion of cells according to the cutoff level, the active linkages are summed accordingly and the values of these are listed in Column 4. In sum, Column 4 shows how many relations between goals are retained when non-active cells are ignored. Column 5 of **Table 8** shows the number of active linkages as proportion of all linkages, which takes the values from Column 4 and divides these to the original number of all linkages that is 1155. For instance, for the cutoff level of 2, upon the deletion of cells that after the sum of direct and indirect relation in each cell was < 2, the number of remaining active linkages (as recorded in Column 4) is 1013. 1013 is then divided by the number of all linkages (also the original number of linkages in the IM), that is 1155, to get the proportion of active linkages proportionate to all linkages – resulting in, 88% for the cutoff level of 2. In other words, Column 5 shows which proportion of the total number of relations made by respondents is accounted for at cutoff levels of 1 through 5.

Reynolds and Gutman (1988) has suggested a general rule of thumb proposing that an appropriate cutoff would account for two-thirds of all relations among elements. Pieters et al. (1995) also proposed that to balance informativeness and interpretability, the data shown after cutoff should still account for a large enough percentage of the total number of connections made by respondents (previously suggested two-thirds is deemed appropriate), while with a relatively small number of distinct relations between factors. Based on these suggestions, the cutoff level of 5 was deemed most appropriate. This cutoff level allows us to account for 68% (Column 5) of all connections between factors made by our respondents, using only 33% of the cells in the IM that contains non-zero values (Column 3). This aligns with the suggested "two-thirds of all relations" rule of thumb while also keeping to the suggestion by Pieters et al. (1995) to use a small number of distinct relations between factors.

Table 8 Statistics for determining a cutoff level

Cut-off	(1) Number of active cells	(2) Number of active cells as a proportion of all cells	(3) Number of active cells as a proportion of all cells mentioned at least once	(4) Number of active linkages	(5) Number of active linkages as a proportion of all linkages
1	244	0.31	1.00	1155	1.00
2	169	0.22	0.69	1013	0.88
3	136	0.17	0.56	955	0.83
4	101	0.13	0.41	863	0.75
5	81	0.10	0.33	790	0.68

Using the cutoff level of 5, the factor hierarchy is constructed as illustrated in **Figure 18.** This map is constructed from the IM in **Table 5** by graphing all relations that met or exceeded the chosen cutoff level of 5. The hierarchical ordering of the factors represents the factors' level of abstractness as listed in **Table 6.** In other words, the higher the vertical position of the factor, the more abstract the factor, the greater the proportion of relations in which the factor is treated as a destination (value or end), instead of the origin (attribute or means) of a relation, and these correspond to the six layers of A-C-V categories. The varying boldness of the arrow lines indicate the relative strength of the connection between factors – dashed lines indicate relatively weaker relations (5-9 times mentioned), regular lines indicate moderate relations (10-16 times mentioned) and bold lines indicate strong relations (more than 16 times mentioned)[13]. Bold boxes indicate the factors that the strong relations passed through or in other words were involved in these strong relations. These coincide with the notion of factor centrality – which means that the factors in the bold boxes are important factors relative to other factors in the A-C-V chain.

[13] Both direct and indirect relations are aggregated together when determining the strength of relations.

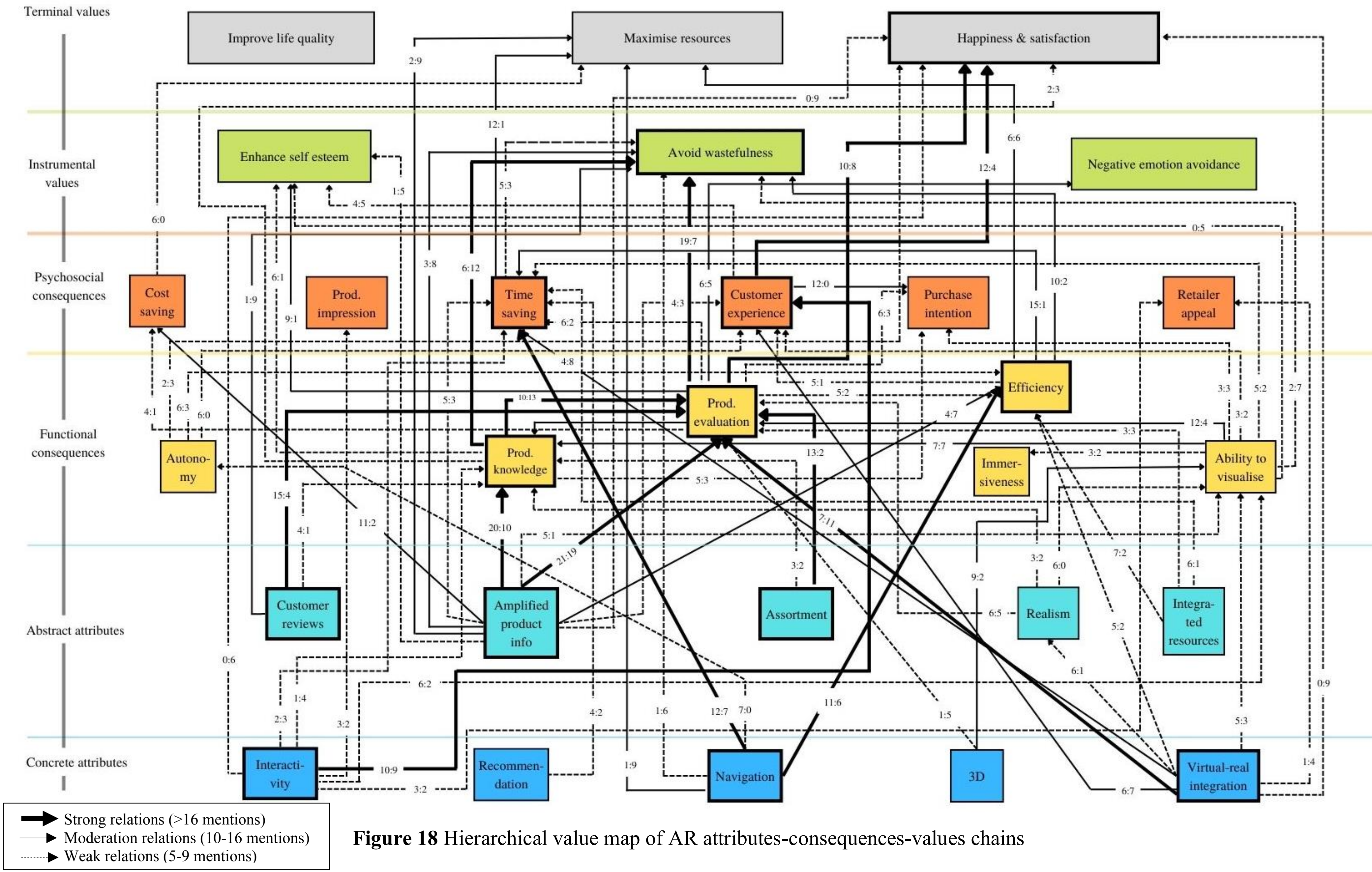


Figure 18 Hierarchical value map of AR attributes-consequences-values chains

3.5. Discussion

The following sections discuss the AR attributes-consequences-values (A-C-V) paths derived from the construction of the HVM, followed by how AR affordances are interpreted from the HVM through the lens of goal-directed actors of perceiving AR attributes as means to obtain consequences, which would essentially lead to the gratification of actors' personal values.

3.5.1 Paths led by AR concrete attributes – Interactivity, navigation and virtual-real integration

Based on **Figure 18**, we can primarily identify the three AR concrete attributes that are found to be the origin of strong paths, namely – (1) interactivity; (2) navigation; and (3) virtual-real integration. Firstly, the path led by AR's attribute of interactivity is one that is fairly straightforward. The dominant path reveals that interactivity is a strong enough concrete attribute that need not be mediated by an abstract attribute to result in positive customer experience, which gratifies the terminal value of happiness and satisfaction (see **Figure 19**). This result affirms prior literature that have investigated the interactive nature of AR, particularly in how this is related to hedonic outcomes. For instance, through survey data, Yim et al. (2017) found that interactivity can lead to enjoyment via the mediator immersion. Although "immersiveness" in our study, a similar factor as immersion in the study by Yim et al. (2017), was not mentioned often enough to appear as a strong consequence relation of AR's interactivity, we observed that it was mentioned twice as seen in the IM in **Table 5**, wherein interactivity had two direct relations to immersiveness. However, it would seem that enjoyment, investigated as an important outcome variable of AR's interactivity in Yim et al. (2017), as well as similar findings in other studies such as Nikhashemi et al. (2021), which found that AR's interactivity attribute led to users' perception of hedonic benefits, align with this study's user-grounded inductive data that AR's interactivity does lead to hedonic outcomes such as a positive customer experience (which subsumes elements of enjoyment) and helps users gratify their personal needs for happiness and satisfaction. It may also be useful to note that positive customer experience is the strongest driver of purchase intention out of all the other factors and it is found that the interactivity attribute is a driver of positive customer experience. Illustrating this is a quote from Participant P35:

> *"... you get a feeling of joy in the process of shopping. So if you are in a good mood and enjoy the shopping experience, the quantity and quality of consumption [purchase] will go up."*

From this, one practical consideration that could be made by retailers and brands is to ensure that customers enjoy the experience of shopping and when interacting with their products. The findings show that tapping onto AR's interactivity and highlighting this attribute in the AR experience to advertise products in stores can lead to a positive perception of the shopping experience thus leading to higher purchase intentions. In addition, what we can infer from our findings, is that positive customer experience can lead directly to the gratification of the abstract, terminal value of individual happiness and satisfaction. Literature in retail has suggested that individuals can experience self-expressiveness in shopping (Sirgy et al., 2016). In the discussion on the concept of self-expressiveness, the concept is characterised as an important part of their self-concept of happiness. Specifically, self-expressiveness in shopping is defined as “the degree to which customers think shopping activity is an important part of their self-concept, perceiving themselves as making progress towards the realisation of their best potential through shopping” (Sirgy et al., 2016, p. 293). Sirgy et al. (2016) found that self-expressiveness in shopping drives life satisfaction, and what is interesting is that it was found that consumers’ *flow* experience during shopping activities predict the self-expressiveness construct. In this study, Sirgy et al. (2016) describe people experiencing flow in an activity are individuals who find the activity enjoyable and are highly involved in that activity. It is thus unsurprising that our findings revealed that the interactivity attribute of AR, which involves users in the AR experience [14], led to perception of positive customer experience as a consequence – similar to the concept of flow as described by Sirgy et al. (2016) – and how this subsequently led to the value of happiness and satisfaction. Interestingly, albeit being just a moderate relation, our findings also revealed that individuals’ perception of a positive customer or shopping experience driven by AR’s interactivity also led to the value of the enhancement of self-esteem. This finding also echoes that of the self-expressiveness notion investigated in Sirgy et al. (2016), as the “realisation of their best potential through shopping” shares similar meanings to that of our factor of “enhancement of self-esteem” (see **Table 4**). These two values, happiness and satisfaction as well as the enhancement of self-esteem are relatively important value factors compared to other values elicited from our respondents, and from our findings, we see that AR interactivity can eventually lead to the gratification of these value for users.

[14] As listed in **Table 4**, the interactivity concrete AR attribute is an aggregate factor of the code “user-content interaction” whereby individuals can interact with the dynamic virtual content superimposed into their physical environments.

The second dominant A-C-V path is the path led by the concrete attribute of navigation, as illustrated in **Figure 20**. To the best of my knowledge and based on the literature on AR that has been reviewed, navigation is not a core property of AR, but a function that can be incorporated in AR applications. Studies in computer science have explored this indoor navigation function powered by AR in malls and retail settings, and such applications of AR technology can greatly help users locate products quickly – particularly if the physical space is large (e.g. Saeliw et al., 2022; Winkler et al., 2011). This aligns with our study's finding whereby our respondents cited this function to lead to the function consequence of efficiency and also directly to the psychosocial consequence of helping them save time. Interestingly, in an article on digital retail services and in-store technologies, it was discussed that out of the different in-store technologies, such as mobile payment, online reservation for store pick-up and others, in-store navigation is the technology that ranks lowest in user awareness and also has very low utilisation levels (Linzbach et al., 2019). Our findings suggest in-store navigation could be something worth exploring for practitioners as these were reported to lead to efficiency and help with saving time, which are both consequences greatly valued by users. As shown in Saeliw et al. (2022) and Winkler et al. (2011), this can be done effectively with the aid of AR technology (Saeliw et al., 2022; Winkler et al., 2011). Although there are no strong relations in the path from consequence to value from the consequence factors "efficiency" and "time saving" in the overall A-C-V chain, a noteworthy finding is that there are two moderate relations leading from these two factors to one terminal value, that is "maximise resources". Achieving resource maximisation is the second most important value among the other values identified in this study and this is an interesting result as this is not, to the best of my knowledge, a common value that prior MEC studies have found. This A-C-V chain that highlights how individuals appear to value time and efficiency to ensure their personal resources such as time, energy (physical, mental, and/or emotional), and financial resources (see Grawitch et al. (2010)), are maximised supports the changing trend among consumers in China. According to Accenture (2022), Chinese consumers are increasingly placing more importance on leisure time. It is reported that the time Chinese people spend on caring for their children and the elderly has increased significantly over the last decade, leaving them with very little personal resources[15]. Following this trend, it was found that Chinese consumers are increasingly willing to pay a premium for convenience, and this emphasis on convenience has led to the increase in online shopping (Accenture, 2022). However, this is not to say that offline shopping is becoming irrelevant. The report also notes that with the rising incomes and greater willingness to pay for convenience, consumers are increasingly seeking leisure opportunities and this may include shopping offline. According to Accenture (2022, p. 26), offline channels will attract more experience seekers "but only if they can provide consumers with unique leisure and entertainment scenarios, in addition to convenient shopping experiences". As discussed in the aforementioned A-C-V path brought about by AR's attribute of interactivity and navigation, AR can provide both leisure or entertainment *and* convenience or efficiency respectively, which can in turn gratify the combination values (i.e. personal resources maximisation and enjoyment or happiness) that individuals seek.

The third concrete attribute leading a dominant A-C-V path is the virtual-real integration attribute of AR (see **Figure 21**). This attribute is the defining feature of AR

[15] Time spent by Chinese people on caring for children and elderly more than doubled from 0.4 hours to 0.9 hours per day between 2008 to 2018 (Accenture, 2022)

(Azuma, 1997), and is therefore intuitive that this was a frequently mentioned attribute of AR. It is also unsurprising that is one of the attributes that are lowest in abstractness among other AR attributes, as the virtual-real combination AR feature is one of the most basic technological elements of AR. Our findings show that the concrete AR attribute of integrating the real and virtual allows users to better evaluate a product. Based on our interview data, this was often related to the superimposition of virtual items, such as clothing and shoes, on themselves in real-time that enabled them to easily determine the fit of the product. An example to illustrate this is the below quote from one of our participants:

P13: *I can try on all the possible colours [of virtual clothes] and styles to see which one fits me best.*

Product evaluation is also one of the most important functional AR consequences alongside "product knowledge" and "efficiency", and is a common destination for many concrete and abstract attributes. The virtual-real integration attribute of AR allows for users to evaluate products better, and this subsequently leads to the instrumental value of "avoid wastefulness". In other words, the virtual items embedded into their real world that allow them to make sound product evaluation in turn help individuals to avoid wasting a purchase (the product), and to some extent, their personal resources put into evaluating whether to purchase the product. Valuing personal resources and not wasting these is related to the value of maximise resources as discussed above, but the "avoid wastefulness" value is one that is less abstract than maximising personal resources. As seen in **Table 5**, participants have mentioned that "avoid wastefulness" leads directly to maximisation of resources. One way to understand this is that the product that goes to waste that is caused by an unsound purchase evaluation process, though is a *material* waste, carries the symbolic meaning of also wasting personal resources that went into getting the product initially. As this is a very strong relation with 19 direct mentions and 7 indirect ones, this is evidently an important value for users. Aside from avoiding waste, the AR consequence of "product evaluation" is also strongly related to helping users achieve happiness and satisfaction without going through any psychosocial consequences or instrumental values. This is interesting as this suggests that the users affective and cognitive perception of having their product evaluation process aided by AR is strong enough to achieve the terminal value of happiness and satisfaction.

It is also worth discussing that in our qualitative data, there were other sub-properties that were mentioned in relation to the concrete attribute of AR integrating the real and the virtual. For instance, "vividness" and "fidelity to the real" were characteristics of this concrete attribute that but were coded as an aggregate abstract AR attribute of "realism". This was treated as a resulting perception on the part of users stemming from AR's ability to combine the real and the virtual. The realism element was deemed to be important to users because the varying levels of realism of the AR experience and how close to reality the virtual items were to real-life objects led to their ability to visualise the use of the product, to learn about the product and to make a decision about the product, as depicted in the weak relations mapped out in the HVM in **Figure 18**. The concept of realism in relation to AR technology, particularly in the intellectual dialogue within the social sciences, lacks a unifying interpretation. For instance, Javornik (2016b) recognises that the uniqueness of AR lies in its ability to *augment* the physical environment with virtual objects and investigates a concept that the author termed as the perceived augmentation. Augmentation "is linked to the visual annotations of AR technology as they represent its most salient and well-developed feature" and is "specified as a unique AR feature, while its perception – perceived augmentation – is the psychological correlate of this feature" (Javornik, 2016b, p. 994). As discussed in the literature review in Chapter 2 of this thesis (**Section 2.3.2**), Javornik (2016b) self-developed a scale to measure perceived augmentation with five items – namely: (1) I felt I could enrich X; (2) After I stopped using the site, I could still imagine Y; (3) The virtual objects seemed completely real; (4) I felt that the virtual objects did not add anything to X and; (5) Reality seemed richer *(where X is the element that is being augmented and Y is the virtual element depicted in the application)*. From these items, particularly Item 3, we can infer that the construct of perceived augmentation assumes that the augmentation feature of AR technology is to superimpose realistic virtual objects into our physical environments. However, based on this scale and the definition of augmentation in this study, it would seem that "realistic" virtual objects are the default characteristic of the virtual objects that are being superimposed into our real worlds by AR technology. Sharing similar views is Yim et al. (2017, p. 91), who adopted the vividness perspective to investigate the technology's use in e-commerce, defining AR's vividness property as its ability "to produce a sensorially rich mediated environment", but later compared vividness to the characterisations used by other scholars who "similarly echo this concept, labelling it as realness, realism, or richness". While the respondents in our study described the virtual objects mostly in terms of how close it is to reality (i.e. "realistic") or how it is sensorially rich (i.e. high resolution quality), there were also instances where participants described the cartoonic, non-real characteristics of the virtual objects superimposed into the physical environments by AR:

***P25**: "I think this is a type of toy, and [in the AR] the toy's pieces are presented in cartoon form."*

***P24**: "Although the video of the AR packaging of SIG-W-in-a-Box also provide enriched information like the other apps, this specific AR app were all **cartoons** [cartoonised]"*

This is a type of realism that is not often discussed in AR academic literature, particularly in IS literature. In the aforementioned discussion, the concept of "realism" that has gained the attention of prior investigation pertains mostly to how the virtual items feel like it is "present" in the physical environment due to AR's other concrete properties like superimposing *three-dimensional* virtual objects and is tracking its physical markers in real-time – and this is often achieved when the virtual items are of high quality resolution, which is similar to the vividness perspective argued by Yim et al. (2017). This, however, is not the same as the *visual* realism, which would vary between cartoon-realistic designs of virtual items as indicated in the quotes taken from the interview data. Although this was not a salient theme that was raised frequently in the interviews, the visual realism of virtual items embedded in our physical environments via AR technology is a design element that may have interesting theoretical implications for the reality augmentation phenomenon. Drawing from the affordance theory, perception is key and visual realism is something that can be directly perceived (i.e. an attribute of AR, as illustrated in our HVM results) – thus, the variability of this may effectively lead to interesting outcomes. As stylisation and designs of virtual items can easily range from cartoonish to realistic, it may be worth investigating how the manipulation of these can affect user's perception and psychology. This also presents the opportunity for the theorisation of augmented reality as this directly ties into the augmentation or manipulation of reality in the examination of disrupting or complementing reality with visually realistic or non-realistic virtual items. I continue this discussion in Chapter 4, where I develop this strand of thought further and investigate this design feature of AR to potentially solve a business dilemma that is the basis for Study 2, whilst also interpreting using its findings towards the theorisation of augmented reality.

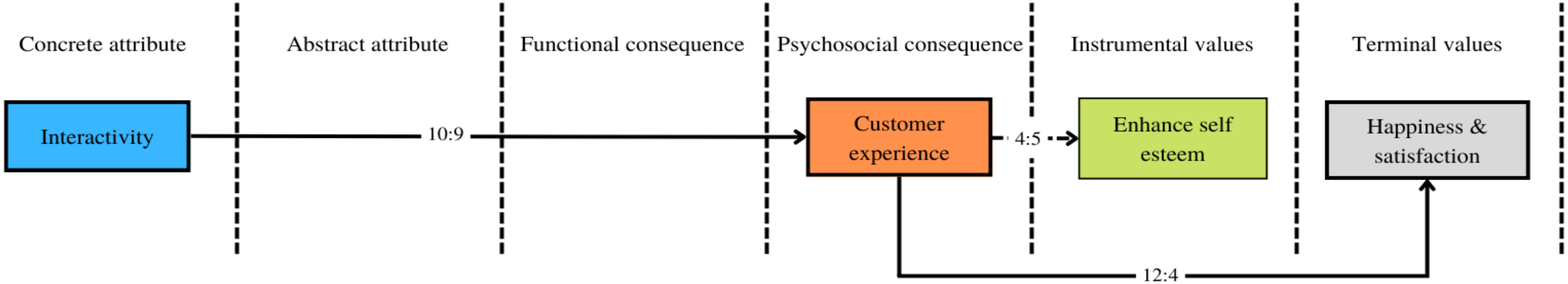


Figure 19 A-C-V path led by AR interactivity attribute

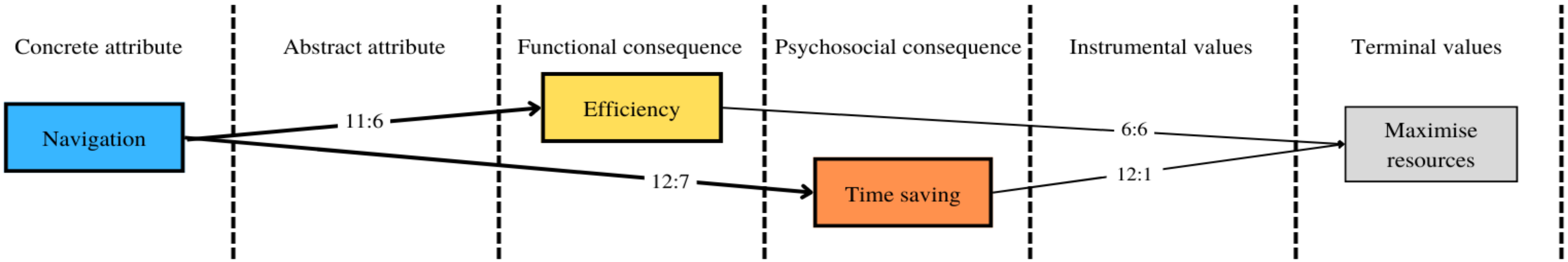


Figure 20 A-C-V path led by AR navigation attribute

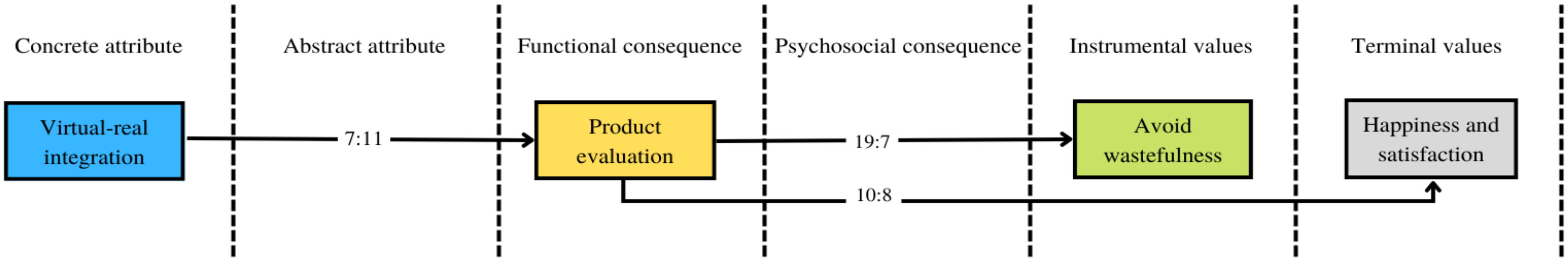


Figure 21 A-C-V path led by AR virtual-real integration attribute

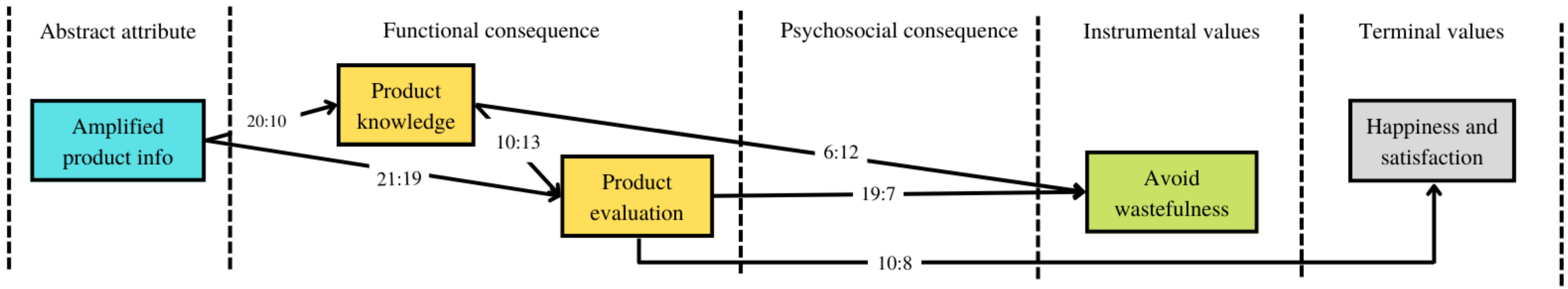


Figure 22 A-C-V path led by AR amplified product information attribute

3.5.2 Paths led by most salient AR attribute – Amplified product information

Although "amplified product information" was not a concrete attribute of which were expected to be the origin of ladders, it is found to be the second-most important attribute across all factors and the most important attribute across all concrete and abstract attributes. Discussion on why this may be the case is provided in the following paragraphs. However, as this abstract attribute is ranked so highly in centrality, this section will unpack the relations associated with the AR attribute of providing amplified product information. **Figure 22** illustrates the strong relations that originate from the AR attribute of amplified product information.

In this study, this attribute refers to the additional and more detailed information about products presented through AR, specifically through its concrete attribute of embedding virtual and digital information into users' physical space. The study respondents have cited these information to include product discount information, product feature information and guides on how to use products. From a technological point of view, it is the function of AR's superimposing of virtual objects into real environments (i.e. virtual-real integration) that allows for this abstract attribute of AR of providing users with an additional layer of information, but respondents have not made this connection and directly perceived this for AR's more abstract function of information amplification. This perception is a strong one and was elicited frequently as indicated in the HVM and IM that recorded the frequency of relations. Notably, the amplified product information attribute of AR was elicited to be directly related to product knowledge and product evaluation, and was also mentioned in a two-step ladder of first leading to product knowledge and then consequently from product knowledge to product evaluation.

The direct relations elicited from respondents are from the respondents' explanations that the amplified product information allow for users to understand a product in more depth and breadth, and these were mentioned to include the uses and potentials of the products and knowing what to expect of the product. This increase in product knowledge was reported to lead to product evaluation, or in other words, allowing users to evaluate a product, such as its fit, credibility and worth. However, some respondents do not perceive the mediation of increased product knowledge as a salient process that occurs between amplified product information and enhanced product evaluation, thus mentioning that amplified product information directly led to them being able to evaluate a product better. Nevertheless, knowledge acquisition through AR is a well-researched domain, particularly in the field of education technologies. For instance, in testing the use of AR technology in STEM laboratory courses, Altmeyer et al. (2020) found that AR technology's ability to present corresponding information from different sources simultaneously through its attribute of superimposing virtual objects onto real objects or environment led to higher knowledge gains, and this was argued to be due to the reduction of the split-attention effect. AR technology creates an integrated format that consists of the physical laboratory and the virtual information, and this is was found to be particularly useful in knowledge acquisition as the AR technology presented real-time measurement data in close spatial proximity to the corresponding components in the learners' physical environment. A similar study by Liu et al. (2021) found that the virtual-real mixed learning environment afforded by AR technology yielded similar results in leading to higher knowledge improvement and lower cognitive load.

It is interesting to note that in both the aforementioned prior studies, the cognitive process of learning and acquiring knowledge is aided through AR, in that the amplified information, which is the content of teaching and learning, is directly connected and perceived in the users' immediate setting wherein the information or knowledge are applied. The supplementing of information that would typically be unavailable in the users' immediate setting, but is made possible through AR's attribute of integrating virtual information into physical contexts, allow for users to make connections between new information and a physical object – whether it is a STEM experimental component or a retail product – with less cognitive effort. Best representing this is a quote from Participant P37, where she commented*, "[AR-presented information] is direct and clear. Makes things easier to understand"*. This perceived ease of acquiring product knowledge leads to better product evaluation, as found in our laddering interview data. As **Figure 22** shows, satisfactory acquisition of product knowledge was reported to directly lead to the gratifying of waste avoidance and subsequently happiness and satisfaction, which are important personal values, as discussed in **Section 3.5.1.** An alternative pathway is product knowledge leading to product evaluation, but also leading to the same ends; instrumental and terminal values of "avoid wastefulness" and then "happiness and satisfaction" respectively.

3.5.3 Other noteworthy AR attributes – Customer reviews and assortment

"Customer reviews" and "assortment" are two attributes of AR that have shown saliency in our data despite not being categorised as concrete AR attributes, but rather as abstract attributes. These two abstract attributes did not have strong connections to origin concrete attribute factors in particular, as depicted by our HVM in **Figure 18.** Similar to the amplified product information abstract attribute, customer reviews and assortment were perceived with immediacy by participants despite these being more abstract than the other concrete attributes (see **Table 6**). While this study's objective was primarily to identify concrete attributes that could be designed in order for it to be personally relevant to users' motivation, and useful AR design insights could be provided if these attributes were unrooted at the most concrete level, an understanding of the more abstract AR attributes elicited to be salient in this study is also helpful in unravelling the motivation of AR use in the context of shopping in physical stores in a more nuanced way. Thus, the below briefly discusses some considerations for these two AR attributes that though may not take primacy relative to our thesis's focus on concrete attributes, are still relevant as secondary functions.

Customer reviews. Reviews from other customers, though not an AR-specific function, remains to be an important functional consideration for app developers and retailers when designing AR experiences for consumers in physical stores. Several participants have indicated that information from individuals who have already purchased the product play a supporting role in evaluating the product. For instance, P25 mentions, "*It [Customer reviews] is important especially when you are on the fence about buying something or not. This is when you care a lot about other people's opinion.*

It's quite similar to the herd mentality. When many people say that the product is good and when I am deciding between two products; Product A and Product B – if more people have bought Product A and reviews are also positive, then I'm more inclined to take my wallet out for Product A". Reviews from customers enabled by AR in physical stores can work hand in hand with amplified product information provided by retailers as a supplementary source of information that can enhance the product evaluation process. This also aligns with the arguments by Parise et al. (2016, p. 417), who have suggested that retailers could design in-store mobile apps (that can include AR mobile apps) for consumers to gain product information that integrates a social element to it, such as allowing "users to comment on and mark products as 'favourites'". The close proximity and the level of immediacy of the information in relation to the physical products through AR's ability to overlay digital information onto real environments and physical objects, is something that is arguably distinct from other mobile in-store technologies, and as previously discussed, reduces cognitive effort from users.

Assortment. Another abstract attribute that has evidenced saliency in our data, which was also found to drive the enhancement of product evaluation is the abstract AR attribute of assortment. Assortment refers to the extended variety of product-related options, and this was perceived to be an important abstract attribute driven by AR technology from the consumers' perspective. Capturing the essence of this attribute and its importance is this quote from P33: *"... sometimes when we buy clothes in stores, there might be some clothes that are not hung up for people to see. Or maybe some clothes [of the same brand] are available in other stores but not in this store. This happens a lot, and so with this AR app, I can see all the colours that are available and know what is available. Then maybe they can purchase it and have it delivered to me –*

that would be very convenient". This attribute is in many ways similar to the "amplified product information" of AR technology in stores, but the assortment attribute of AR emphasises the *breadth* of information that allows for consumers to become aware of the scope of their choices. As mentioned in the introduction, and as highlighted in Hoffmann et al. (2022), product information in physical spaces are restricted to material spaces that may be bound to the product packaging or the store space. A new space is opened up by AR that contextualises a breadth of information onto the consumers' physical space as well as onto the physical product, and retailers can use this space to provide consumers with information and options that will help them evaluate products – as product evaluation was elicited to be an important activity in their shopping in-stores, and something that AR can support and enhance.

In addition, our interview data in relation to these two AR abstract attributes in particular have shown support for arguments on how AR complements the omnichannel shopping experience by enabling activities typically associated with online shopping (e.g. accessing customer reviews, exploring all available product options, such as sizes, colour assortment) in the physical store setting (Hilken, 2018). As exemplified by P33's quote, some products or product options may not be available in stores, but with AR technology, consumers can obtain information of their availabilities elsewhere, and can proceed to making a purchase online. From an omnichannel perspective, AR helps counteract the potential loss of customers that could be a result from consumers not being able to determine the right product fit due to limited choice set (Hilken, 2018). Customer reviews as a form of peer-to-peer communication, on the other hand, that is a typical feature of e-commerce and online shopping channels, on the other hand, can be supplemented in physical stores via AR to further support consumers' product evaluation and certainty, as indicated in our data. The integration of both these digital, online elements to the physical store environment where consumers can physically inspect the products, may drive stronger purchase intentions as well as brand loyalty – essentially creating “the best of both worlds” scenario.

3.5.4 Summarising AR A-C-V paths: An affordance perspective

Based on the findings of the salient A-C-V paths and the central AR factors involved in these paths, there are several affordances that can be interpreted. However, this section first starts with discussing the layers of the A-C-V hierarchy, specifically in explaining why some paths did not involve factors from all six layers. Following the explanation on this is the discussion on the two AR affordances in the brick-and-mortar retail context, interpreted from the findings. These include AR’s affordance of *supporting experiential shopping* and AR’s affordance of *providing users mental shortcuts.*

Perception of A-C-Vs. In the conceptual background section that introduced the background and tenets of the MEC theory (see **Section 3.2.2**), it was discussed that MEC theory holds the assumption that individuals view products and services for their tangible attributes and how these can lead to consequences derived from using the products or service, which in turn gratify their personal values. In the same way, AR technology holds a set of attributes that can lead to consequences that later gratify user values. However, during our laddering interviews where I asked interview respondents to rank and distinguish the ten AR applications at the attribute elicitation stage, they often mentioned abstract attributes (e.g. amplified product information) rather than concrete attributes (e.g. virtual-real integration), as depicted in **Figure 22** and in the IM in **Table 5.** Firstly, this is consistent with the assumption of the MEC theory that assumes individuals focus on the instrumentality of an attribute that are related to their personal value (Gutman, 1982). It is thus unsurprising that participants elicited abstract attributes instead of concrete ones, as the former are directly related to functional consequences and are more closely related to users' choices.

Secondly, this apparent disconnect with concrete AR attributes in our A-C-V paths can also be explained from the affordance perspective. As discussed in **Section 3.2.1.,** the goal-oriented actor perceives the potential for behaviours (defined as affordances) associated with achieving outcomes through an object. According to the affordance theory (Gibson, 1986), perception of the actor thus plays an important role. The awareness of potential actions (i.e. affordances) is something that can be directly perceived. It is conceivable, then, like the argument of the MEC theory that highlights individuals' tendency to focus on the instrumentality of material attributes, the immediate response during the elicitation process from respondents would be the potential actions of technical attributes of AR rather than the technical or concrete attributes itself. The frequently mentioned AR factors in this study can therefore be understood as the most relevant means and ends that individuals can relate to and the most frequently mentioned attributes are those that are highly perceived as actionable.

As seen from **Figures 19 to 22**, some linkages elicited in laddering interviews may not always involve all six layers in the refined MEC model introduced by Olson and Reynolds (1983). Olson and Reynolds (1983) explain that this is because respondents may not always be able to elaborate on the abstract meanings of the products they use, or in our case, the AR application in question. In the case of our ladders, some concrete attributes may not be elaborated to the abstract contributes level, and some functional consequences may not be elaborated to psychosocial consequences. On the values level, there were also ladders that ended at the instrumental value layer rather than the terminal value layer. According to Olson and Reynolds (1983), the inability to abstract can be due to the inactivation of self-relevant knowledge in the individual's working memory. While it was easy for respondents to perceive and make direct connections from the functional element of AR technology, it is also not uncommon or surprising that they were unable to draw more abstract meanings into finer layers. As a result from this, the most frequently mentioned AR factors are saturated at the centre of the hierarchy, from the functional attribute level to the psychosocial consequence level.

Interpreting AR affordances. These central layers in the overall AR factors hierarchy are also key in revealing the "for whats" and "whys" of AR technology use in the offline retail shopping context (i.e. what can the AR attributes be used for and why these are used), highlighting the goal orientation aspect of users when using technologies. Subscribing to an interpretative approach, it is through these that I draw and infer AR's affordances from, aligning with the definition of affordance as being action possibilities.

Based on the overall HVM **Figure 18,** the most salient A-C-V pathways were teased out, as depicted in **Figures 19** to **22.** The central layers of these four dominant pathways (i.e. the AR consequence layer) are categorised into two main themes, thereby revealing two AR affordances. The first being one that is focused on the customer experience (i.e. pathway in **Figure 19**) that is supported by AR's concrete attribute of interactivity. The second is focused on the cognitive resource element involved in the purchase decision making process that AR can have an impact on, such as in the product evaluation process (i.e. pathways in **Figure 21** and **Figure 22**) and in the efficiency consequence of AR (i.e. pathways in **Figure 20**) that allows consumers to achieve maximum productivity with minimal personal resources that include cognitive effort. The below discusses the two affordances in more detail.

AR affordance 1: Supporting experiential shopping. The hedonic value in shopping is a topic that has been discussed and investigated extensively in consumer research. The seminal work of Hirschman and Holbrook (1982) has established the importance of enjoyment and pleasure when it comes to shopping and consumption. This is often referred to as hedonic consumption, and the concept of hedonic consumption is often contrasted to the concept of utilitarian consumption (Alba & Williams, 2013; Babin et al., 1994). To put it simply, the distinction between the two is typified in the work-fun mentality, in that whether shopping is viewed as work (utilitarian) or fun (hedonic) (Babin et al., 1994). Babin et al. (1994) argue that utilitarian consumer behaviour is reflected in shopping activities such as collecting product information out of necessity rather than recreation, and in consumers finding value in completing shopping tasks efficiently and productively. On the other hand, hedonic consumer behaviour is largely about fun and playfulness rather than about task completion. Hedonic shopping value is thus reflected in shopping's entertainment and emotional worth (Babin et al., 1994). As Hirschman and Holbrook (1982, p. 92) best describe it, "hedonic consumption designates those facets of human behaviour that relate to the multisensory, fantasy and emotive aspects of one's experience with products". Individuals who value hedonic shopping are hence likely to focus on the *experience* of shopping and partake in what is known as an experiential orientation to shopping (Büttner et al., 2013; Ho & Wyer, 2021).

Experiential consumption is motivated by the desire to have an enjoyable life experience as an end in itself, and such an orientation depend on the situational and individual idiosyncrasies at the time when consumers are engaging in the consumption activity (i.e. shopping) (Ho & Wyer, 2021). When shopping under an experiential orientation, the hedonic value of shopping will be assessed, and consumers will seek to maximise this, for instance by shopping in an entertaining or stimulating store environment (Büttner et al., 2013). In our study, we found evidence in the experiential orientation of individuals, particularly those who have mentioned enjoyable customer experience and autonomy as important consequences that AR can bring. As illustrated in **Table 7,** positive customer experience is a psychosocial consequence that is highly ranked in salience, and as shown in the HVM and **Figure 19,** this can be driven effectively by AR's attribute of interactivity. The A-C-V pathway as illustrated in **Figure 19** aligns with the notion of experiential shopping, in that the value of it is reflected in its emotional worth, which is echoed in our value factor of happiness and satisfaction. Prior studies on AR in retail have also pointed to this affordance of AR in appealing to consumers with experiential shopping orientation (e.g. Dacko, 2017; McLean & Wilson, 2019; Scholz & Smith, 2016), and this study provided insights grounded from the users perspective as evidence to substantiate prior literature. In addition, this study teased out which of the concrete attributes of AR that can support users with experiential orientation in shopping, and we have found that the interactivity attribute of AR can maximise the hedonic value that individuals seek to gratify.

While not the most salient consequence found in our study, the "autonomy" consequence that refers to the ability of AR to provide consumers with a sense of control and independence over their shopping experience is also something that can contribute to the emotive element of experiential shopping. Our data has shown that this perceived sense of control also lead to a positive customer experience and can also directly lead to the happiness and satisfaction value in our HVM. This is an AR consequence that is relatively under-researched. Albeit limited, the study by Huang and Liao (2017) found that the sense of ownership control over virtual objects in AR experiences is positively related to the flow experience and this indicates the potential of this functional consequence that can lead to the abstract consequence of positive customer experience. Similarly Hoffmann et al. (2022), found that the controllability element of AR presented information in brick-and-mortar retail can reduce the potential overload that comes with the amplification of information made possible by AR.

The layered and laddering approach employed in our study has led us to the finding that perceived control or autonomy can drive positive customer experience, which is crucial to individuals with experiential shopping orientation, and this is useful as it concretises the means of which the end of a positive customer experience can be achieved. Based on our interview data and IM, "navigation" is a concrete attribute that was frequently mentioned as a direct relation that drives this sense of autonomy, and practitioners as well as researchers can explore the function of AR navigation or adjacent attributes like virtual buttons to navigate the shopping experience that could lead to users' perceived sense of autonomy or control, which would hence lead to a positive customer experience and gratify the hedonic value of shopping that was found to be important to individuals.

Overall, the experiential orientation as well as the hedonic goals and values that were elicited through the laddering probes used in this study allowed us to interpret AR's affordance of supporting experiential shopping, and gratifying hedonic values of shopping. Through our findings, we propose and interpret that this affordance is driven by AR's interactivity that can lead to users' sense of autonomy and control and an enjoyable shopping experience in general.

AR affordance 2: Providing cognitive shortcuts. While the first affordance discussed stemmed from a hedonic perspective, this is one that is rooted in the utilitarian point of view of shopping as characterised by Babin et al. (1994). Our laddering interview have shown that users engage in rational consumption activities, such as learning about and evaluating a product prior to making a sound purchase decision to avoid resulting in the waste of personal resources such as time, effort and money. As seen in our interview data, the value of maximising personal resources and not wasting these are important values, reflecting the conscientious considerations made by individuals when it comes to shopping in-store. We found that individuals place high importance to efficient shopping (as depicted in **Figure 20**), while also being able to make informed purchase decisions (i.e. through supported product evaluation as seen in **Figure 21** and **Figure 22**). Our interview data suggests that users perceive AR as a means to reduce the time and effort it takes to complete a shopping task, or in other words, to provide cognitive shortcuts.

This "shortcut" affordance of AR can also be seen in the salient AR consequences identified in our qualitative data, such as the acquisition of product knowledge (i.e. product knowledge consequence) that allows for the sound evaluation of products (i.e. product evaluation consequence). Although not as salient as the former two consequences, the cognitive shortcut affordance of AR is also reflected in the consequence of AR of aiding users in their ability to visualise a product that may be packaged, but also in their ability to visualise using the product in the future, post-purchase. As mentioned in the beginning of this thesis, AR's value proposition in brick-and-mortar store lies in its ability to bring virtual, amplified information in stores and onto the physical products. Traditionally, users would have to collect product information through their own means (e.g. browsing on the Internet, searching for customer reviews or images of product use), and this requires time and effort. In this sense, the superimposition of virtual information into physical stores provides a "shortcut" to this, in that users can cut down on the time and effort spent on filling the information gaps that shopping physically can sometimes pose. In addition, the virtual objects such as virtual clothes, or the virtual duplicate of products that may sometimes be unobservable due to products' packaging in physical stores, can help users visualise the product. What is interesting is that participants mentioned that AR can help them "imagine" (i.e. visualise) using this product. This indicates that AR, through its attribute of superimposing virtual objects into our physical, immediate environment, has the ability to reduce the psychological distance between users and the products, providing a construal shortcut.

Regarding construal shortcuts that minimises the psychological distance between consumers and products, similar themes have been investigated in AR literature, particularly in the context of online or e-commerce usages of AR. Heller et al. (2019), for instance, have investigated how users offload the cognitive process of generating mental imagery that fills missing information about products through AR technology, helping consumers build visual maps of potential consumption experiences. Similarly, the “environmental embedding” attribute in Hilken et al. (2017) that is similar to the visual-real integration attribute in our study, was found to lead to spatial presence, which refers to the psychological perception that the product is present in the users’ immediate environment. Both these AR-related processes have a shared underlying theme of AR’s affordance of minimising the psychological distance that spans between users and products, and this is particularly salient in e-commerce or online contexts where the products is not physically available for inspection during the purchase decision-making process. However, our study has shown that this affordance of AR is also relevant to the brick-and-mortar shopping context, especially when products are boxed up.

Nevertheless, as this study highlights the brick-and-mortar retail setting, the cognitive shortcut afforded by AR through AR’s attribute of amplifying information is what sets it apart from online or e-commerce uses of AR. To reiterate, the product information that individuals have access to in physical stores are limited, and are bound to physical spaces, such as the space on product labels or the store racks. Users would thus have to rely on other means to collect additional product information either by asking store personnel or by searching for it through their mobile device. Both ways would require personal resources that were reported to be limited and precious for users. Consistent with prior literature that have advocated for the information amplification consequence of AR (Hilken, 2018; Hoffmann et al., 2022), we found that this is indeed an important attribute of AR and is particularly salient in the context of offline retail, where the acquisition of product knowledge and the process of product evaluation can be enhanced through this attribute of AR. AR thus provides a cognitive shortcut of filling the information gaps that are inherent in brick-and-mortar shopping, with minimal cognitive effort spent by users, thereby maximising their time, effort as well as money too, as they are able to make well-informed purchase decisions.

In sum, drawing from the affordance theory's tenet to argue that goal-directed users perceive technologies in terms of how they can be used, I have employed laddering interviews to elicit the perceived AR attributes and the goals and values important to users, which can be gratified by the elicited AR attributes. In the interpretation of affordances, I drew from established concepts on hedonic and utilitarian values of shopping (Alba & Williams, 2013; Babin et al., 1994; Hirschman & Holbrook, 1982), which were consistently elicited in our user-grounded approach of laddering interviews. The A-C-V paths showed the hedonic and utilitarian value pathways that were both salient in the HVM results, and more importantly, the laddering approach allowed us to have an understanding on the corresponding AR attributes that can lead to the gratification of these values. The approach also gave us the more concrete AR-related consequences that could act as mediators and moderators for these abstract ends to be achieved. From the critical realist perspective, this study have teased out the potential generative mechanisms that explain AR's value proposition in offline retail (i.e. the causal powers that explain how and why AR is valued in offline retail) that are reflected in our AR affordance interpretation that was achieved through the A-C-V laddering data collection and analyses. Staying true to the critical realist research philosophy, however, I maintain that patterns discovered are dependent on contingent conditions, and for us to yield claims and develop theories that more accurately explain the AR phenomena, the patterns and propositions discovered should be tested to affirm or falsify the theorised mechanisms. On this note, the following chapter discusses some propositions taken from this first study to be tested and applied into this thesis's second study.

Chapter 4 An Interlude: Testing Mechanisms from Study 1 in Study 2

"Science is a very human form of knowledge. We are always at the brink of the known; we always feel forward for what is to be hoped. Every judgment in science stands on the edge of error and is personal. Science is a tribute to what we can know although we are fallible."

– Jacob Bronowski

This chapter is a brief one that serves as a foreword to the second study of this thesis. In spirit of the opening quote of this chapter and in close connection to the principles of critical realism, judgments of the truth are prone to error, and the "truth" we observe are changeable and provisional to conjunction of events (Bhaskar, 2008). To understand the nature of causality, there is a need to understand the mechanisms that *generate* these conjunctions of events (i.e. generative mechanisms), or in other words, the structures that frame these tendencies as they interact. For instance, we find that AR affords users cognitive shortcuts through the technology's attribute of amplifying product information, and this is inferred from our interview data where it was found that AR aids in the filling of information gaps when shopping in physical stores, which enables individuals to better make sense of the product and consequently evaluate the product better. If we draw from the critical realist perspective, the relationships observed here are contingent to conditions and structures that may not be observable. What appears to be a positive relationship between amplified product information and increased product knowledge may be contingent to *how* the product information powered by AR is presented. As suggested from prior literature, the different design of how information is presented and its formats can lead to varying cognitive outcomes on the part of users (e.g. Jiang & Benbasat, 2004, 2007). These may likely be the conditions of mechanisms that generate the outcomes or events that we observe in Study 1.

To understand the causal nature of what was observed, to better theorise on the AR phenomenon and to be closer to the "truth" in our scientific endeavour, this thesis employs an experimental approach to identify the conditions that give rise to the AR relationships that we observe. As there are many proposed relationships or propositions found in the former qualitative study, Study 2 will only examine the few that are representative of AR's uniqueness, which were substantiated through the salience of A-C-V factors and their interrelations found, and also through prior literature. The selection of these is discussed in the section below. This is followed by an introduction to the context of the second study of this thesis.

4.1. Findings of Study 1 – Foundations for Study 2

Study 1 has identified two affordances AR: (1) supporting experiential shopping; and (2) providing cognitive shortcuts. The former affordance highlights the recreational perspective of shopping, and the hedonic value of shopping. This is related to the human behaviour that relate to the multisensory, fantasy and emotive aspects of shopping (Hirschman & Holbrook, 1982), and our qualitative data reveals that this is driven by the interactivity attribute of AR. The latter affordance on the other hand, is related to the utilitarian perspective of shopping, where shopping is viewed as a task, in which our data indicated involved conscientious considerations and evaluation that AR's attribute of amplifying product information can assist with, through the integration of virtual objects and digital information into the physical in-store environment.

Affordance potency. Study 2 examines these two affordances of AR by testing whether the use of AR in the physical store setting does indeed appeal to consumers both in terms of its hedonic and utilitarian values. This second study specifically narrows in on two salient AR attributes, namely AR's interactivity and amplified product information attributes, as these two were found to drive the hedonic (i.e. elevated customer experience) and utilitarian (i.e. enhanced product knowledge) consequences respectively, based on our A-C-V pathways data (see **Figure 18).** While the quantitative frequencies of repeated codes from our data analysis have given us insights into the saliency of AR-related factors that were interpreted into AR affordances, the qualitative nuances and descriptions of these A-C-V factors provide a deeper insight into the sub-properties or characteristics to the AR attributes – or in other words, design variations to which may influence the *actualisation* of affordances. This coincides with the concept of affordance potency coined by Anderson and Robey (2017). Affordance potency is based on the argument that "affordances differ in their power or utility to enable user goal achievement", and affordance potency is defined as "the strength of the relationship between the abilities of the individual and the features of the system at the time of actualisation" (Anderson & Robey, 2017, p. 103). Based on this concept, there are different levels of potential for affordance actualisation, and these are dependent on not just users' abilities but importantly related to this thesis, is the state of implemented system features at the time of use. Anderson and Robey (2017) found that affordance potency can be strengthened and weakened depending on the *design* of features or attributes of the system, which ultimately explains whether or not the affordance is actualised. For example, in Anderson and Robey's (2017) case study on a medication administration record system at a hospital, it was found that the potency of its affordance of coordinating care is weakened by the freeform structure and character limit of textboxes in the system. Drawing from these arguments on how the affordance actualisation is influenced by the design of technology features and attributes, I turn to the qualitative insights related to the two salient attributes (i.e. interactivity and amplified product information) that were found to drive the two affordances interpreted in Study 1 (i.e. supporting experiential shopping and providing cognitive shortcuts), to further investigate in Study 2. These are further explained below.

AR design factors. In Study 1, the AR consequence "product knowledge", which is a key element in the AR's affordance of providing cognitive shortcuts, is described as users' ability to "have more in-depth and clearer knowledge of the products, including its uses and potentials as well as an understanding of what to expect of the product". This was found to be driven by AR's attribute of providing amplified virtual information in physical environments. These virtual information were described in our interview data as *interactive, vivid and animated*. In **Section 3.5.1**, where the sub-properties and designs of the AR attribute of such amplified virtual information were discussed (e.g. these are interactive, vivid, animated etc.), it was also discussed that participants also mentioned how these virtual information and/or objects can look *unrealistic or cartoonish* (**see Section 3.5.1**). The visual realism design of AR experiences is, to the best of my knowledge, a design feature that is not investigated in social science literature, particularly in how it affects human behaviour. However, this is elicited in Study 1 to be a design feature that is perceived by our participants. While this design feature was not mentioned frequently, prior studies in computer science (e.g.

Fischer et al., 2005; Lee et al., 2013), that have examined the visual realism design of AR experiences, suggest that this could be a potentially impactful design feature to be investigated in the context of user behaviour, and in the consumer context. On the other hand, with regard to AR's interactivity, which was found to be an attribute driving the hedonic and experiential affordance of AR – several participants from Study 1 also mentioned that AR systems gave users *control* over the information they receive about a product. AR's interactivity attribute allows users to navigate and control the AR content through its haptic functions that mobile devices provide. These qualitative characteristics of AR attributes raises the question of whether the design of these AR attributes would affect the potency of AR's affordances, and what are the mechanisms that can explain this.

Potential mechanisms and mediators. Participant P20 from Study 1 mentioned that he feels that users of AR would be able to be more imaginative with the vivid and interactive information presented, and would "*enlighten me on things that I wouldn't be able to think of [if not for the AR presentation]" and "can help us think out of the box"*. This hints toward some *creativity* elements that may be triggered by AR experiences. To some extent, the *novelty seeking* aspect or the cognitive openness (i.e. thinking outside the box) that Participant P20 of Study 1 have suggested, hints toward the explanatory mechanism that drives individuals to accept or understand product concepts that they were not initially exposed – and this is facilitated through AR technology. There is evidence from prior literature to support this, where the use of AR was found to lead to arousal and stimulation, and features of AR, particularly its interactivity attribute, formed an avenue for novelty and sensation seeking (Park & Stangl, 2020). Furthermore, the qualitative findings of Study 1 also indicate that participants' heightened perceived or sense of control and autonomy in relation to AR's interactivity attribute played a salient role in the emotive AR consequence of enhancing customer experience. This may be where the two AR affordances identified in Study 1 converge, in that the experiential, hedonic affordance of AR technology by which is characterised as creative, playful, as well as controllable, complements the utilitarian affordance of AR that is focused on the cognitive element – in that the positive experiential elements from AR drive cognitive openness that may further enhance consumers' acquisition of product knowledge. Thus, Study 2 examines novelty seeking and perceived controllability as potential mediating mechanisms that can explain the aforementioned affordances.

As mentioned in the problem statement of this thesis in Chapter 1, the context in which AR's potentials can be maximised remains unclear. However, based on our findings that AR can afford consumers experiential shopping and cognitive shortcuts, combined with qualitative data from Study 1 suggesting that AR presentations of products can facilitate consumers' openness to products' possibilities – an interesting question to investigate is whether the two affordances of AR identified in this thesis can be maximised in the context of *unfamiliar* products or products that are initially difficult to comprehend. I explore this in Study 2, linking the findings of Study 1, specifically the AR function of control derived from AR's interactivity attribute (i.e. with AR presentation control feature vs. without AR presentation control feature) and its attribute of superimposing amplified information with virtual items that can be designed in varying visual realism levels (i.e. realistic vs. cartoonised), to a context that puts unfamiliar and difficult-to-understand products at its focus. This context juxtaposes a scenario where the affordances of AR (experiential and utilitarian affordance) are highlighted and represented, allowing us to investigate the features that may affect the actualisation of the identified affordances. AR presentation control feature and AR's visual realism are thus two design features that may result in varying levels of affordance potency, thereby giving us insights into how different design features may affect the actualisation of AR affordances. The following section introduces the business problem that sets the context for this thesis's second study while also clarifying how the investigation of the aforementioned generative mechanism can address a business problem.

4.2. Context of Study 2

After over a hundred of years selling red ketchup to consumers, H.J. Heinz company pivoted suddenly on July 10, 2000, and gave the condiment a colourful makeover. The Heinz EZ Squirt debuted with Blastin' Green ketchup as a promotion in support of the first "Shrek" movie. Below is an extract taken from an online news article introducing the product:

> "After conditioning consumers for 124 years to expect ketchup to be red, the H.J. Heinz company pivoted suddenly on July 10, 2000, and gave the condiment a colourful makeover. The Heinz EZ Squirt debuted with Blastin' Green ketchup as a promotion in support of the first "Shrek" movie" (Simmons, 2020)

EZ Squirt was a new product that featured an innovative ergonomic design for kids with its plastic, squeezable bottle and a narrow nozzle. The launch of the product was timely, coinciding with the premiere of the animated film Shrek, starring a green ogre as the protagonist whom which the movie was named after. The product was initially well-received, but its success was essentially short-lived. In 2011, Business Insider even named Heinz's EZ Squirt Ketchup one of the biggest food flops of all time (Spector, 2011). Many have attributed the fall of EZ Squirt to the inability for consumers to make sense of the product anymore (Glass, 2011; Pang, 2019). As the buzz of the Shrek movie dwindled, consumers could no longer make sense of the product.

Ketchup are made from tomatoes, which are typically red – it therefore made sense that ketchup *should* be red. Without the connection to Shrek the green ogre, green ketchup simply spiralled into being an odd food fad. As the above extract aptly points out, expectations of ketchup being red is hard-wired into our heads, and researchers, such as Jhang et al. (2012) and Noseworthy et al. (2017) have substantiated that the more discrepant an innovation is from conventional expectations, the more likely it is to fail. However, if sensemaking of this discrepancy in expectations is successful, product innovation failures may be avoided – much like how the connection to Shrek was a rationale behind the Heinz's product innovation led to momentary success in the beginning. Thus, it is important for firms to help consumers understand the rationales behind product innovations and thereby become more willing to accept and purchase such products, which may be achieved through product presentations and demonstrations.

In the following chapter, I continue with introducing our second study of this thesis that investigates how AR-powered product presentations can solve this innovation dilemma. I see the significance of this research endeavour in two complementary perspectives – on the one hand, this study's implications can provide insights to addressing the aforementioned innovation dilemma, while on the other, this dilemma and study context is an extreme juxtaposition of a situation where AR's proposed consequence of facilitating product knowledge and understanding is highlighted. The following chapter refer closely to the context and innovation dilemma but in the discussion part (**Chapter 5, Section 5.5),** the findings of this study are elaborated on its broader implications of the AR phenomena, and what it means for the theorisation of AR (**Chapter 6, Section 6.2)**.

Chapter 5 Study 2: Resolving Schema-Incongruity with AR Technology

"The persuasive power of AR lies in its ability to create immediacy and relevance by shifting the loci of control and interaction through situated simulations within the control and environment of the user. Combining visual simulation of data in situ creates and enhances meaning and engagement." – Dr Pam Rutledge

5.1. Introduction

Chapter 4 introduced the risks that some innovations can pose, particularly in how some new product concepts can violate consumer expectations of a product. This creates a dilemma because the value of product innovation has been well-established both in academic literature as well as in practice. The importance of product innovation has been reiterated by a rich stream of literature, particularly its impact on business growth and product performance (Henard & Szymanski, 2001; Utterback & Abernathy, 1975), and companies are continuously pressured to produce innovative products (Gourville, 2006). According to McKinsey, 84 percent of CEOs believe innovation plays a critical role in business growth – yet only 6 percent of CEOs are satisfied with their innovation performance. Further, Schneider and Hall (2011) reported that about 75% of new consumer packaged goods and retail products fail to earn even 7.5 million USD in their first year of launch, which is a low benchmark of a successful launch.

Product innovation is tricky, in that companies need it to stay ahead of the competition, but it is a risky pursuit as failure rates are high. One of the reasons why new products or innovative ideas fail is because it can sometimes violate existing schemas and are incongruent with consumer expectations (Noseworthy et al., 2014). As exemplified by Heinz's "innovative" product, not all product innovations end up with success, especially when the innovative product is highly schema-incongruent. Businesses are trapped in this Catch-22 as innovation necessitates novelty and newness, but at the same time introducing products that deviates radically from established schemas can result in low return of investment at best, and irreparable damage to brand image or reputation at worst.

According to the schema congruity effect coined by Meyers-Levy and Tybout (1989), new products that are extremely incongruent with consumers' schemas or expectations will result in lower evaluations in comparison to those of more congruent products. Subsequent studies have drawn from this theory to identify ways to improve consumers' evaluation and attitudes towards incongruent products, specifically in facilitating consumers' ability to resolve incongruity (e.g. Jhang et al., 2012; Noseworthy et al., 2014; Noseworthy et al., 2017). This study intends to contribute to this stream of literature by focusing on how AR can facilitate incongruity resolution, making this one of the first investigations on how AR technology can be leveraged to assist in this cognitive process. This investigation is also based on the retail context as the retail environment provide an interesting opportunity for such product innovation endeavours, as physical retail stores constitute an important touchpoint for consumers to learn about new products (Burke, 2002). As Fornari et al. (2009) aptly argue, retailers 'filter' product offerings and thus play an important role in the introduction of new products. In addition, Study 1 showed strong indications that AR use in brick-and-mortar facilitates the acquisition of product knowledge through the amplification of information.

AR is a technology that combines two worlds – the *real* world and the *virtual* world. In the virtual space, product information is abundant, ranging from customer reviews to detailed information about products. In the brick-and-mortar store space, on the other hand, information is limited to what we see on product packages and labels. To reiterate, the superimposition of virtual information into in-store environments can mitigate the product information gaps associated with conventional brick-and-mortar retail. As found in our findings in Study 1, the vivid and interactive AR-delivered information allow users to make connections and bridge product knowledge gaps. In this second study, I investigate whether AR-enabled product presentations can assist consumers in making connections between disparate schemas elicited by a schema incongruent product in the same way in the context of brick-and-mortar retail.

I argue that the value of AR for businesses can be ascertained and maximised by examining how the unique properties of AR can be *designed* to achieve meaningful outcomes. This study examines a plausible meaningful outcome that AR technology can facilitate, that is the incongruity resolution of innovative but potentially schema-incongruent products. Against this backdrop, this study investigates the unique attribute of AR, namely the superimposition of virtual objects into real-world environments as an AR attribute, and two specific design elements in relation to this technological attribute – that is the visual realism of virtual items (realistic vs. cartoonised) and the different levels of control (with AR presentation control feature vs. without AR presentation control feature) of an AR product presentation. This study draws from prior findings in extant literature on incongruity resolution, and investigate if this cognitive process can be facilitated by two AR-evoked mechanisms, namely novelty seeking and perceived controllability. This study employs a between-group field experiment involving a schema-incongruent product.

5.2. Conceptual Background and Hypotheses Development

5.2.1 Schema-incongruity resolution

According to Mandler (1981), the level of congruity between a new product and an existing category or schema of the product influences cognitive processing among individuals, which in turn influences their evaluation of the new product. This mechanism can be understood as the schema congruity effect (Meyers-Levy & Tybout, 1989). This concept further explains that information perceived as schema-congruent requires little cognitive processing, and result in the comfort of familiarity. On the other hand, schema-incongruent information demands extensive cognitive processing in order for individuals to make sense of the incongruence and this is usually accompanied by feelings of surprise and unfamiliarity. There is a general consensus from literature investigating schema-incongruent products and resulting consumer evaluations, that when consumers can successfully make sense of an incongruent product, their evaluation of the product are likely to be more positive; whereas if the consumers are unable to make sense of it, their evaluation are likely to be negative (Jhang et al., 2012; Noseworthy et al., 2014; Noseworthy et al., 2017). Thus, making sense of incongruity is critical in ensuring the success of innovative products that may violate existing schemas.

Solutions for increasing incongruity resolution have been investigated in several studies. Noseworthy et al. (2017) investigated the use of feature-based association by incorporating an enabler for incongruity resolution. In the study, a green, vitamin-enriched coffee was used as an schema-incongruent stimulus. It was found that the colour green can help consumers make sense of a semantically-related feature, which is the “vitamin enriched” feature of the perceived incongruent product. The study came to a conclusion that two “wrongs” – the features “green” and “vitamin-enriched” – which were both incongruent with our understanding of coffee, made a “right”, in that matching these two semantically-related feature to an incongruent coffee product, helped consumers make sense of the incongruent feature and led to positive evaluations. In another study, Jhang et al. (2012) tested consumers’ evaluations of incongruent products using strategies related to cognitive flexibility. Instead of using semantic enablers, Jhang et al. (2012) manipulated for cognitive flexibility using positive affect, a future (vs. past) product launch description and the cognitive flexibility prime of generating multiple explanations of a given situation. The authors found that cognitive flexibility increased the likelihood for consumers to make associative links across disparate schemas, therein resolving incongruence and similar to the study by Noseworthy et al. (2017), led to more positive evaluations. Drawing from the concepts and empirical findings in these key studies on incongruity resolution, I investigate how we can leverage AR technology in product presentations to resolve incongruity and enhance purchase intentions as well as actual purchase of schema-incongruent products.

5.2.2 Novelty seeking

I draw from the study by Jhang et al. (2012) that centers on the role of cognitive flexibility and employed several assumptions of the cognitive flexibility concept in this study to investigate AR's potential of facilitating incongruity resolution through similar mechanisms. Cognitive flexibility is defined to be a person's awareness that there are alternatives available at any given situation, as well as his or her willingness to be flexible to adapt to the situation and self-efficacy in being flexible (Martin & Rubin, 1995). The concept this study adopts is one that resonates with such a definition of cognitive flexibility – the concept of novelty seeking.

Cognitive flexibility is often discussed as a mechanism that fosters creativity (Ionescu, 2012), and some even go as far to argue that cognitive flexibility is a necessary component and cognitive core of creativity (Ritter et al., 2012). Novelty seeking, on the other hand, has also found to be linked to creativity, in that higher degree of novelty seeking is associated with higher levels of creativity among individuals and groups (Gocłowska et al., 2019). While cognitive flexibility and novelty-seeking share similar "creativity" undertones, the nature of the two are different in that cognitive flexibility is viewed as an ability (Ionescu, 2012), whereas novelty seeking is related to disposition (Gocłowska et al., 2019). Novelty seeking is concerned with people's propensity and tendency to explore novel and new experiences rather than the ability to (Li et al., 2020). Authors Li et al. (2020) aptly explain the socio-cognitive view to novelty seeking, drawing from the social cognitive theory of personality in a seminal work by Bandura (1999) which emphasises the dispositions and the dynamic nature of these in the shaping of personalities, departing from the view of personality as static traits. In line with these arguments, this study maintains the view that novelty seeking is a dynamic construct that can be induced and facilitated through external factors.

The concept of novelty seeking, in a narrower context of consumption, is explored in an influential work by Hirschman (1980), in which the author describes consumer novelty seeking as the desire for consumers to seek out novel information or stimuli. In examining the constructive purpose of novelty seeking, Hirschman (1980) has proposed that novelty seeking may function as a means of self-preservation. Here, the author explains that a consumer seeks information regarding a product and consumption situations and these are deposited into a "bank" of potentially knowledge for the uncertain future where consumption problems are inevitable. Hirschman (1980) also suggested that these information may include vicarious adoption of unfamiliar product concepts, the vicarious experiencing of unfamiliar consumption situations, the actual adoption of novel products and personal exposure to novel consumption situations. Resonating with the socio-cognitive views on novelty seeking (Li et al., 2020), Hirschman (1980) posits that while novelty seeking is seemingly innate in nature, individuals are *activated* to seek out novel information or stimuli through some motivating force. It stands to reason that by activating the consumer's innate novelty seeking tendency, the consumer is more likely to seek and accept information that are unfamiliar, including incongruent product information. I propose that by activating novelty seeking among individuals in the presentations of products, incongruity resolution can be enhanced, leading to higher purchase intention of the product.

5.2.3 Facilitating novelty seeking with cartoonised AR and AR with presentation control feature for incongruity resolution

The hypotheses development of this study in relation to novelty seeking is based on the assumption drawn from prior literature that novelty seeking is a tendency or disposition that can be activated and facilitated (Bandura, 1999; Hirschman, 1980; Li et al., 2020). Specifically, I investigate how the visual realism and the AR presentation control feature of AR product presentations can lead to or activate novelty seeking, which in turn facilitate incongruity resolution. In this study, visual realism of AR refers to the level of visual realism of the virtual items in the AR experience, and the presence of control feature refers to the haptic functions that allow for the control of these virtual items in the AR experience. These two variables are based on AR's salient attributes of superimposing virtual objects into physical environments and AR's interactivity that were substantiated in the first user-grounded study of this thesis (**Chapter 3**).

Firstly, in relation to the visual realism of an AR experience, the virtual items embedded in an AR experience can range from visually unrealistic, cartoon items (e.g. of fictional characters in AR books) to textual information (e.g. customer reviews), as well as 3D virtual clothes presented in a visually realistic form, like in the Magic Mirror or virtual try-on applications of AR. These were also elicited in the interview data discussed in **Chapter 3.** Interestingly, prior literature on AR in retail have not given much attention to the level of visual realism of the virtual content superimposed into our real-world environments, and on the cognitive processes pertaining to it. Although these have not been investigated in the context of AR, prior studies in advertising have examined the use of cartoons and unrealistic visual content in advertising in relation to cognitive processes. For instance, the work of Smith and Yang (2004) discuss extensively on advertising creativity, and the authors argue that one of the fundamental characteristic of ad creativity is divergence, whereby ads containing elements that are novel, different or unusual are deemed creative. Two factors were included in the list of determinants of divergence: (1) unusual perspective (i.e. seeing things from a different or unusual outlook); and (2) fantasy (i.e. the ability to generate non-real ideas, worlds or creations). Both factors included examples of the use of cartoons in ads, which departed from conventional advertising using real-world elements, suggesting that the use of cartoons can facilitate the effects of divergence. Evidence of this is found in a study investigating the use of cartoon or animated effects of spokespeople in print ads (Heiser et al., 2008). It was found that the use of cartoon spokespeople performed better than photographed spokespeople in terms of consumer advertising outcomes, such as attitude toward the ad, attitude toward brand, as well as the purchase intention of the advertised brand. Heiser et al. (2008) found that the cartoon ads led to these positive outcomes through creativity and distinctiveness effect induced by cartoonised formats of the ad. Drawing from the above arguments and findings, I postulate that the use of cartoonised virtual objects in AR product presentations (in contrast to realistic ones) will be regarded as divergent, distinct and creative, thus activating users' novelty seeking tendencies, which will lead to incongruity resolution.

Secondly, AR is characterised as an interactive technology, afforded by its objective feature of AR presentation control, particularly with its synchronicity in user input and feedback through its interface (Javornik, 2016a). The first study has also found that interactivity is a central attribute of AR. Users are able to access different content and interact with the interface through this feature of AR. Interactivity is a broad construct investigated in many studies on digital technologies, and AR is no exception (Park & Yoo, 2020; Yim et al., 2017). However, this study is concerned with the controllability dimension of the interactivity construct (Park & Yoo, 2020; Zhao & Lu, 2012), and thus adapt the definition from Fortin and Dholakia (2005) that highlights the controllability dimension of interactivity, as it relates closely to this study. The term *AR presentation control* is used in this study to refer to the objective control feature that allows users to access information on demand where the content, timing and sequence of the information received are under the control of the end user, in contrast to a broadcast basis (Fortin & Dholakia, 2005).

A similar technology attribute termed “navigability” was examined, corresponding to the wider construct of interactivity, in a study on the impacts of website design attributes on flow experience and web performance (Huang, 2003). In Study 1, our results have also shown that navigation was an attribute that was frequently elicited as an important attribute of AR, and though not directly equivalent to the navigability construct discussed in Huang (2003), there are elements in the meaning of these two attributes that highlight the ease of going from one point to another in a contextual space. The navigability construct discussed in Huang (2003) captures the same understanding of this second study’s AR presentation control variable, where the term navigability is described to be the degree to which users have “unrestrained connectedness” that allows them to navigate from one point to another in the web experience (Huang, 2003, p. 428). While this attribute was not tested specifically, it was investigated as a dimension of the wider construct of interactivity, which was found to have a direct positive impact on *curiosity, a concept closely related to novelty seeking* (Collins et al., 2004). Curiosity and novelty seeking share an emphasis on intellectual inquisitiveness and cognitive processing of information, and the behaviour of seeking novel stimuli is argued to be an overt expression of curiosity (Berlyne, 1954). In the survey used to test the relationship between the construct of interactivity wherein the dimension of navigability (which I treat as synonymous to AR presentation control) is assumed (Huang, 2003), participants were asked to rate whether navigating the website triggered and aroused their curiosity. It was found that there was a significant relationship between interactivity, which includes the dimension of navigability, and curiosity. Drawing from the assumptions of controllability as a defining dimension of interactivity and empirical evidence of its relation to curiosity, I speculate that AR product presentations designed to be controllable by its users would have similar effects in enhancing novelty seeking in the same way that interactivity attributes of a webpage was found to have positive impacts on user curiosity, which would lead to positive outcomes in incongruity resolution and subsequent purchase intentions.

I summarise our conjectures in the below hypotheses in relation to the novelty mechanism of this study:

H1: *Novelty seeking facilitates incongruity resolution.*

H1a*: Novelty seeking tendencies is more enhanced for product presentations with cartoonised AR visuals compared to realistic AR visuals.*

H1b*: Novelty seeking tendencies is more enhanced for AR product presentations with AR presentation control feature compared to AR product presentations without AR presentation control feature.*

5.2.4 Perceived controllability

In addition to novelty seeking, this study seeks to shed light on how perceived controllability can also lead to increased incongruity resolution of schema-incongruent products. While similar in terminology, perceived controllability is a different construct from the AR presentation control feature of this study. The AR presentation control feature variable is a concrete attribute of AR, whereas perceived controllability is a psychological mechanism that is hypothesised to lead to incongruity resolution, which I propose can be driven by the two design properties of AR that is the visual realism and the control feature of the AR product presentation.

Concepts related to perceived controllability has been widely examined across the IS discipline in studies on a multitude of technologies such as online customer decision support systems (Kamis et al., 2008), virtual worlds (Lee & Chen, 2011) and social networking sites (Hajli & Lin, 2016). This study adapts the definition used in Kamis et al. (2008) which draws from the environmental psychology perspective of the dominance construct, defined as the feeling of being unrestricted and free (Mehrabian & Russell, 1974). This sense of control or dominance as delineated in this study's perceived controllability construct is in direct opposition of feelings of frustration and confusion when interacting with AR systems. Perceived controllability in this study can be understood as an affective perception by individuals associated with the level of control over their environment and their actions (Kamis et al., 2008).

According to Jhang et al. (2012), positive affect fosters cognitive flexibility, as it was found in their study that participants who were primed to experience positive affect made more sense of an incongruent product than those who were not. In the same vein, I suggest that the positive affect associated with individual's perceived controllability of AR product presentations can have an impact on the cognitive process of incongruity resolution. The process-based account of incongruity resolution also provides support for our conjecture of the role that perceived controllability plays in incongruity resolution. Jhang et al. (2012) speculated that there may be a difference in whether incongruity resolution is self-generated or externally prompted. The latter would, for example, include message-driven approaches, such as the provision of rationales or explanations of why incongruity exists in advertisements. Proponents of the process-based account reason that the process of resolving the incongruity achieved by oneself would result in a stronger positive affect than if the individual took on a more passive role, wherein the "insight" to the incongruity is given externally. Based on these arguments, it is plausible that individuals' sense of control over the cognitive process of making sense of the product is a key driver that leads to this stronger positive affect that would then result in higher incongruity resolution. Further, there is empirical evidence that complements the role of individuals' perceived controllability in the process-based account of incongruity resolution, where it was found that individuals with strong beliefs that outcomes depend primarily on their own actions are more likely to "cope with new usage situations, and to challenge and appreciate improvements in existing products", while those with low control beliefs, tend to avoid new and difficult situations (Schreier & Prügl, 2008, p. 337). I draw from these arguments to propose that individuals with higher perceived controllability are more likely to resolve incongruity.

5.2.5 Enhancing perceived controllability with cartoonised AR and AR with presentation control feature for incongruity resolution

In addition to their roles in facilitating novelty seeking, this study examines the influence of the visual realism and AR presentation control feature design properties of AR on perceived controllability and its subsequent effects on incongruity resolution and consequently, purchase intentions of schema-incongruent products. I posit that by making specific design choices with regards to these two elements in AR product presentations, individuals' sense of control can be enhanced.

Rich literature in the computer science discipline have reported the improvements in technologies and visualisation techniques such as in 3D modelling and rendering (Abu Alhaija et al., 2018), localisation and mapping of synthetic elements into real scenes with high accuracy and in real time (Marchand et al., 2016), as well as superior graphics (Whelan et al., 2016) – all of which have made the insertion of virtual objects into real environments increasingly seamless. In particular, high degrees of visual realism of the virtual objects, defined to be "the degree to which the images of the simulated world are perceived to be real by the users" (Lee et al., 2013, p. 548), are becoming increasingly possible in AR applications, owing to technological advancements. However, these virtual items' high fidelity to reality can be a source of confusion for users. Fernandes et al. (2015) tested participants' ability to recall and distinguish virtual versus real objects after viewing virtual objects in an AR experiment. In the experiment, participants viewed objects in a virtual form or a physical, 3D-printed form and they were later requested to view photographs of each object and judge whether they had formerly seen it as a physical or virtual object. Only 60% of the participants correctly identified the real/virtual format of objects (Fernandes et al., 2015). In a separate study on virtual worlds, Lee and Chen (2011) adapted the landscape preference model proposed by Kaplan and Kaplan (1989) to examine the design patterns in relation to how users use environmental cues to process information and conduct themselves effectively and pleasantly. A key concept in this model is the concept of making sense, referring to individuals' ability to keep one's bearings and to comprehend the immediate environment as well as in the larger, more abstract world (Kaplan & Kaplan, 1989; Lee & Chen, 2011). Lee and Chen (2011) highlight the coherence factor with regards to the making sense concept, which can be understood as the perceived structure of the environment that includes elements that allows users to easily characterise the environment. In the case of the virtual world, this coherence factor is encapsulated by the capability "to provide consistent and orderly contents, structures and multimedia component within and across sites" (Lee & Chen, 2011, p. 276). It is found that the coherence factor in their study significantly influences users' perceived controllability of the virtual world.

In the case of AR environments, the characterisability of the real and the virtual could play an important role in perceived controllability of users. The ability for users to distinguish and categorise what is real and what is virtual in an AR experience may enhance their sense of control in the AR experience. As the study by Fernandes et al. (2015) indicates, realistic designs of virtual items can interfere in the "making sense" process explained in the landscape preference model as the virtual objects superimposed in the real environment is no longer *coherent* with users' expectations of what is virtual (i.e. unrealistic and distinguishable from the real). It is plausible that this may decrease users' perceived controllability of the AR environment. In logical opposition to this, low realism of virtual objects may increase users' perceived controllability in an AR experience, and one way to lower the visual realism of virtual items is to design cartoon versions or renderings of the virtual objects used in AR applications.

In addition to using cartoon designs with low visual realism of virtual objects in AR product presentations to enhance users' perceived controllability, an overt way to achieve higher levels of perceived controllability is to provide users with functional control of the AR product presentation. With the ability to bring digital and virtual information into our physical world, AR technology breaks down the limits of the physical world and brings forth an unlimited space for product information for brick-and-mortar stores. However, the abundance of information poses the danger of information overload, whereby users are being confronted with too much information that could result in feelings of confusion and loss of control. Control features presented as a design aspect in AR product presentations can afford users the ability to choose the information that serve their interests and needs. Several studies have shown the benefits of information control features and users' involvement in the access of information with regards to alleviating information overload and its resulting negative effects (Häubl & Trifts, 2000; Liang et al., 2006). AR's synchronous interface in user input and feedback, allowing for the controllability of AR product presentations, may lead to a higher perceived control, which may enhance incongruity resolution and thus, purchase intention of schema-incongruent products.

Based on the arguments presented in relation the mechanism of perceived controllability above, this study proposes the following hypotheses:

H2: *Perceived controllability facilitates incongruity resolution.*

H2a: *Perceived controllability is more enhanced for product presentations with cartoonised AR visuals compared to realistic AR visuals.*

H2b: *Perceived controllability is more enhanced for AR product presentations with AR presentation control feature compared to AR product presentations without AR presentation control feature.*

5.2.6 Incongruity resolution, purchase intention and actual purchase

Drawing again from Mehrabian and Russell's (1974) work in environment psychology, individual emotions such as pleasure, arousal and dominance are important determinants of behaviour. Studies investigating the influence of consumer emotions and mood on behaviour have provided evidence for this account, where pleasurable emotion and positive mood were found to be positively related to purchasing and shopping behaviour (Sherman et al., 1997; Spies et al., 1997). Successfully resolving schema discrepancies can result in a positive affect accompanied by the "lightbulb" or "Oh, I get it!" response that works similar to a psychological reward mechanism (Mandler, 1981; Meyers-Levy & Tybout, 1989). This positive affect or emotion as a result of incongruity resolution may increase behavioural intention as suggested in prior literature. The findings in Abolhasani and Golrokhi's (2021) study on musical incongruity resolution supports this hypothesis, as the authors found that resolving incongruity positively influenced participants' purchase intention. I argue that the strong positive affect from the reward-like mechanism of incongruity resolution provides a strong basis for behaviour, so much so that they are willing to purchase the source of incongruity. Hence, I propose that:

***H3:** Incongruity resolution is positively associated with purchase intention of schema-incongruent product.*

This study also examines the actual purchase behaviour of schema-incongruent products. Ajzen's (1985) theory of planned behaviour have been extensively used in information systems literature to predict behaviour in relation to technology use (Mathieson, 1991), as well as in marketing literature to predict purchase behavior (Kalwani & Silk, 1982). The theory is based on the premise that behaviour is planned, and that the likelihood of an individual engaging in a behaviour is related to the strength of the individual's intention to engage in that behavior (Ajzen, 1985). According to Sheeran and Webb (2016), the realisation of intentions is more likely when intentions are easier to perform. In the context of this study, the setting is immediate, in that individuals are able to purchase the schema-incongruent product right after experiencing the AR product presentation in a brick-and-mortar store. Furthermore, the basis or formation of intentions is argued to influence whether intentions are realised as well (Sheeran & Webb, 2016). This study contends that incongruity resolution is a pertinent driver that leads to the formation of strong intentions for purchase. It would stand to reason that individuals with strong intentions would be strongly driven to act on their intentions. Hence, I formulate the below hypothesis:

***H4:** Purchase intention of schema-incongruent product is positively associated with actual purchase of schema-incongruent product.*

5.3. Experiment Design

To test the above hypotheses, I, together with a team of four research assistants, conducted a field experiment using different AR designs of a product presentation to introduce a schema-incongruent product. The schema-incongruent product stimulus used in the experiment is a food product that has been found to be schema-incongruent as reported in mainstream media (see **Section 5.3.1**). The experiment was conducted at a small grocery store located at our university campus's student living area that sells both packaged and fresh food products. The store owner agreed to provide us access to the store as a field experiment site.

While there was the option of conducting the experiment in a laboratory setting, I chose to conduct a field experiment because I believe that a field experiment would help us achieve higher ecological validity, in that it would allow me to replicate a retail experience that is as close to a natural retail setting as possible. When recruiting participants, we introduced this experiment ambiguously as a study on consumer feedback regarding a new product that was added into the store. In doing so, participants were less likely to guess the focus of the research or of the AR design manipulations used in the different treatment groups, which may affect their behaviour. The experiment design and data collection procedure was approved by the Ethics Committee of the university [16].

[16] Ethics committee approval is provided in **Appendix G**.

5.3.1 Stimulus selection

To further enhance external validity, the incongruent product stimulus selected for this study was a real product, JUST Eggs. JUST Eggs is a product of Eat Just, a California food technology start-up that offers plant-based alternatives to conventional egg products (Crunchbase, 2022). JUST Eggs are made entirely from plants and contrary to the name of the product, contains no actual, animal eggs. The product is in liquid form and stored in a bottle. While the product is claimed to be a safer and more sustainable alternative to conventional eggs (Piper, 2020), consumers have expressed scepticism regarding this feature of the product.

In an online article, Thompson (2019) wrote the following:

> *"I cracked open a bottle [of JUST Eggs] in the morning and was admittedly hesitant. I love eggs for breakfast, but something about eating eggs poured from a bottle has never appealed to me – even from a bottle of real eggs. Here, I was diving into the unknown world of mung bean eggs."*

The initial hesitation described by Thompson (2019) was caused by what can be understood as feature-based incongruence, as have been pointed out in the study by Noseworthy et al. (2017), in which the incongruent product stimulus used was green coffee. Green coffee was incongruent because the feature (colour) green is incongruent with our schema of coffee colours, which are typically black or brown. As the quote above aptly highlighted, eating eggs poured from a bottle is something Thompson (2019) found unappealing. In the same way that the green colour feature was mismatched with our schema of coffee, the feature of eggs being stored in a bottle was incongruent with our schema of eggs, which would assume that eggs are retrieved naturally from an oval shell. Thus, this product is deemed to be an appropriate stimulus for this study as it captures the conceptual understanding of schema incongruence indicated in prior literature.

Additionally, this product is still relatively new to China where the experiment data was collected. According to Mucerino (2021), JUST Eggs has just entered the Chinese market in 2019. It has been reported that Chinese authorities are considering healthier and safer animal-free protein sources, especially following the coronavirus outbreak in China that was allegedly traced to Chinese wet markets where freshly slaughtered and unpackaged meat were sold (Shanker, 2020). However, food market report shows that although the pandemic had a disruptive impact of meat consumption in the country, the country's appetite for meat generally continues to increase, and China remains to be the world's largest consumer of meat (CB Insights 2021), and the leader in chicken egg consumption (IndexBox, 2021). In this regard, using this product as this experiment's stimulus is also meaningful in that we can see how AR technology can be designed to lead to higher acceptance of innovative products that are beneficial to consumers and the society, but are at risk of negative evaluations due to its schema incongruity.

5.3.2 AR product presentation design manipulations

Drawing from prior studies on cartoon effects in conventional print advertisements (Heiser et al., 2008), I took original advertising materials such as promotional videos, images and nutritional information from JUST Eggs website and their official YouTube channel and digitally modified these to vary the execution of cartoon-realistic effect on the AR presentation (see **Figure 23**). For the AR presentation control feature manipulation, we varied between the presence and absence of four buttons that allowed users to: (1) play/pause; (2) skip segments; (3) go back to previous segment; and (4) go back to start (see **Figure 24**).

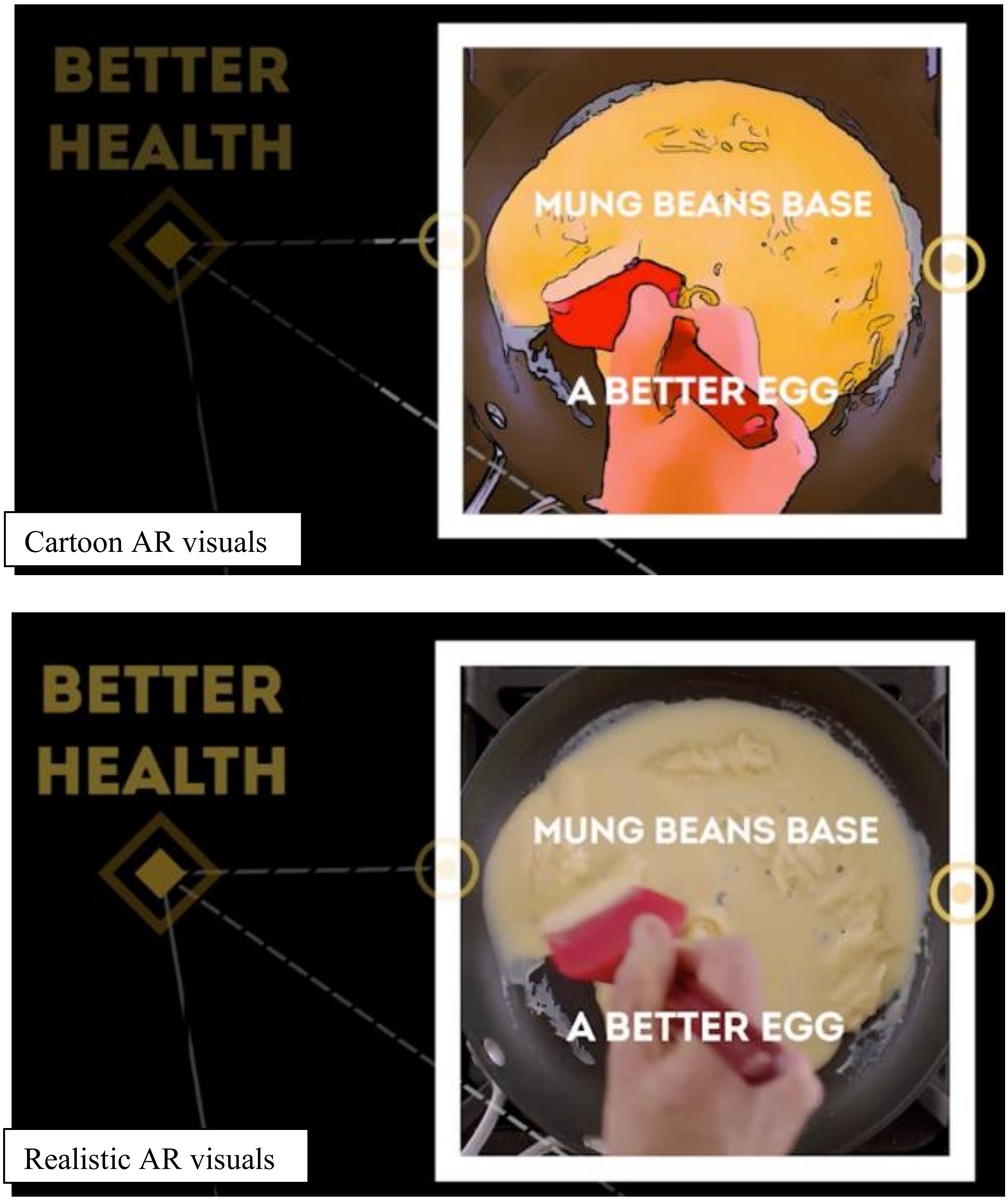
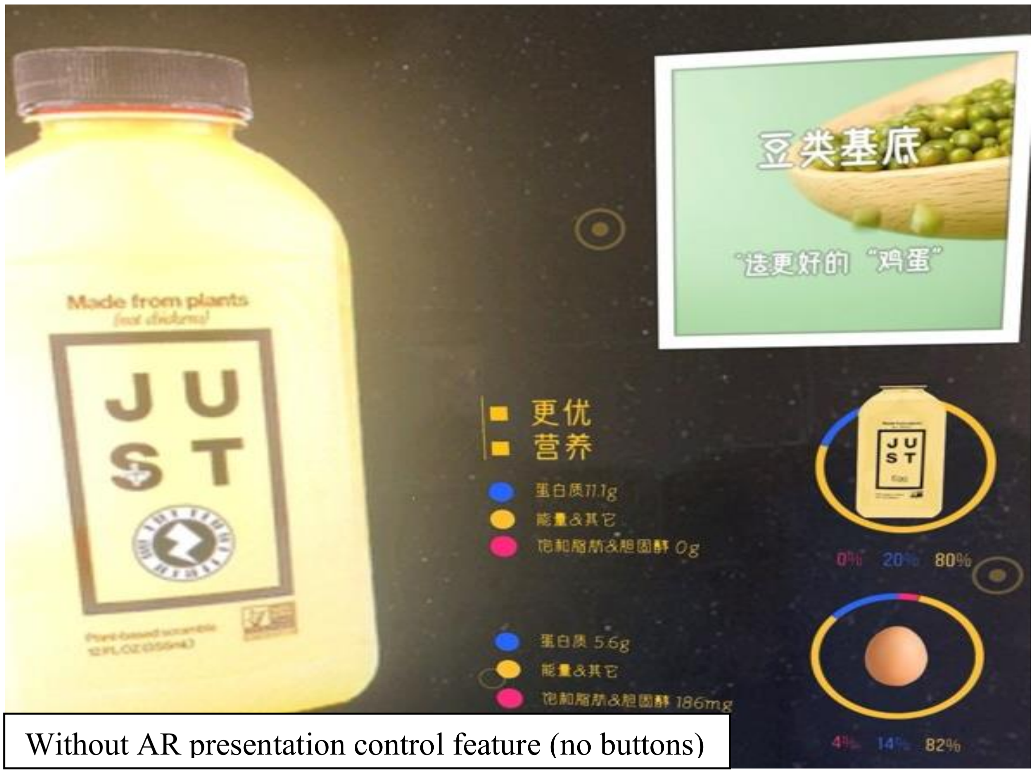


Figure 23 AR cartoon-realistic visual manipulations

With AR presentation control feature (buttons)



Without AR presentation control feature (no buttons)

Figure 24 AR presentation control feature manipulation with the presence and absence of buttons

With these, there are four versions of AR product presentations that make up our 2 (AR realistic vs. AR cartoonised) x 2 (AR with AR presentation control feature vs. AR without AR presentation control feature) between-group design. An AR presentation of one of these four versions would appear when the participants scan a sticker code that is stuck onto the product, corresponding to their assigned treatment group (see **Figure 35**). The content and information of all four versions of the product presentation are kept consistent with only the cartoon-realistic effects and presence of buttons as design manipulations.

Figure 25 Mock-up of product stimulus with QR code that triggers AR product presentation

5.3.3 Participants

Undergraduate and master's students from within the university were recruited to be participants for this field experiment. University students were chosen as participants for two reasons. Firstly, the grocery store that agreed for us to use their space as our experiment store is located in the university campus's student living area and having student participants living in close vicinity to the experiment site would greatly reduce the likelihood of participants dropping out of the experiment. Secondly, AR is a relatively new technology, and it has been found that users of AR applications tend to be young and educated (Olsson & Salo, 2011). Thus, student participants were deemed as an appropriate population for our sample.

Participant recruitment advertisements were circulated on Chinese social media platform, WeChat and on an online forum for students from the university that is operated independently by the university's students. The study was introduced as a study on consumer evaluations regarding a new product at the campus's grocery store. The advertisement also stated that participation of this study consists of two parts. The first involves a pre-experiment survey, where participants are required to fill in an online survey a week before the experiment. The second is the field experiment part whereby participants must meet the requirements of the survey in order to join. Participants must complete both parts in order to receive the remuneration of 80 RMB. In total, 197 subjects participated in the experiment. They were randomly assigned into one of the treatment groups.

5.3.4 Pre-experiment survey

The pre-experiment survey was designed to resemble an online quiz, in which students were be required to watch 3 videos that shows the use of AR in retail and product packaging. Each video was less than 1.5 minutes long, and was followed by 3 multiple-choice questions, 9 questions in total. Students were required to answer at least 7 out of the 9 questions correctly in order to proceed to the field experiment part of the study. The questionnaire is provided in **Appendix H**.

This pre-experiment survey is aimed to eliminate any novelty effects of AR that can produce noise to the study. It is taken into consideration that AR is still a relatively new technology to some participants, and the novelty of the technology may influence the participants' behaviour when they are exposed to the technology during the field experiment stage. With this quiz survey, participants would watch the video attentively to obtain at least the minimum score. The questions in the survey were simple and were not phrased to be directed at AR technology (e.g. "In the video, the user scanned a code on a product to start the game. What was this product?"). Participants were allowed to make unlimited attempts until they get the required score.

5.3.5 Field experiment procedure

After the completion of the pre-experiment survey stage, the participants are allocated into the 4 treatment groups. There were 72 time slots, and each slot was assigned a maximum of 4 participants, and all participants within a slot received the same treatment (i.e. one slot, one treatment group). Participants were assigned a slot depending on the treatment group that they were randomised into. The rationale for having a single treatment within one time slot instead of different treatments within one slot is to minimise the risk of participants guessing that there are different treatments being administered in this experiment.

On the week of the experiment, I conducted a briefing and training to the team of four research assistants employed to assist with the logistics and participant communication of this experiment. They were given a script that described in detail of the procedure of the experiment and their corresponding tasks so that they can execute the procedures in a standard way. Throughout the experiment, the research assistants would act in the role of a store assistant. The research assistants were informed to ensure that there is minimal interaction between participants and to only introduce the stimulus as a new product introduced in the store. They were told about the different treatments being administered in different time slots and to be discreet when they switch the QR codes on the product at the end of each time slot (each treatment administration) for the next one. They were also trained to use the web scanner so that they can assist with any questions regarding the use of the scanner should it arise during the experiment.

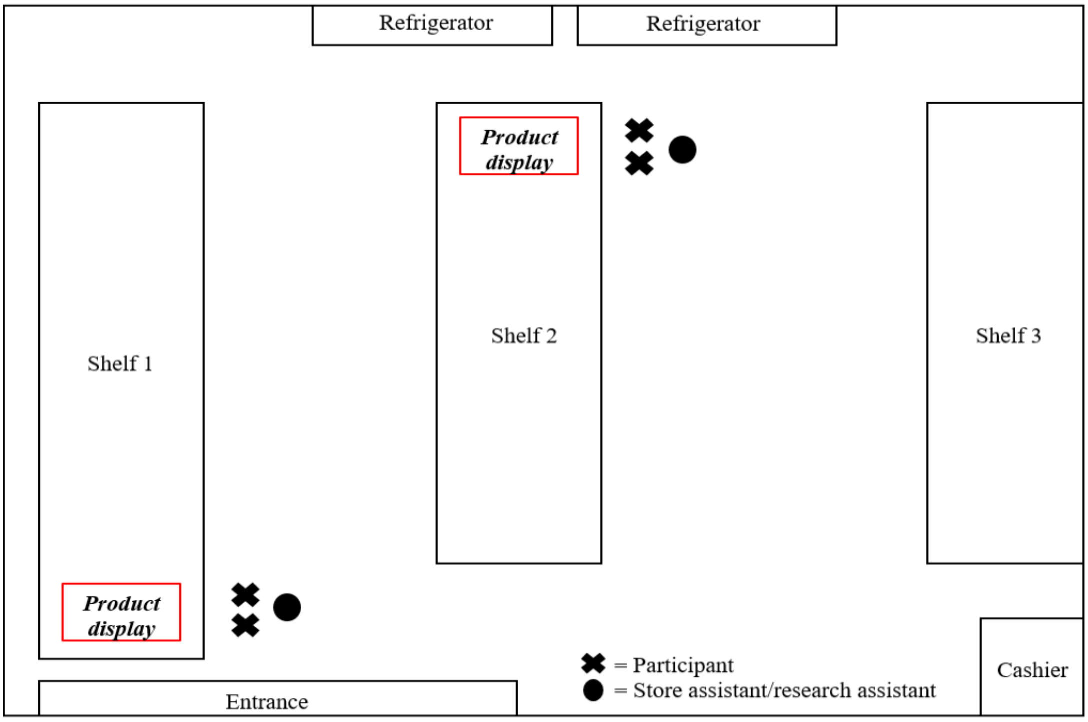


Figure 26 Field experiment site's store layout

For the participants, the students who signed up for the experiment were informed of their participation time slots via email, together with directions to the grocery store on campus. The students were also told that the experiment will be held in this grocery store. A research assistant in the experiment team was tasked to address all enquiries from participants about the on-site experiment. When students arrived at the store, they were invited into the store to view a new product (the stimulus) promoted in the store. The students went in either alone or in a pair (a maximum of 4 participants at a time) and were led into the store by one of two store assistants (one assistant attending 1 to 2 participants). The store assistant led them to one of two corners of the store where the product was displayed as shown in **Figure 26** above. This was to ensure that the store assistants, who were research assistants, were able to monitor the students attentively and make sure they do not interact with each other.

The store assistants introduced the product stimulus as a new product that has just been introduced to the market and in the store, and there was a printed poster next to the products with the very basic information of the product, including what the product is (plant-based eggs), its nutritional information and promotional price (see **Figure 27**). The students were given some time to look at the product and the poster. After a few minutes, the store assistants requested for the student participants to complete an online questionnaire about students' demographic characteristics, including age and gender, as well as their product knowledge and brand familiarity (see **Table 9**).

Figure 27 Mock-up of product promotion poster

Table 9 Overview of variables and measurement items for pre-treatment questionnaire

Variable		Item/Scale
Product knowledge (self-developed)	(1-Strongly disagree; 7-Strongly agree)	
	PK1	Before being introduced to this product today, you were familiar with other products that are similar to the product presented.
	PK2	The product presented is new to you. (R)
Brand familiarity (self-developed)	(1-Strongly disagree; 7-Strongly agree)	
	BF1	Before being introduced to this product today, you were familiar with the brand presented.
	BF2	The brand of this product is new to you. (R)

R = reverse code items

After the completion of the first questionnaire, the store assistants asked participants to scan a QR code that leads them to a webpage. The webpage opened a web scanner that participants used to scan the QR codes on the product stimulus, which triggered the AR product presentation according to their assigned treatment group. The participants viewed or interacted with (if they were in the with-AR presentation control feature groups) the AR product presentation for 3 to 5 minutes. Pictures capturing these procedures can be found in **Appendix I**. When the participants no longer wanted to view or interact with the AR product presentation, the store assistant asked if they would like to pre-order the product at their own cost. The participants were reminded that this would be outside of the participation remuneration of this study and that they had no obligation to purchase the item. Pre-orders here were the objective measure of actual purchase for this study. Finally, the participants were asked to fill in the post-treatment online questionnaire that included the manipulation checks, and measurements of the investigated constructs (see **Table 10**). All constructs were measured using validated items from prior literature as indicated in **Table 10**, except for prior product and brand knowledge measured in the first questionnaire, as well as the manipulation checks in second questionnaire. Minor changes in phrasing and wording were made to fit the investigation context.

Table 10 Overview of variables and measurement items for post-treatment questionnaire

Variable	Item/Scale	
Visual realism of AR (self-developed)	(1-Strongly disagree; 7-Strongly agree)	
	RE1	The visual content in the product presentation are realistic.
	RE2	The visual content in the product presentation look lifelike.
AR presentation control feature (self-developed)	(1-Strongly disagree; 7-Strongly agree)	
	CO1	There are options for me to control the playing of parts of the product presentation content.
	CO2	There are functions for me to control how the product presentation content is to be played.
Perceived controllability (Park & Yoo, 2020)	(1-Strongly disagree; 7-Strongly agree)	
	PC1	I felt that I had a lot of control over my experiences when viewing the product presentation.
	PC2	During the product presentation, I could choose freely what I wanted to see.
	PC3	I am confident I can control the product presentation.
	PC4	I feel a lot of personal control over the product presentation.
	PC5	What I viewed was entirely up to me.
	(1-Strongly disagree; 7-Strongly agree)	
	At the moment, what would best describe your current state?	

Novelty seeking (Manning et al., 1995)	NS1	I am willing to seek out information about new products.
	NS2	I am willing to be exposed to information about new products.
	NS3	I am willing to look for new products and services.
Incongruity resolution (Jhang et al., 2012)	(1- Makes no sense; 7-Makes sense)	
	IR1	How does this product make sense to you?
	(1-Strongly disagree; 7-Strongly agree)	
	IR2	I understand the logic of this product.
Purchase intention (Bues et al., 2017)	(1- Very unlikely; 7-Very likely)	
	PI1	Would the purchase of the demonstrated product be more likely or less likely given the presentation shown?
	PI2	How likely will you purchase this item in the future?
	PI3	Given the presentation, how likely is it that you would consider the purchase of the presented product?
Need for change [a] **(Wood & Swait, 2002)**	(1-Strongly disagree; 7-Strongly agree)	
	Generally, your friend and/or family would describe you as a person who…	
	NCH1	Always likes introducing new things to friends.
	NCH2	When seeing a new or different brand on the shelf, you would often pick it up just to see what it is like.
	NCH3	Often reads the information on product packages just out of curiosity.
Need for cognition [a] **(Lins de Holanda Coelho et al., 2018)**	(1-Strongly disagree; 7-Strongly agree)	
	Generally, your friend and/or family would describe you as a person who…	
	NCOG1	Prefers complex problems more than simple problems.

	NCOG2	Likes to have the responsibility of handling a situation that requires a lot of thinking.
	NCOG3	Would rather do something that requires little thought than something that will challenge my thinking abilities. (R)
	NCOG4	Enjoys tasks that involve coming up with new solutions to problems.
Health consciousness [a] (Chen, 2009)	(1-Strongly disagree; 7-Strongly agree)	
	Generally, the following statements apply to you:	
	HC1	I consider myself very health conscious.
	HC2	My health is so valuable to me that I am prepared to sacrifice many things for it.
	HC3	I often ask myself whether something is healthy for me.
Dietary group attitude [a] (Povey et al., 2001)	(1-Strongly disagree; 7-Strongly agree)	
	Generally, you…	
	DGA1	Consciously avoid eating meat.
	DGA2	Do not enjoy eating meat.
	DGA3	Intend to have a vegetarian or vegan diet in the future.
Food variety seeking [a] (Van Trijp & Steenkamp, 1992)	(1-Strongly disagree; 7-Strongly agree)	
	Generally, the following statements apply to you:	
	FVS1	Usually, when I eat out, I like to try unusual items, even if I am not sure I would like them.
	FVS2	I think it is fun to try out food items that one is not familiar with.
	FVS3	I am curious about food products I am not familiar with.

[a] = control variables
R = reverse code items

5.4. Analyses and Results

Out of the total 197 subjects participated in the experiment, 188 valid questionnaires were received, and 34 pre-orders were made at the end of the experiment. Subjects who did not complete the questionnaires were removed from subsequent data analysis. To check the extent of response bias, subjects who did not complete the entire experiment were treated as the no-response group and the non-respondents were compared to the response group based on users' gender, product familiarity and brand familiarity. The results indicate no significant differences between the two groups. Randomisation checks that included gender, health consciousness, dietary group attitude, food variety seeking, product knowledge, brand familiarity, need for change, and need for cognition information collected in the questionnaires found no significant differences across the treatment groups ($p > 0.10$ for all, except $p > 0.05$ for food variety seeking).

Independent sample t-tests were conducted to confirm the manipulations of the independent variables. Results show a significant difference between the means for different levels of realism of AR ($t(186) = -2.37$, $p < 0.05$). Respondents in the realistic visual condition perceived the level of visual realism to be higher (n = 92, M = 5.56, SD = 1.06) than respondents assigned to the cartoonised visual condition (n = 96, M = 5.19 SD = 1.09), indicating that the visual realism of AR was successfully manipulated. We also found a significant difference between the means for with- and without-presentation control feature ($t(186) = 10.07$, $p < 0.01$). Respondents in the without presentation control feature condition perceived AR presentation control feature to be lower (n = 97, M = 3.90, SD = 1.41) than respondents assigned to the with presentation control feature condition (n = 91, M = 5.64, SD = 0.89). Hence, the presentation control feature manipulation was successfully manipulated.

The reliability and validity of the focal constructs in this study were examined. Cronbach's alpha for novelty seeking, perceived controllability, incongruity resolution and purchase intention was 0.79, 0.90, 0.60 and 0.88 respectively. These results indicate adequate internal consistency reliability for the four constructs. Next, the exploratory factor analysis (EFA) was conducted to assess the constructs' convergent and discriminant validity utilising the principal components method with Varimax rotation. The EFA consistently provided four factors. The loadings of items on their corresponding factor were higher than 0.75, higher than loadings of other items on this factor, and higher than loadings of these items on the other factors within the rotated component matrix. Finally, average variances extracted (AVEs) for novelty seeking, perceived controllability, incongruity resolution and purchase intention were 0.67 and above, demonstrating convergent validity (Fornell & Larcker, 1981). All square roots of AVEs were greater than the corresponding correlations. This confirms that discriminant validity is achieved. Below **Table 11** shows the descriptive statistics of the novelty seeking and perceived controllability constructs according to the AR design conditions.

Table 11 Means and standard deviation of novelty seeking and perceived controllability

Variables		Novelty Seeking		Perceived Controllability	
		M	SD	M	SD
Visual realism of AR	Cartoonised	6.11	1.00	4.16	1.42
	Realistic	5.76	1.22	4.14	1.19
AR presentation control feature	With	6.13	0.99	4.63	1.21
	Without	5.76	1.23	3.70	1.25

5.4.1 Effects of visual realism of AR and AR presentation control feature

First, the univariate analyses of variance (ANOVA) was performed to test the effects of the design features manipulated and investigated in this experiment study (i.e. H1a, H1b, H2a and H2b). Gender, age, product knowledge and brand familiarity were input as covariates for the ANOVA. As shown in **Table 12**, there are significant main effects of visual realism of AR ($F = 5.34$, $p < 0.05$) and AR presentation control feature ($F = 6.03$, $p < 0.05$) on novelty seeking in support of H1a and H1b; we also found significant main effects of AR presentation control feature on perceived controllability ($F = 26.25$, $p < 0.01$) in support of H2b, but insignificant effect for visual realism of AR on perceived controllability ($F = 0.05$, $p>0.1$). Thus, H2a is not supported. No significant two-way interactions were found between the treatments.

Table 12 ANOVA results for treatment effects

Treatment Variable	Novelty Seeking			Perceived Controllablity		
	Df	**F**	**Sig.**	**Df**	**F**	**Sig.**
Visual realism of AR	1	5.34	0.022**	1	0.05	0.823
AR presentation control feature	1	6.03	0.015**	1	26.25	0.001***
Visual realism x Presentation control feature	1	0.17	0.679	1	0.01	0.978
Covariates						
Age	1	0.14	0.713	1	0.01	0.988
Sex	1	1.83	0.178	1	1.60	0.207
Product knowledge	1	2.96	0.087*	1	2.73	0.100
Brand familiarity	1	0.78	0.379	1	4.07	0.045**
Model	7	2.32	0.027**	7	6.10	0.001***
Root MSE	1.104			1.204		
R-squared	0.083			0.193		

Notes: *p<0.10, **p<0.05, ***p<0.01

5.4.2 Path leading to purchase: Structural model analysis

As discussed in the hypotheses development of this study in **Section 5.2**, I argued that the AR presentation design components, namely its visual realism and its control feature, can enhance users' novelty seeking and perceived controllability, which in turn facilitate incongruity resolution that can promote the purchase of innovative, but schema-incongruent products. The confirmation of a measurement model allows us to access the structural model and obtain a fuller picture that considers all the hypothesised relationships. The structural model extends users' perception of the design factors to their incongruity resolution (subjective), purchase intention (subjective) and actual purchase (objective), allowing us to also test H1, H2, H3 and H4. This structural model is hence estimated with SEM using Stata.

In addition to the individual factors including age and gender, product knowledge and brand familiarity that we have included in the ANOVA, users' cognitive factors, such as need for change and need for cognition (Srivastava & Sharma, 2012; Wood & Swait, 2002), may affect their attitude toward innovative products, and were thus also included as control. Similarly, individual preferences in health consciousness (Hsu et al., 2016), dietary group attitude (Sogari et al., 2021), and food variety seeking (Van Trijp & Steenkamp, 1992) may affect purchase intention and actual purchase. Thus, these factors were incorporated as covariates to control for their possible effects.

The overall fit indices are: $\chi2=276.37$ ($\chi2/df = 1.68$), RMSEA=0.055, CFI=0.924 and TLI=0.901. **Table 13** shows the coefficient details of all variables in the model. Results suggest that all the hypothesised paths in the SEM model are statistically significant. Novelty seeking ($z=0.197$, $p<0.05$) and perceived controllability ($z=0.219$, $p<0.01$) had a significant positive effect on incongruity resolution, supporting H1 and H2 respectively. In addition, incongruity resolution further significantly enhanced users' purchase intention ($z=0.763$, $p<0.01$), which leads to their actual purchase ($z=0.085$, $p<0.01$), providing support for H3 and H4 respectively.

Table 13 Structural model results

Structural Model		Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
IR <-	NS	.197**	.077	2.53	0.011	0443506	.3499199
	PC	.219***	.070	3.10	0.002	.0805293	.358559
	Sex	.007	.163	.04	.966	-.313469	.3274817
	Age	.047	.039	1.19	.234	-.0307888	.125904
	PK	.148**	.064	2.29	.022	.021397	.2755857
	BF	-.072	.081	-.88	.376	-.2329118	.0880427
	NFCH	.203***	.070	2.88	.004	.0651141	.3423016
	NCOG	.089	.066	1.36	.175	-.0399161	.2192202
PI<-	IR	.763***	.185	4.12	.001	.4006446	1.126745
	Sex	-.003	.192	-.02	.987	-.3795662	.3731016
	Age	-.033	.047	-.70	.482	-.1259102	.0594393
	HC	.082	.064	1.28	.199	-.0434136	.2081388
	FVS	.012	.062	.19	.847	-.1097572	.1338003
	DGA	.022	.067	.33	.743	-.1100095	.1542499
AP<-	PI	.085***	.022	3.84	.001	.0415843	.1284648
	Sex	-.085	.056	-1.51	.132	-.1958172	.0257031
	Age	-.008	.013	-.60	.550	-.0351892	.0187367
	HC	-.006	.019	-.30	.763	-.0450484	.0330248
	FVS	.019	.018	1.04	.296	-.0171141	.0561566
	DGA	-.016	.020	-.80	.422	-.0574241	.0240347

Notes: *p<0.10, **p<0.05, ***p<0.01 (IR=Incongruity resolution; PI=Purchase intention; AP=Actual purchase; NS=Novelty seeking; PC=Perceived controllability; PK=Product knowledge; BF=brand familiarity; NFCH=Need for change; NCOG=Need for cognition; HC=Health consciousness; FVS=Food variety seeking; DGA=Dietary group attitude)

5.4.3 Mediation analysis of AR designs

A mediation analysis was conducted to examine whether and how the effects of the two AR design components on incongruity resolution are facilitated by novelty seeking and perceived controllability. As discussed over the course of this thesis, components to generative mechanisms that explain what is observed are important in this research endeavour. This mediation analysis would reveal whether novelty seeking and perceived controllability are plausible mechanisms that can explain the effects of the design components on the incongruity resolution outcome. Following the suggestions from Baron and Kenny (1986), SEM was employed to conduct the mediation analysis as the model contains latent variables and multiple variables. The SEM technique was chosen instead of standard regression techniques because all possible mediation processes of multiple independent variables, mediators or outcomes are tested directly rather than deriving asymptotic variance by combining results of various regressive equations. Furthermore, measurement errors and goodness-of-fit statistics are incorporated in the SEM model. This provides us with model-fit information regarding the consistency of the hypothesised mediational model to the data and enhancing the plausibility of the hypothesised model.

Figure 28 illustrates the results of the mediation analyses. The effect of the cartoonised AR visuals on incongruity resolution is fully mediated by novelty seeking as the direct effect between the two constructs is insignificant (coef.=.036, $p > 0.1$), while the effect of AR presentation control feature on incongruity resolution is partially mediated by novelty seeking and perceived controllability (coef.=.242, $p < 0.05$). In addition to this, to ensure robustness, the bootstrap mediation analysis for obtaining variance estimates was conducted, rather than using the standard errors and confidence intervals directly from SEM. The analysis with 200 replications confirmed the fully mediating role of novelty seeking between cartoonised AR visuals and incongruity resolution, and the partial mediating role of novelty seeking and perceived controllability between AR presentation control feature and incongruity resolution.

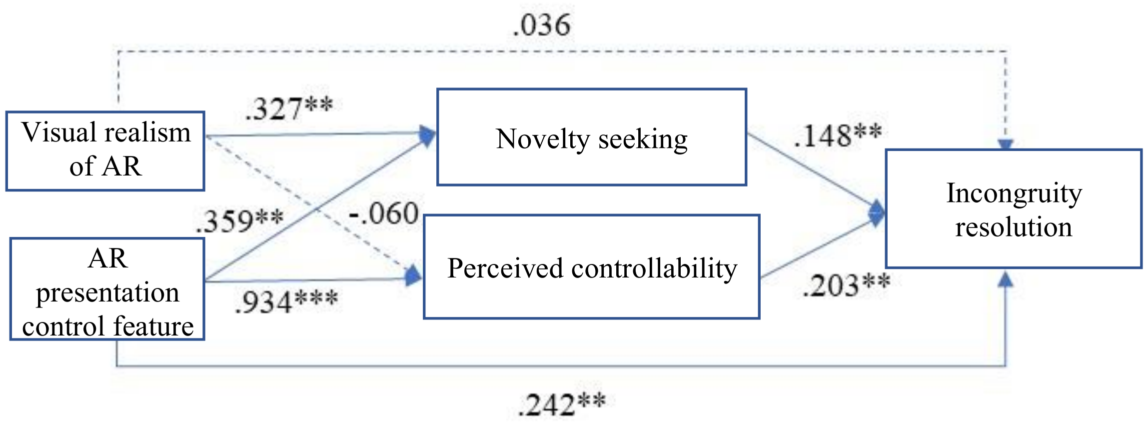


Figure 28 Mediation analysis

5.5. Discussion

5.5.1 AR visual realism

On perceived controllability. All our hypotheses were supported with the exception of H2a as there was no significant difference between realistic and cartoon AR designs on perceived controllability. Although this hypothesis was not supported, this is unsurprising as extant literature has had inconclusive views on this relationship. On one hand, literature suggests that the inability to distinguish between the virtual and the real can lead to difficulties of making sense of the AR environment and therefore the sense of loss of control (Fernandes et al., 2015; Kaplan & Kaplan, 1989). On the other hand, studies have found that realistic virtual objects or "para-authentic" experiences using AR technology increases immersion and presence (Daassi & Debbabi, 2021; Verhagen et al., 2014), which may lead to higher sense of self-efficacy and control as users are less burdened by processing two distinct information formats.

While the hypothesis that cartoonized virtual items would result in higher degrees of perceived controllability was unsupported, the latter view arguing for the superiority of realistic designs of AR in this respect remains unverified too, as the ANOVA results showed no significant difference between the two on perceived controllability. This suggests that the varying levels of visual realism has no effect on individuals' perceived controllability. A plausible explanation could be that the participants in this study are what Prensky (2001) calls digital natives, a generation described to have superior information processing capabilities. The digital natives are young people who are heavy users of digital devices, and partake heavily in digital multitasking (Vedechkina & Borgonovi, 2021). It stands to reason that the generation of digital natives possess a multitasking proficiency that allows them to split their attention between the virtual and the real with little cognitive effort, hence it makes little difference whether the virtual items are discernable from the real on their sense of control. Further, this is a generation that is well-acquainted with the blurred line of the real and the "un-real", especially with popular live-action movies with photorealistic cartoons depicted in real-world environments, like in the live-action Avatar and Sonic the Hedgehog movies, where cartoons and human actors co-exist. Movies blending unrealistic animations with live-action, like Enchanted and Scott Pilgrim vs. the World, of this generation were also well-received. The familiarity of seeing both realistic and unrealistic virtual objects coexisting with real-life elements may also explain the finding of this study, as neither cartoonised nor realistic conditions would create any sense of cognitive dissonance that could lead to a heightened or diminished perceived controllability in the AR experience.

On novelty seeking. Although I did not find support for the hypothesis on the effect of visual realism on perceived controllability, visual realism of virtual objects in the AR product presentations was found to have an effect on novelty seeking. The ANOVA results showed a significant difference between the cartoonised and realistic conditions on the novelty seeking construct, in which the SEM mediation analysis further confirmed facilitated incongruity resolution. This finding validates prior literature suggesting that the novelty seeking tendency is one that can be activated (Hirschman, 1980), and can indeed lead to the resolution of schema incongruity and subsequently the purchase of schema-incongruent products. This study has shown evidence that using AR product presentations can facilitate novelty seeking tendencies, specifically when the virtual objects in the AR product presentations are designed to be unrealistic and cartoonish. This provides interesting practical implications as a small adjustment in design like stylising virtual objects with cartoon effects can make a difference with regards to increasing individual novelty seeking. Special stylisation techniques are becoming increasingly efficient and requires only the use of graphics algorithms to result in non-photorealistic renderings (Markosian et al., 1997).

5.5.2 AR presentation control feature

On perceived controllability. With regards to the perceived control mechanism, while there was no evidence to support the hypothesised effect of AR's visual realism on individuals' perceived controllability, the ANOVA analysis found significant difference between the with-AR presentation control feature and the without-AR presentation control feature conditions on perceived controllability. Thus, we find support for the argument that having functional control features (i.e. in the form of buttons) of the virtual information presented in the AR experience helps individuals manage the cognitive and information load, thus enhancing individuals' psychological state of perceived controllability.

Perceived controllability was also found to have influence on incongruity resolution, which complements two perspectives. Firstly, this finding provides evidence for the environmental psychology perspective, particularly with respect to the dominance construct, where the sense of feeling unrestricted and free leads to positive affect that drives individuals to approach (as opposed to avoid) an environment. Secondly, our finding also supports the process-based account of incongruity resolution, which argues that self-generated incongruity resolution would lead to stronger positive affect than insight-based incongruity resolution, where the link between disparate schemas is given externally to an individual, for instance through marketing messages (Jhang et al., 2012). This study hypothesised that the positive affect can be derived from one's involvement in and perceived controllability over the sensemaking process, which is made salient through the functional control feature of the AR product presentation. Instead of viewing these two as alternative explanations for this finding, I see both arguments as two sides of the same coin as they both highlight the affective perception associated with individuals' degree of involvement and dominance in their context. In essence, this finding shows the critical role of the involvement of oneself and one's own sense of control in generating the positive affect that has been previously established to be related to the process of resolving incongruity (Jhang et al., 2012). This not only affirms prior findings on the role of positive affect on incongruity resolution, but gives insight on the opportunities AR can present to evoke this positive affect through the mechanism of perceived controllability.

On novelty seeking. In addition to the visual realism of AR, the results of this study also indicate that AR presentation control feature facilitates novelty seeking. This study showed that giving users functional presentation control over the AR product presentation simply by incorporating buttons that allowed users to control the pace of the AR experience via pause, skip and replay the product presentation options enhanced their novelty seeking tendency. This finding supports the conjecture that the novelty seeking tendency is more salient among individuals in the with-presentation control feature condition because these control functions allow for exploratory behaviour, in that individuals can see more and explore more by going back and forth throughout the AR product presentation.

Prior studies hinted towards similar findings – for instance, Jessen et al. (2020) found that AR use led to customer engagement and sequentially to customer creativity. Much like our assumption on how AR can lead to novelty seeking, Jessen et al. (2020) argued that AR positively impacts customer engagement, which heightens their sense of creativity. The authors aptly uses the term "playground-effect" to describe their process framework, in that AR interactions are similar to that in playgrounds, where safe exploration and playful creativity take place. The arguments share similar lines of reasoning to those of this study, in that AR environments facilitate exploration of novel ways to creatively solve consumption problems. This study concretises and provides a deeper insight into what it is about AR use that led to novelty seeking (similar notions of creativity) by taking a deeper look at the unique attribute of AR of overlaying virtual objects onto our physical environment, and two specific design features related to it. That is, the visual realism of the virtual objects and the control feature. This study identified and showed evidence that varying visual realism and presentation control designs make a difference in the strength of novelty seeking tendency these induced. Overall, the results confirmed that the variation of these two features influenced the degree of novelty seeking, which sequentially drove incongruity resolution and subsequently purchase.

5.5.3 Incongruity resolution and purchase behaviour

Finally, the confirmed hypotheses on incongruity resolution on purchase intention and actual behaviour provide further support to prior literature which showed that incongruity resolution positively influences behavioural intention (Abolhasani & Golrokhi, 2021), as it was found in this study that incongruity resolution led to purchase intentions of schema-incongruent products. This is a meaningful finding for this study as not only did AR facilitate individuals' incongruity resolution, this resolution was strong enough to have led to their willingness to purchase the source of incongruity itself. Further, the purchase intentions reported in the study also translated to actual behaviour as shown in the findings where purchase intention was found to be associated with actual purchase.

The objective measure of actual purchase in this study provides strong evidence of the effectiveness of AR-evoked mechanisms (i.e. novelty seeking and perceived controllability) driving incongruity resolution that led to purchase of products. Contending views of Ajzen's (1985) theory of planned behaviour highlighted the intention-behaviour gap (Sheeran & Webb, 2016), which describes the failure of translating intentions into behaviour. While prior literature have shown the existence of this gap (Jenkins et al., 2021; Lim et al., 2011), this study draws from Sheeran and Webb's (2016) counterargument that highlights the ease of intention realisation and formation of intention. In the case of this study's context, it is plausible that the ease of realising the intention of purchasing the schema-incongruent product within the context of shopping in a brick-and-mortar store is assumed, and that the strength of the intention formed as a result of incongruity resolution is strong enough to drive individuals to act on their purchase intention. To the best of my knowledge, studies on the influence on incongruity resolution on behaviour is scant, as the outcome of incongruity resolution often investigated is product evaluation (Jhang et al., 2012; Noseworthy et al., 2014; Noseworthy et al., 2017). This study adds to the scarce literature on behavioural outcomes of incongruity resolution, particularly with purchase behaviour, and solidifies existing findings of reported purchase intentions (Abolhasani & Golrokhi, 2021), by using objective measures of purchase.

Chapter 6 Concluding Discussions

"The measure of greatness in a scientific idea is the extent to which it stimulates thought and opens up new lines of research." – Paul Dirac

This chapter presents the closing of this thesis by first summarising the meeting of the objectives that this thesis's two studies were set out to achieve (**Section 6.1**), and second, discussing how the overall findings in this research endeavour may contribute to the theorising of the AR phenomena (**Section 6.2**). Thirdly, in spirit of this chapter's opening quote, the implications of this thesis for future research are discussed (**Section 6.3**), as well as its implications for practice (**Section 6.4**). Finally, this chapter presents the limitations of this thesis, which may be explored and addressed in future, new lines of research.

6.1. Thesis Summary

This thesis started with an introduction that provided an overview of the practical problems that highlighted AR's untapped potential in brick-and-mortar retail (Chapter 1) and later dived deeper into reviewing the existing literature that revealed some gaps and opportunities for research (Chapter 2). Specifically, to best capture AR's problem from a practitioner's point of view, I draw from technology writer Om Malik's quote below:

> "Augmented reality is the 'boy who cried wolf' of the post-Internet world—it's long been promised but has rarely been delivered in a satisfying way." (Malik, 2016)

AR technology has gained substantial attention among retailers and technology experts, and the academic world have also caught onto AR's potential in the retail domain. Yet, the realisation of these potentials is like what Malik described, it still falls short on delivery. Motivated first by this real-world observation, a systematic literature review was conducted and it was found that there were some gaps, of which filled, may provide some insights into how we can effectively tap onto the potentials of AR and maximise its values. As highlighted in Chapter 2, there is a lack in AR research on its uses and benefits in offline retail, and data grounded in users' perspectives were also scarce. In an attempt to address these considerations, this thesis is designed to first "go back" to the roots and explore what are the AR attributes that are important and relevant to users, grounded from the users' perspective. For this, I have argued that the individual motivational, goal-oriented perspective of AR use can reveal the values that AR can bring forth, that can meet users wants and needs in the specific setting of offline retail. This, intuitively, provides a start in steering practitioners and researchers alike in the right direction of the unique value propositions that AR may bring forth, which are worth investing effort into, both in terms of its designs for real-world uses and in research.

Another significant discovery from the literature review is that there is a lack of theory development of the AR phenomena. As revealed in Chapter 2, most extant studies borrow well-established theories from other domains (e.g. situated cognition, flow theory and uses and gratifications) to study specific outcomes, such as decision-making comfort, purchase intentions and technology adoption. These theories are not AR-specific and few have sought to develop a theory that hits the head on the nail in explaining the AR phenomenon and uniqueness, particularly in the context and its application in retail. Taken together, the state of AR in research as well as its untapped practical potential provide the motivation and objectives for this thesis, which is to obtain concrete knowledge of how AR can be maximised to provide value for users in the brick-and-mortar retail and to develop an understanding that can explain the AR phenomena that taps into its uniqueness. These two objectives are seen to complement each other.

With these considerations, this thesis adopted the affordance theory as an overarching framework to identify generative mechanisms that can explain how AR is perceived by individuals and what AR can afford its users in their offline shopping. Rather than using it as a narrow theory, I used it as an overarching framework to guide this thesis. This theory has been employed by critical realist IS researchers (e.g. Bygstad et al., 2016; Volkoff & Strong, 2013), who have found the affordance framework helpful in identifying the socio-technical processes and mechanisms related to the technology artefact under investigation. Generative mechanisms, as discussed in the prior chapters, provide the explanatory power in theories, and is therefore the backbone of theorisation.

In an effort to zero in into the concrete, technical attributes of AR to discover the unique outcomes these can provide, and knowledge of which can later be technically manipulated to maximise ideal outcomes, the first study in **Chapter 3** of the thesis integrates the MEC perspective and laddering method to systematically break down the layers of attributes, consequences and values and how these are interrelated with each other. These give the study a goal-directed lens, which aligns with the affordance theory, and zooms in on the interaction between technical attributes of the AR and the value that these provide to users in the specific context of brick-and-mortar shopping. The laddering technique systematically teases out the cognitive linkages that hint toward the AR mechanisms that are worthy of further investigation, and these linkages also allowed for the interpretation of affordances. The laddering data from 45 respondents have resulted in a frequency of 1,155 mentions of direct and indirect relations between the AR attribute, consequence and value factors identified. The abstractness and importance of these are computed, allowing for the generation of the hierarchical value map that visually presents the most salient AR attribute-consequence-value (A-C-V) pathways among all the paths identified. From these, two affordances were interpreted, namely AR's affordance of supporting experiential shopping and of providing cognitive shortcuts.

The integration of the affordance and MEC approaches as well as the qualitative nature of the first study revealed potential components that may serve as contingencies to these mechanisms that drive the aforementioned two affordances. Specifically, the A-C-V pathways led by the interactivity and the visual-real integration attributes of AR were particularly interesting in the cognitive and affective consequences that these provide. The qualitative data suggested that there are varying designs to these two concrete attributes of AR, and it is plausible that variations in designs to these technical attributes may generate different outcomes that could determine the fallibility and contingencies of the affordances identified in the first study, consistent with the concept of affordance potency (Anderson & Robey, 2017). This thesis is also very much grounded in the critical realist research philosophy, and staying true to its principles, this thesis embarked on the second study to examine these contingencies and achieve a deeper and more nuanced understanding of the mechanisms and affordances that AR can bring forth, as explained in **Chapter 4.**

To this end, the second study as introduced and reported in **Chapter 5** contextualises the cognitive shortcut and experiential, hedonic shopping affordance of AR, particularly the proposition of Study 1 that AR's amplified product information attribute through which the technical attribute of virtual-real integration enables, by examining how AR presentation control feature and the visual realism of the AR-overlaid information can aid consumers in the cognitive process of resolving product schema-incongruence. While this context is quite specific, it is a juxtaposition that puts AR's affordances as a cognitive support and a driver of positive affect as proposed in Study 1 under scrutiny. Further, examination of the visual realism design factor gives us insights into the "augmentation of reality" phenomena as it closely reflects how users perceive and psychologically negotiate the boundaries of the real and the non-real. This, I believe, could potentially be the line of reasoning that highlights AR's uniqueness but also provide a theorising angle that has not been previously explored before.

The second study of this thesis found evidence to support the proposition that AR affords users cognitive support, through which is complemented by AR's other affordance of driving positive affect, particularly in the sensemaking and incongruity resolution process of innovative but schema-incongruent products. Specifically, the two mechanisms that were found to be evoked by AR to facilitate this process, is novelty seeking and perceived controllability. In this study, I hypothesised that two AR design components evoke these mechanisms. First, I hypothesised that (1) cartoonised (visually non-realistic) AR visuals as opposed to realistic ones; and (2) with-presentation control features as opposed to without-presentation control features would lead to higher novelty seeking tendencies. Second, I hypothesised that (1) cartoonised (visually non-realistic) AR visuals as opposed to realistic ones; and (2) with-presentation control features as opposed to without-presentation control features would lead to higher perceived controllability. Of these hypotheses, all were supported with the exception of the hypothesis that cartoonized (visually non-realistic) AR visuals would lead to higher perceived controllability. The second study also found support for these relationships leading to actual purchase behaviour (implications of this are discussed in **Section 6.4.2**).

6.2. Implications of Thesis toward AR Theorising in the Context of Retail

The findings of this thesis's first study have led to the investigation of the visual realism of virtual objects in AR designs in the second study, and specifically how this influences the cognitive process of incongruity resolution in the retail setting. The topic of visual realism in AR experiences is rarely discussed outside of computer science literature. I maintain that this is an important variable that warrants further attention as AR's defining feature is its function of augmenting reality. AR applications introduce foreign or unreal objects into our physical realities, and designing these objects to look more "real" or more "virtual" can have interesting and meaningful outcomes that may advance our knowledge on the very defining function of reality augmentation. Unlike virtual reality where there is no confusion between the real and the non-real, AR environments blur the line that separates the two, and this thesis's findings indicate that there is a significant difference between realistic and unrealistic (i.e. cartoonised) visual realism of the virtual objects overlaid in our physical environments on novelty seeking tendencies, in that cartoonised virtual objects with low visual realism performed better, and led to higher novelty seeking tendencies.

This finding challenges prior assumptions, especially with regard to the concept of presence, whereby AR researchers have advocated for realistic or "vivid" AR experiences to successfully create the illusion that a product (that can be presented in virtual form) is present in the physical environment (Verhagen et al., 2014), and allowing for users to feel immersed in the AR experience (Yim et al., 2017). Intuitively, this assumption would hold if the context of AR use in presenting a product is online, where the sensory experience of the product is limited as individuals are unable to physically inspect the product. However, in the offline setting, such as in brick-and-mortar stores where individuals have direct access to the product, this thesis found that realistic designs of virtual objects were not as effective as visually unrealistic, cartoonised visuals.

A perspective that could unify and explain both seemingly contradictory accounts is the distinctiveness effect (Heiser et al., 2008). The distinctiveness effect, whereby an unusual or divergent perspective is introduced to an individual's immediate environment, could stimulate divergent thinking that could in turn lead to creative processes like novelty seeking. This perspective could explain why overlaying unrealistic virtual objects in the real physical environment and overlaying realistic virtual objects in the virtual online environment led to positive cognitive outcomes, as both scenarios make the virtual and the real categorically distinct. On this note, in theorising the augmentation of reality, it may be worth considering the online or offline context of AR use, as the "realities" of both contexts are different, and this thesis has shown the relevance of the virtual-real categorisation from the user's perspective.

If we borrow the reasoning from the distinctiveness effect, overlaying visually realistic objects into a virtual environment and overlaying a visually unrealistic objects into a real-world environment are two scenarios that would result in the same act of introducing a divergent perspective on a psychological and symbolic level. The augmentation of reality in this sense may "open up" users' mind in the same way how Heiser et al. (2008) argue that the distinctiveness effect stimulates divergent thinking, and in the same way how in the second study of this thesis where it was found that the augmentation of physical reality (in the offline store) through AR-embedded visually unrealistic elements, making them categorically distinct (i.e. virtual-real categories), was able to lead to individual novelty seeking tendencies. As Participant P20 from Study 1 mentioned, AR could help "enlighten me [him] on things that I [he] wouldn't be able to think of [if not for the AR presentation]" and "can help us think out of the box".

Hence, we may understand AR's technical function of overlaying categorically distinct elements into users' task environment (i.e. shopping in virtual environments like in online stores and shopping in physical environments like in brick-and-mortar stores) as the augmentation of reality. Augmentation, in this line of reasoning, is thus *the introduction of categorically foreign elements into users' perceived space, rather than it being an enhancement of reality* (as previously coined in Javornik (2016b)).

However, this is not to say that reality is not enhanced through AR, but rather this "enhancement" is a perception or a psychological outcome of AR. The theorising of the augmentation of reality, based on how I now argue it to be, could therefore involve both the contexts of offline and online "realities" where these are symbolically perceived as physical and virtual respectively, and are nuanced in that the augmentation of both scenarios can be explained.

The breadth and depth of this PhD project has allowed for both the qualitative exploration of the concrete attributes of AR and the abstract values AR can bring forth, and for these to be later tested through an experimental design. While this research process has had many fragmented implications separately as individual studies (see following sections), the user-grounded approach of Study 1 that elicited the potential importance of the visual realism and controllability designs of AR, and the finding that AR can help users "think out of the box", combined with the testing of hypotheses in Study 2 that were informed by the findings of Study 1, this section has summarised the key takeaways to be considered in the theorising of the AR phenomena in the retail context.

6.3. Implications to Research

6.3.1 Implications of Study 1 on current and future research

The first study demonstrated that the combination of the affordance and MEC perspectives can be useful to capture how users interact with material properties of AR to obtain the consequences that these provide, which ultimately gratify individual personal values. Prior studies on AR in retail have investigated the perceptions of AR in broad dimensions, such as its utilitarian quality and its hedonic quality (e.g. Pantano et al., 2017; Poushneh & Vasquez-Parraga, 2017), without connecting the specific attributes to such perceptions. Study 1 unravels and fills in the AR 'blackbox' to systematically identify the AR attributes that drive AR consequences and gratify consumer values within the context of retail.

The pairing of the affordance perspective and the laddering method, which is essentially informed by the MEC theory, is a novel approach to identify and interpret technology affordances. The two perspectives complement each other to elicit the motivational dimension of goal-oriented actors that gives rise to AR affordances, building on prior studies that have indicated the importance of users' goals in the context of AR use in shopping (e.g. Park & Kim, 2021). The use of affordance-MEC integrated framework resulted in the identification of components that make up AR-related mechanisms, which is situated in a large network of human, social and technical objects. Having a broad view as such allowed me to ascertain AR-related patterns worthy of investigating, but also to have a deeper and layered notion of the *hows* and *whys* that explains the patterns found, and to facilitate the development of an AR-specific theory. The integration of these two perspectives can be considered for future researchers who are investigating new technologies. The integrated affordance-MEC approach can provide future IS researchers an additional motivation-cognitive element to the existing affordance framework as an overarching lens to guide their study. Similar to this first study, future researchers can also build and develop theories based on the linkages found, guided by this integrative framework.

As the thesis took on a focused approach to identify salient linkages to be tested in the thesis's subsequent study, there are some results and different approaches that can be further investigated. For instance, future researchers can also narrow in on the AR-related personal values that were identified to be important to users. For example, IS researchers may consider examining if the AR affordance outcomes post-affordance actualisation is congruent to the personal values that were found to be related to AR attributes in this study, and if incongruency between the affordance outcomes and expected gratified values from using AR causes undesirable consequences. These were not explored in this thesis, but could be an interesting avenue for research in future works.

Further, I argue that the affordance approach can resolve the long-standing friction between the technology deterministic and social constructivist view on the role of IT (Galliers, 2003; Orlikowski & Iacono, 2006b), as discussed in Chapter 2, which was claimed to have caused a fragmentation in the IS discipline. This work not only incrementally contributes to the affordance literature which advocates for the bridging of these two perspectives by examining the interaction of the material properties of the

AR artefact and actors' agency, but it also extends the affordance theory to encapsulate the technology actors' cognitive linkages that drives goal-oriented AR use.

6.3.2 Implications of Study 2 on current and future research

The research implications for this study can be explained from two perspectives; in terms of its contribution to first, the concept of schema incongruity resolution and second, the theorisation of augmented reality in the context of retail. The latter has already been discussed in **Section 6.2**, therefore this section will address the former. With regard to schema incongruity resolution, this study has introduced novelty seeking and perceived control as constructs that can facilitate incongruity resolution. Extant literature have examined strategies to enable incongruity resolution (Jhang et al., 2012; Noseworthy et al., 2014; Noseworthy et al., 2017), and this study shows the applicability of AR technology in this endeavour. The study isolated two mechanisms evoked by AR, namely novelty seeking and perceived controllability, and I extended current understandings of incongruity resolution by finding evidence that inducing these can help individuals make sense of schema incongruence.

Notably, Jhang et al. (2012) have examined the role of cognitive flexibility in the enhancement of incongruity resolution. This study draws from similar conceptual assumptions of cognitive flexibility, particularly the flexible and creative thinking elements that underscores the novelty seeking concept employed in our study. Novelty seeking is treated as an adjacent concept, but unlike cognitive flexibility which is viewed as an ability (Ionescu, 2012), novelty seeking is a tendency that can be dependent on and activated by external factors (Bandura, 1999; Hirschman, 1980). In their investigation, Jhang et al. (2012) used primes for cognitive flexibility, whereas the second study of this thesis differentiates itself by examining concrete attributes and designs of AR to enhance novelty seeking in relation to incongruity resolution. On the other hand, perceived controllability is a mechanism that to the best of my knowledge, has not been discussed in prior literature on incongruity resolution. Prior work has shown that positive affect can facilitate incongruity resolution, and this study draws on the concept of dominance from environmental psychology that explains that individual's sense of control gives rise to positive affect (Mehrabian & Russell, 1974), and it was found that perceived controllability is a viable instrument that can be used to enhance incongruity resolution. This study presents a novel perspective by focusing on the external factors that can lead to incongruity resolution, and this investigation concretises this by testing the use of technology to create an environment that facilitates this cognitive process.

Overall, this second study represents the next step and the potential direction future research on AR in the business and management field could take. As described in the literature review in Chapter 2, existing literature have already established through many TAM studies (e.g. McLean & Wilson, 2019; Pantano et al., 2017; Rese et al., 2017; Saleem et al., 2022), that perceptions of AR are generally positive, and it is thus appropriate to move forward with how AR experiences can be designed to create more effective value for users, that can also create tangible value for companies. Tan et al. (2021) have argued in their proposed research agenda for future studies on AR in retail that companies are interested in the impact of AR on consumer behaviours as well as how different design features could be leveraged to create more effective experiences for consumers. Regarding the former proposed research direction, while the consumer behaviours in relation to AR technology have been studied relatively extensively – for instance how it relates to individuals' sense of ownership control (Huang, 2019), consumers' decision comfort (Heller et al., 2019; Song et al., 2020), mental imagery generation (Hilken et al., 2022; Park & Yoo, 2020; Sun et al., 2022), among other behavioural factors – these studies were often focused on the use of AR in online spaces and e-commerce, where the physical products are not available in their immediate setting to be inspected and thus the behaviours and related mechanisms investigated in these prior studies were more focused on alleviating that issue. **Chapter 1** has argued for the need to also examine the offline retail setting where AR's significance is different from the online space, in that it can provide consumers with a range of information that is not restricted to physical, material spaces. With AR technology, consumers are able to shop in an environment that integrates the virtual and the real – where information abounds, and where information can be presented in different styles to evoke different responses from consumers, as has been suggested by literature in computer science (Fischer et al., 2005; Lee et al., 2013). Both studies in this thesis add to the limited stream of literature that have indicated the meaningful role that AR can play in impacting cognitive functions and decision-making in the brick-and-mortar retail setting. With regard to the latter research topic in the research agenda where Tan et al. (2021) called for more investigations on the design features of AR, Study 2 in particular, have looked at the two design features of AR, namely its visual realism and presentation control feature, that were found to impact consumers cognitively and affectively. This study is one of very few (e.g. Hoffmann et al., 2022) to advance knowledge on the design features of AR experiences in the retail context.

Finally, while this study has taken on the context of schema incongruence to examine the effects of AR designs, the context is an extreme juxtaposition of a scenario where product understanding and sensemaking are key outcomes. It is expected that future research on AR use incorporating the design components examined in this study (i.e. visual realism and presentation control features) will provide the same results in research contexts that relate to the cognitive process of subject understanding and sensemaking that may not necessarily involve schema-incongruity – for instance, in introducing new topics in educational contexts, or even in communicating a change in company policy within an organisation. It could be worth investigating the effectiveness of AR-delivered teaching presentations or AR-delivered corporate messages through the same theoretical lens. In sum, this study's findings open up many promising avenues for future research.

6.4. Implications to Practice

The examination of both the material attributes of AR and how it relates to user values in the first study provides both AR developers and retailers with rich insights. Specifically, developers can exploit the specific AR attributes to design AR applications in a way that make them personally relevant to users. Meanwhile, the findings would also provide marketers with insights on how AR applications can be used in stores to achieve specific outcomes – for instance, the study found that the interactivity attribute of AR is related to the users' feeling attracted to the stores or retailers. If it is the primary goal of retailers to attract consumers into stores, the interactivity design component in the AR experience should be emphasised in this case. Furthermore, the goal orientations can also aid marketers to develop market segmentation strategies based on the orientations identified. Consumers can be classified according to their goal orientations, and strategies can be targeted following the different layers of consumer goals according to the orientation paths. The results of the first study have shown both hedonic and utilitarian orientations of consumers, and through the HVM generated in the first study, we found that interactivity was the most salient AR attribute that related to consumers with hedonic shopping values, while other attributes, such as navigation, virtual-real integration and amplified product information, were the most central AR attributes that related more to consumers with utilitarian shopping values. Depending on the type of product marketed, or the customer data brands and retailers have of consumers, AR experiences can incorporate or highlight the AR attributes that correspond to these values to maximise the business outcomes and customer experience that these may result in.

The second study, which was less broad than the first, examined the specific design and technical attributes of AR that allows for more concrete design implications for AR-delivered messages and presentations compared to that of the first study. The field experiment conducted in a store also provides external validity of the findings and evidence for AR technology use and design practices. The findings provide evidence that AR-delivered product presentations can indeed facilitate incongruity resolution and lead to acceptance of innovative products that may risk violating existing schemas. Brands could consider designing and leveraging AR technology in marketing campaigns in conjunction with product launches to increase the likelihood of product acceptance and purchase. The cost of designing an AR experience is a small price to pay compared to the losses that can incur if the launch of a new product fails due to low consumer receptiveness as a result of schema-incongruity. With the ubiquity of mobile services and devices that can easily support the reliable delivery of AR-enabled product presentations, businesses can consider this as a viable way to market a new product.

Specifically, the second study demonstrates the effectiveness of AR product presentations for in-store purposes using specific designs. Cartoon, unrealistic stylisations of virtual objects and adding functional presentation control features for users, for instance in the form of buttons or even a scrollbar, which would provide users controllability of the AR experience, are two design considerations that AR designers can explore in order to facilitate novelty seeking. Further, incorporating presentation control features in the AR experience can enhance users' overall perceived controllability of the AR environment, that could lead to positive affect and therefore better evaluations and increase the likelihood of purchase. The designs used in this thesis's experiment were relatively basic but adequate to operationalise the cartoon stylisation and presentation control feature design variables. Yet, we were still able to see the different hypothesised effects of the different designs. It is expected that these can lead to even better performance with designs that are more salient in the stylisations and control features, leading to higher degrees of novelty seeking and perceived controllability.

6.5. Limitations (and Future Research Opportunities)

There are several limitations to this thesis. I address these in the order of each study and finally suggest future research opportunities in addressing these limitations.

Limitations. For the first study, one limitation is in the collection of laddering data, specifically in the elicitation process. The materials or elements for the elicitation process used are in the form of videos as listed in **Table 2.** Rather than using direct experiences of AR use, the data collection relied on the indirect perceptions of users through watching videos of AR use. As AR is a relatively new technology and respondents are hence less likely to have used AR in their shopping activities, the elicitation process required respondents to watch videos of different types of AR use in offline contexts. Understandably, the validity of this research design may be deemed challengeable but considering that AR use in physical stores are rare, combining with the small variation in uses that are readily adopted in-stores which makes the elicitation process difficult[17], this is treated as a tradeoff in this study's research exploratory objective. Furthermore, the second study of this thesis that was based on a self-developed AR prototype application that users interacted with in a real-world retail scenario for the objective of testing the salient AR properties found in Study 1, lends validity to the findings of Study 1 as well.

Another limitation of the first study is that the sample selection was largely purposive to achieve the research objective of exploring AR affordances in offline retail and the personal values that AR attributes can gratify. The findings did not account for possible variations that may have arisen from factors such as user age groups and different levels of technology familiarity. I thus caution against the generalisability of the first study's findings to diverse user populations. While I acknowledge this limitation, I maintain that the selected sample reflects the expected population AR users, who are likely to be digital natives or early adopters of innovative technologies.

[17] This is because the elicitation phase requires many elements in order for study respondents to identify differences (in the form of attributes) between elements. Elements are the items used as a point of reference to categorise and elicit attributes. These can include products or brands, but in the case of this study, it is presented in applications of AR in retail. Too few elements would result in the inability for users to draw out meaningful differences in attributes.

On the other hand, the second study investigated the effects of the two design components (i.e. visual realism and presentation control feature) of an AR product presentation in the context of solving the perplexing problem of schema-incongruity that confronts companies that are pressured to make innovations to their products, but may risk violating existing schemas among consumers. The research context of schema incongruity provides an extreme juxtaposition of a scenario for when AR can provide tangible value in facilitating the cognitive process of incongruity resolution through unique AR functions and its specific designs. The generalisability our findings remains to be tested in similar context that highlight the sensemaking processes, that do not necessarily involve schema incongruity.

Further, Study 2 did not explore boundary conditions that could moderate the effects found in this study. The stimuli used in our experiment was a food product. The novelty seeking as well as the perceived controllability mechanisms and their effects on incongruity resolution may be influenced if it was a different product category that could implicate different levels of involvement. It is also plausible that functional vs. hedonic values associated with different products may have moderating effects on the relationships found in this study.

Future research opportunities. Addressing the aforementioned limitations, it may be worth exploring the transferability of these findings in a different population groups, such as a different age groups, particularly for Study 1. The mean age of Study 1's participants is 29, but the average age of active technology users are increasing (cite), however consumption patterns might differ for different age groups. It could be worth investigating how different individuals of diverse age groups engage with AR technology and what are the values that may be more salient for them. These could also hold practical implications, particularly in segmenting consumers and targeting certain groups of consumers with AR marketing.

In addressing the limitation on generalisability and effectiveness of the results found in Study 2, as mentioned, can be further tested in comparable sensemaking processes that may not necessarily involve the incongruity resolution process. This perhaps, as suggested in **Section 6.3.2**, could include organisational change, or in educational contexts where foreign concepts are introduced into individuals' schemas, which may or may not challenge prior understandings. In addressing the limitation on boundary conditions, on the other hand, future researchers can investigate if different types of products would influence the relationships that were found in the present study. It may also be worth investigating whether or not unrealistic (vis-à-vis realistic) virtual objects in AR experiences lead to other positive outcomes aside from the enhancement of individual novelty seeking tendencies. Although our study found that cartoonized virtual objects in the AR product presentation led to higher novelty seeking tendencies, we did not see a significant difference between realistic and unrealistic conditions for perceived controllability.

In Section 6.2, it was discussed, quite briefly, about the implications of this thesis in the theorising of the augmentation of reality phenomena. I argued for the theorising of the phenomena to draw from the distinctiveness effect and advocated for the plausibility that augmentation occurs when categorically distinct virtual elements (which could be designed to be visually realistic or unrealistic) are introduced into users' environment (which can be physical or virtual), for instance by adding a layer of visually unrealistic elements into physical environments or visually realistic elements into virtual environments. Here, I proposed that this "opening up" of perceptions for users to perceive not just a single category (i.e. the combination of virtual and real categories) may have a spillover effect in also the opening up of cognition that has been suggested in Study 2's findings in relation to novelty seeking. These are large propositions that require substantiating through an online context, which can also be worth examining in future research. The investigation of these could lead us to understanding when it is more favourable to use visually realistic and unrealistic AR designs, and more meaningfully, to verify the proposed theorising of the augmentation of reality in this thesis.

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Appendices

Appendix A: AR in Retail literature review

Literature review on refined pool of publications on AR in retail (n=53)

Source	App and context	Method	Theoretical /conceptual background	Variables	Main findings
Sengupta and Cao (2022)	Online; decision making for Décor Matters	Survey	S-O-R model	AR based shopping tool (Stimulus), Perceived immersion (Organism); Decision making quality (Organism) Purchase intention (Response); Privacy concern (moderator)	While experiencing AR, customers' positive perceived immersion improves their purchase intention. The impact of customers' perceived immersion on their purchase intention is partially mediated by decision-making quality. The impact of customers' decision-making quality on purchase intention is negatively moderated by privacy concerns.
Caboni and Pizzichini (2022)	Online; increased adoption of AR during/post COVID	Interviews	Technology affordance (TAM)	N/A	People appreciate the ability to experience shopping using AR. AR allows for contactless shopping. AR is viewed as proactive way to find other shops. Satisfaction is gained through AR technology.

Heiman et al. (2022)	Online; increased adoption of AR during/post COVID	Business case analysis; micro economic modelling	Microeconomic model	Virtual dressing room (VDR) adoption; Retailer share of online trade; Speed of adoption	Significant changes in market demand and supply conditions following the outbreak of COVID-19 accelerated the adoption of VDR technologies.
Holdack et al. (2022)	Offline; AR wearables (smart glasses) in stores	Field study	Extended TAM	Perceived informativeness (PI); Perceived ease of use (PEOU); Perceived usefulness (PU); Perceived enjoyment (PE); Attitude towards using tech (AT); Behavioural intention to use (BI)	PI and PE positively influence AT and BI. The effect strength of PE on AT even exceeds PU. Enjoyment seems to play a crucial role in the acceptance of wearables in offline shopping environments. In contrast to other studies, this study shows that PEOU does not affect PU and AT directly but indirectly through PE and PI. At the same time, PE mediates the relationship between PI and PU.
Ho et al. (2022)	Online; use of retail mobile app online	Field study	Hierarchy-of-effects (HOE) model; situated cognition theory	Interactivity; Vividness, Spatial presence experience (SPE); Customer engagement; Need for cognition (NFC); Domain specific interest	Mobile apps with high interactivity and distinct vividness significantly stimulate the experience of spatial presence. This is explained with the embodied and embedded cognition concepts. Compared to interactivity, vividness cognition has a stronger positive impact on spatial presence experience - suggesting that the embedded cognition process generates a stronger level of spatial sense in virtual environments than the embodied cognition process does. High-NFC consumers are found to be more likely to focus on interactive features and information,

					whereas those with low NFC are more likely to count on vividness during the purchase process.
Zimmermann et al. (2022)	Offline; AR applications with and without AI recommendation system	Design science, Survey	TAM	Usefulness; Entertainment; Informativeness; Irritation; Purchase intention; Trust in technology	Augmented reality shopping assistants (ARSAA) had a positive influence on perceived shopping experience. Usefulness, entertainment and informativeness were all significantly higher in the ARSAA assisted shopping than in the unassisted condition. However, this positive effect might indeed be diminished as the ARSAA assisted shopping scenarios also showed a significantly higher level of consumer irritation. No significant differences were found between participants' purchase intention across the different scenarios. Data did not reveal a significant difference in the trust for the two ARSAA assisted shopping scenarios.
Sung et al. (2022)	AR digital humans in mixed reality (MR) environment	Field study	Visual perception theory and information processing theory	Esthetic experience; Entertainment experience; Escapism experience; education experience.	Study reveals sequential links between the four realms of experience economy theory in a MR environment. These had effects on storytelling satisfaction. Storytelling satisfaction are boosted by digital human storytelling.
Hoffmann et al. (2022)	Offline; Use of AR in brick and mortar store	Field, lab and video experiments	Cues-filtered out theory	Controllability; Detailedness of information; Perceived	Study confirms that the backfire effect of AR controllability arises due to reduced perceptions of information

	focusing on the controllability element			comprehensiveness, Interaction quality; Brand image, Purchase intention; Rush hour vs. medium	comprehensiveness. This negative effect occurs mostly for higher degrees of controllability: when controllability is spread across rounds and users have an exit option. Under these conditions, consumers realise that the cues of the richer medium are filtered out, and there was more information available and they lack part of this information.
Tawira and Ivanov (2022)	Online; Personalisation and customisation in the latest generation of apparel virtual try ons (VTOs) Forma and Zeekit	Quasi-lab experiment	Theory of the self; Theory of interactive media effects (TIME)	Body esteem; Photo satisfaction; Perceived augmentation; Fit confidence; Consumer inspiration; Adoption intention	Inspiration and fit confidence induced from AR's customisation affordance in the exploratory task influenced adoption intention. For both conditions, users' satisfaction with their avatar picture had a stronger effect on perceived augmentation than the individual trait of body esteem.
Romano et al. (2022)	Consumer segmentation according to AR attitudes	Survey; latent class analysis	Stimulus load theory; TAM	Attitude toward AR; Decision confidence, Perceived information overload; Experiential value	Four consumer segments that differed in terms of their attitude towards AR, experiential value, choice confidence and perceived information overload include: AR Averse, AR Hesitant, AR Open and AR Enthusiastic. The segments with a greater positive attitude towards AR recorded higher experiential value and decision confidence and lower perceived information overload. Segments with a less positive attitude towards AR had lower

					experiential value and decision confidence and higher perceived information overload.
Kang et al. (2022)	Use of AR and patronage intention in online and offline channels	Survey	Expectancy-value judgments (EVJ) model of uses and gratifications theory	Novelty; Fashion/status, sociability; Relaxation; Trust in AR apps; Usage intention; Online/offline store patronage intention; Consumer self-determination	Trust in and usage intention toward AR apps were determinants of online/offline store patronage intention. Trust in AR apps was a determinant of usage intention toward AR apps and online/offline store patronage intention. Self-determination moderated the influence of their trust in AR apps on usage intention toward AR apps and online/offline store patronage intention. Novelty and fashion/status for EVJ of uses and gratifications had a positive influence on trust in AR apps. Sociability for EVJ of uses and gratifications had a negative influence on trust in AR apps. Relaxation for EVJ of uses and gratifications was not an important factor influencing trust in AR apps.
de Amorim et al. (2022)	Offline; Use of AR Hololens (AR shopping assistant) in supermarket on and the effect of media richness (information cue, variety and feedback) on	Experiment	S-O-R model	Media richness (Stimuli); Cognitive and affective states (Organism), Brand engagement and willingness to buy (Response) - specific organism variables: [cognitive: attitude and perceived information	Brand engagement and willingness to buy increase with consumer attitudes and perceived information quality. Emotional responses (pleasure and arousal) do not play a significant role in increasing brand engagement and willingness to buy. The explanation given is that maybe the product is utilitarian so emotional/hedonic responses were not salient.

	users cognitive and emotional responses			quality), [affective: pleasure and arousal]	
Xi et al. (2022)	Offline; Comparison between XR technologies (AR included) in terms of the workload involved	Lab experiment	Task load perspective	Workload sub-dimensions: Frustration, performance; Effort; Physical, mental, and temporal demand.	Users experienced higher workload in all three XR-mediated realities than non-XR. AR was significantly associated with overall workload, especially its sub-dimensions of mental demand and effort. VR did not cause increased perceptions of workload for any of the sub-dimensions (explained to be because of “non-consequentiality” - VR-mediated environment could be seen as free of many of the constraints and consequences that govern activities in the real world, and so transforms the environment into playgrounds of free experimentation). The combination of AR and VR had a lower physical demand compared to using AR or VR alone.
Alimamy and Gnoth (2022)	Online; Personalisation and co-creation in AR in shopping	Survey	Value co-creation	Perceptions of personalisation; Perceived trust; Perceived risk; Intention to co-create; Perceived value	Customer personalisation perceptions predict intention to co-create in the web-based shopping group directly but not in the AR group. This is explained to be because AR requires more operant resource integration from the customer which may result in the feeling that there is limited personalisation due to the large amount of knowledge, skill, and

					experiences that are required by the customer to interact with the technology.
Gatter et al. (2022)	Online; Autotelic need for touch (NFT) in AR use	Experiments	Uses and gratification theory	Feature type; Autotelic NFT; Need for touch; Utilitarian benefits; Hedonic benefits; Imagined tangibility; Attitude toward app; Attitude toward brand Attitude toward product; Attitude toward shop; Purchase intention	It was found that consumers with a high need for touch tend to rate AR content even better than those with a low need for touch. In the case of a real interaction with the AR content, consumers higher in autotelic need for touch experience higher hedonic benefits than consumers lower in autotelic need for touch.
Christ-Brendemühl and Schaarschmidt (2022)	Online; Fairness perceptions on AR-enabled customer participation	Online experiment	Equity theory	Distributive fairness; Procedural fairness; Price fairness; Engagement intention; Negative WOM	The use of AR technology requires increased inputs such as searching costs, the effort to operate the AR interface, waiting costs. Results show AR-enabled customer participation in online services is associated with lower perceptions of distributive, procedural and price fairness when compared to in-store alternatives. Engagement intentions are lower while negative WOM intentions are higher for AR-enabled customer participation than for in-store purchases.
Sun et al. (2022)	Online; Effects of AR features on product uncertainty	Online experiment	Uncertainty reduction theory	Product presentation format (AR vs. non-AR); Perceived informativeness; Sense of presence; Mental	AR product display has a greater effect on product fit uncertainty reduction than on product quality uncertainty reduction. The effect of AR on product uncertainty reduction can be attributed to increased

	reduction and product attitude			imagery; Product involvement; Need for sensory richness; Self-brand connection; Product quality uncertainty reduction; Product fit uncertainty reduction; Product attitude	perceived informativeness, sense of presence, and mental imagery. PI is only partial mediator while presence and mental imagery is a complete mediator. This was explained to be because AR can reduce consumers' product uncertainty through improved user experience, rather than providing additional information. Product involvement negatively moderates the relationship between AR and product fit uncertainty reduction. Effect of product involvement on the relationship between AR and product quality uncertainty is not significant. Explanation: The reason may be that the experimental products are low-priced products.
Plotkina et al. (2022)	How different types of AR apps can improve service brand personality in both online and offline contexts	Lab experiment	Competitive market signal theory	AR type (orientation-/location); Attitude toward AR; Perceived brand personality; Perceived AR app experience (pleasure, playfulness); Consumer characteristics	Consumers prefer VTO features (product specific app rather than brand/store AR apps). Expected pleasure and playfulness increase their overall attitude towards the app. Consumers perceive brands as being more sincere, exciting, competent and sophisticated when AR apps allow VTO. Consumers with higher IT innovativeness perceive brands as sincerer when they appreciate their AR app, Consumers with a hedonic shopping orientation who perceive shopping as an adventure are more impacted by the AR apps, and they, thus, evaluate the brand as more sincere, exciting and competent.

Romano et al. (2020)	AR's role in customer journey in online shopping	Semi structured interviews	N/A (grounded)	N/A (refer to themes on the right)	Grounded findings were discussed in the 3 stages of the customers journey: prior to purchase, point of purchase and post purchase. AR's roles were discussed in themes. ***Early stage***: Theme 1: Widens product consideration; Theme 2: Narrows the choice set; Theme 3: Mitigating brand value; ***Point of purchase***: Theme 4: AR's role in curation, Theme 5: AR drives hedonic value through playfulness; ***Post purchase***: Theme 6: Consumer choice confidence
Erdmann et al. (2021)	Online; AR value dimensions and purchase intention online through AR smart glasses (ARSG)	Survey	Value-based adoption model	AR immersion (experiential); AR tech complexity (technological); AR subjective norms (social); Cost (difficulty)-benefit (usefulness); Perceived value; Purchase intention; Innovativeness	Significant positive of the perceived value of the ARSG on the intention to use. Immersion is confirmed to have a significant influence in the purchase intention online, directly through the perceived value, and indirectly through increased perception of usefulness and a decrease in perceived difficulty. Tech-complexity has a direct positive influence on the perceived value but the complexity effect reduces the economic net benefits. The effect of the social AR dimension, in terms of the subjective norm, has a positive direct effect on perceived value as well as indirect effects through increased perceived usefulness and a reduction of the perceived difficulty.

Poushneh (2021)	Online; perceived proximity of virtual product tested through Wayby Parker app	Lab experiment	Construal level theory	Perceived proximity to virtual product; Perceived measurement feedback (explained as dimensions to reality etc.); Perceived generality; Absence of product in consumers' consideration set; Perceived purchase intention in the near future	Perceived proximity to virtual products enhances perceived measurement feedback as well as perceived purchase intention in near future in AR and non-AR applications. Perceived measurement feedback enhances perceived generality in both AR and non-AR. Perceived proximity to virtual product enhances consumers' purchase intention in the near future in both AR and non-AR applications. Perceived generality compensates for the absence of product information.
Hsu et al. (2021)	Online; adoption of online make up app	Survey	S-O-R model	***Experiential AR features***: Informative feature; Personalisation feature; Interactivity feature ***Experiential values***: Utilitarian value; Hedonic value Perceived customer support; Continued usage intention	Experiential AR app features exert a stronger positive effect on hedonic value than on utilitarian value. Only hedonic value has a positive effect on continued usage intention. Enhanced continued usage intention for hedonic value is moderated by perceived customer support. Overall, informative, personalisation, and interactivity features exerted impacts on utilitarian and hedonic value. For utilitarian value, only personalisation features were influential.
Hilken et al. (2022)	Comparison of AR and VR and its combination together in online-offline	Experiments	Mental imagery	Fluency of product-focused mental imagery; Fluency of context-focused mental imagery;	AR is more effective in stimulating purchase intentions than VR, due to its ability to support customers in fluent product-focused mental imagery. VR is better suited for improving brand attitudes

	customer retail journey			Sequencing of technologies	than AR, as it helps customers to form fluent context-focused mental imagery. AR and VR, in combination, can improve both purchase intentions and brand attitudes, but only when the order is sequenced as AR then VR. This is due to greater alignment with the customer's online-to-offline journey in experiential retail. When deployed the other way around, there is detrimental impact on purchase intentions and brand attitudes.
Ogunjimi et al. (2021)	Offline; Smart mirror (AR) fashion technology (SMFT) in brick and mortar stores	Soft system methodology	N/A	N/A	Positive relationship between service quality, customer satisfaction and the use of SMFT. However, quality of SMFT service is currently perceived as low when compared to customers' expectations. Authors developed a framework that integrates SMFT with traditional in-store transaction processes.
Saleem et al. (2022)	Online; AR mobile app adoption in Pakistan	Survey	TAM	Vividness; Novelty; Perceived usefulness; Perceived ease of use; Perceived enjoyment; Attitude towards use; Behavioural intention to use	AR directly influences perceived usefulness, perceived ease of use, perceived enjoyment, and indirect influence on attitude toward use and behavioural intention to use. No sequential mediation effect of perceived ease of use and attitude toward use between AR app and behaviour intention to use.

Chiu et al. (2021)	Offline; AR use in retail food chain (coffee shop)	Survey	DeLone and McLean Information System Success Model (ISSM)	Information quality; System quality; Service quality; User satisfaction, Continuance intention to use; Individual net benefits	User benefits of the augmented reality retail applications (ARRA) positively influence user satisfaction and user continuance intention to use. User satisfaction with the ARRA and user continuance intention to use the ARRA positively influence user benefits. User satisfaction with the ARRA also positively influence user continuance intention to use the AR technology. Information quality and system quality positively influence user satisfaction and user continuance intention to use.
Castillo S and Bigne (2021)	Offline; Use of augmented reality (AR) self-service technologies (AR-based SSTs) in the form of makeup apps in stores in Nicaragua vs. USA	Survey	TAM	Need for personal interaction; Aesthetics, navigation; Technology readiness; Self-efficacy, Perceived usefulness, Perceived ease of use, Attitude	Aesthetics and navigation predicted of perceived usefulness and perceived ease of use. Self-efficacy explains perceived ease of use. Technology readiness and the need for personal interaction were not found to be influencing factors. The cross-cultural comparison indicated that both countries have similar overall attitudes towards AR-based SSTs.
Rhee and Lee (2021)	Impact of virtual fitting (VF) app in omnichannel journey	Experiment	Brand advocacy	VF experience satisfaction; Brand advocacy; Mobile purchase intention; Offline purchase intention	VF can provide customers the level of product information they want. Connecting mobile experiences to offline stores is more effective when targeting advocates who are attached to the brand. Satisfaction with the VF experience led to positive

					purchase intentions for mobile shopping experiences but negative purchase intentions for offline purchases, contrary to expectations.
Joerß et al. (2021)	Offline; Using AR as recommendation agents (RA)	Survey and lab experiment	Technology-as-solution	Digital device usage; Sustainable consumption habits; Technology-as-solution belief; AR-RA reliance	Usage of AR-RAs can boost the purchases of products that are classified as sustainable by the technology. Neither sustainable consumption habits nor the belief that technology provides solutions to living sustainably led digital device usage. Only the interplay between both determine whether consumers shop more sustainably because of AR-RAs. The usage of this technology only results in more sustainable purchases if consumers hold strong convictions regarding both aspects.
Nikhashemi et al. (2021)	Online; AR use in online shopping	Survey	S-O-R model	AR quality; AR novelty; AR interactivity; AR customisation; AR vividness; Utilitarian benefits; Hedonic benefits; Retail brand engagement; Psychological inspiration; Continuance intention to use the app; Willingness to pay a price premium	AR quality, AR vividness and AR novelty, are positively related to the customers' utilitarian and hedonic benefits perceptions. Only AR interactivity was found not to have a positive relationship with utilitarian benefit.

Silva and Bonetti (2021)	Digital avatars/humans in AR and MR technologies used in fashion industry	Survey	Anthromophism	User demographics; Preferred personal devices for interaction; Preferred forms of interaction with digital humans; Propensity to interact with digital humans	Having humanised aspects is key to make digital humans socially acceptable. Interactions with digital humans need to be informative as well as entertaining. The interaction modality between human and technology needs to be as realistic as possible. Findings showed that participants' most preferred form of interaction with digital humans is via speech, whilst the least preferred form of interaction is via gestures.
Park and Kim (2021)	Online; Effects of VTO (AR) and 3D virtual store (VR) in an apparel retail website	Experiment	Cognitive elaboration	Shopping goals (search vs. browse); Website technology (AR vs VR vs non); Cognitive elaboration; Purchase intention	Compared to a 3D virtual store and static pictures, VTO (AR) led to greater cognitive elaboration and purchase intentions. 3D virtual store (VR) was more effective in increasing purchase intentions than VTO and static pictures when consumers were in a browsing mode, while both VTO and a 3D virtual store were more effective than static pictures when consumers were in a searching mode. Cognitive elaboration mediated the interaction between a specific technology and a shopping goal on purchase intentions for those consumers in a browsing mode, whereas this mediating effect was not found in a searching mode.

Kowalczuk et al. (2021)	Online; Comparison between consumers' reactions to the IKEA Place app and IKEA mobile website on smartphones	Experiment	Experiential hierarchy model	System quality; Reality Congruence; Interactivity, Product informativeness, Enjoyment; Immersion; Product Liking; Usefulness; Choice confidence; Purchase intention; Reuse intention	System quality and product informativeness are perceived as higher for web than for AR-based product presentations. Further, reality congruence does not significantly differ between both conditions, indicating that the computer-generated products in the AR app are perceived as equally realistic as the product pictures shown on the mobile website, indicating the high augmentation quality of the IKEA Place app. However, the AR condition outperforms the web condition in terms of the effects on immersion and enjoyment. Conversely, concerning cognitive responses, the values for usefulness are higher for web-based product presentations.
Manchanda and Deb (2021)	Online; Anthromorphised AR-mediated m-commerce	Survey	Anthromophism; TAM; Behavioural reasoning theory	Anthromorphism; Confidence; Subjective norms; Innovativeness; Cynicism; Product usage obstruction; Attitude towards AR-mediated m-commerce; Intention to adopt	Anthropomorphisation of AR-mediated m-commerce has positive influence on consumer confidence, perception of innovativeness, and subjective norms attributed to AR-mediated m-commerce, subsequently influencing attitude toward AR-mediated m-commerce. Anthropomorphised AR-mediated m-commerce has a negative effect on cynicism and product usage obstructions, whereas cynicism negatively influences attitudes toward AR-mediated m-commerce. Consequently, the study confirms that anthropomorphising AR-

					mediated m-commerce positively affects attitude, and it promotes the adoption of m-commerce
Liu et al. (2020)	Use of personalised avatars in both AR vs VR in garment fitting setting	Experiment and interviews	N/A	VR vs. AR; Motion vs. non-motion; Enjoyment, Convenience; Garment visualisation; Worry about fit problem; Usefulness; Purchase intention; Attitude toward shopping technology	According to the participants' comments, most thought that AR-based try-on provided better 3D visualisation and higher realism virtual avatars, which make the overall fitting experience more realistic than VR-based try-on.
Watson et al. (2020)	Online; AR makeup app online	Experiment	S-O-R model	Augmentation; Positive affective response; Purchase intention; Hedonic motivation	Augmentation creates a more positive emotional response than without augmentation. Results further show that it is this enhanced emotional response that creates greater purchase intention for those experiencing augmentation. The effect of augmentation on purchase intention is mediated by the positive affective response it evokes. Consumers who are more hedonically motivated experience a greater positive emotional response than those with low levels of hedonic motivation.
Song et al. (2020)	Online; AR watch try-on	Experiment	Situated cognition theory	Environmental embedding (EE); Simulated physical control (SPC); Immersion; Feeling of	EE and SPC evoke immersion, leading to the feeling of ownership of the virtual product. Psychological ownership could be formed directly through EE and SPC without the mediating role of

				ownership; Decision comfort	immersion. The mediating role of immersion was significant for the effect of EE on psychological ownership, while the effect of SPC on psychological ownership became insignificant with the inclusion of immersion as mediator. The impact of EE and SPC on immersion was attenuated for those with prior experience.
Moriuchi et al. (2021)	Online; comparing between AR and chatbot in online store	Experiment	Theory of Conversation (ToC) & Partially Observance Markov Decision process (POMD)	Attitude toward chatbot/AR; Technology engagement; Attitude toward firm; Satisfaction; Shopping intention; Revisit	The results show that people have a more pleasant experience when interacting with an AR app than a chatbot app.
Hilken et al. (2020)	Online; shared decision-making on AR apps	Experiment	Socially situated cognition	Point-of-view (POV) sharing (static vs. dynamic); Communicative acts (text-only vs. image-enhanced); Social empowerment; Recommendation comfort; Choice; Desire for the product; Usage intentions; WOM intentions	For recommenders, image-enhanced may compensate for static POV sharing and let them feel comfortable with providing a visually enhanced product recommendation. Initial evidence shows dynamic POV sharing formats may be complementary to providing text-only recommendations. For decision makers, it was found that image-enhanced (vs. text-only) acts enable them to feel socially empowered through another customer, increasing the likelihood of incorporating a recommendation into their choice of product.

Cuomo et al. (2020)	Offline; Adoption of AR technology in fashion chain store by omnicustomers	Survey	TAM	Perceived usefulness; Perceived ease of use; Behavioural intention; Usage behaviour; Consumer eagerness, AR settings; Omni-customer augmented experience	Sample does not show the ability to have a continuous experience across brands, across format and across devices (omni-channel). Despite an overall diffusion of the technology and increasing familiarity with digital devices for shopping, multi-channel consumer behavior that enables customers to browse or purchase products or services via digital devices anywhere was not greatly exercised by the interviewees. Data suggest technological acceptance and customer eagerness for shaping omnicustomer augmented brand experience.
Bonnin (2020)	Online; Use of AR try-on online to reduce uncertainty perceived risk	Experiment	Perceived risk	Presence/absence of AR; Utilitarian evaluation of the online store; Hedonic evaluation of the online store; Perceived product risk; Attractiveness of the online store; Patronage intention; Familiarity with AR	Attractiveness did not mediate the indirect relationship between AR and patronage intention via utilitarian evaluation. It does for perceived risk, but the link was weak. The influence of AR via perceived risk on patronage intention can be direct, with a strong effect. But for hedonic evaluation, the effect is only through attractiveness. This is also an important result because the hedonic influence of AR on patronage intention is dependent of the fact that the online store is perceived as different.

Park and Yoo (2020)	Online; Use of AR makeup app in online store	Survey	Mental imagery	Controllability of interactivity; Responsiveness of interactivity; Playfulness of interactivity; Elaboration of mental imagery; Quality of mental imagery; Attitudes; Behavioural intentions	Dimensions of perceived interactivity (i.e. controllability and playfulness) positively impact the elaboration of and quality of mental imagery, which then influences consumers' attitudes toward a product (more favourable) and their behavioural intentions.
McLean and Wilson (2019)	Online; mobile AR application for online customer engagement	Survey	TAM	AR interactivity; AR vividness; AR novelty; Perceived ease of use; Perceived usefulness; Enjoyment; Subjective norms; Purpose of use; Brand engagement; Satisfaction with customer experience; Brand usage intention	Positive perceptions of AR attributes (AR novelty, interactivity and vividness) and TAM attributes positively impact brand engagement via retailer's AR mobile app. Brand engagement leads to increased satisfaction with customer experience and intention of brand usage.
Brengman et al. (2019)	Online; comparison between touch vs. non-touch AR	Experiment	Perceived ownership	Touch vs. non-touch AR; Perceived ownership; Product attitudes; Purchase intention; Product type	Perceived ownership was higher for product with material properties, for which touch was more important. Perceived ownership would be highest in the case of AR, followed by the mobile phone, with the lowest perceived ownership pertaining to the laptop condition. The difference between the two 'touch' media, mobile phone and AR, is

					significant. Significant difference can be found between AR and the other media, while no significant difference is found between the non-augmented touch and non-touch media. Perceived ownership has a significant positive effect on product attitude and purchase intentions for both product type (material vs. geometric).
Heller et al. (2019)	AR app in offline service and in online webstore	Experiment, survey and field study	Mental imagery	AR imagery generation; Customer processing-type; Product contextuality; Processing fluency decision comfort; Behavioural intention (choice and word-of-mouth)	AR enabled shopping enhances decision comfort, positive word of mouth, and enables choice of higher value products. This is explained by improved processing fluency and decision comfort (mediators). Boundary conditions of AR effects include customer's visual processing styles and product contextuality.
van Esch et al. (2019)	Offline; Use of AR app to scan at point of scale	Field study	Anthromorphism	Anthromorphism; Convenience of transaction; Discomfort; Innovativeness; Product usage barrier; Side effect; Attitude toward brand	Anthropomorphism can have a strong effect on consumers, especially in the context of elicited agent knowledge. Perceived situational similarity yielded results ranging from increased confidence to the association of AR with transaction convenience, innovation, reduced barriers to product usage and the likelihood of side effects.

Huang (2019)	Online virtual try-on	Lab experiment	Self-referencing	Augmented-reality interactive technology (ARIT) vs Non-ARIT; Sense of ownership control; Rehearsability, Self-referencing; Brand love; IT identity	Simulating self-reference in online consumers produces concrete and vivid product utilisation and that online consumers place themselves within the sense of identity that is shaped by their avatar in the simulation experience, transferring it to the e-retailer and generating brand love. Rehearsability and high-level ownership control shaped self-referencing in dynamic simulations. Three major relationships (between rehearsability and self-referencing, self-referencing and online brand love, and self-referencing and IT identity) were found to be strengthened in ARIT environments, whereas the effect of the sense of ownership control on self-referencing was not.
Poushneh and Vasquez-Parraga (2017)	Online virtual try-on	Lab experiment	User experience	UX (includes antecedent variables –pragmatic quality, hedonic quality and aesthetic quality); Trade-off between price and value; User's information and privacy control	AR has a significant impact on UX (made up of 3 dimensions – see left column). UX is found to be positively and significantly associated with user satisfaction and user willingness to buy. UX partially mediated the relationship between AR and user satisfaction as well as AR and user willingness to buy.

Scholz and Duffy (2018)	Mobile AR app (Sephora)	Ethnography	Extended self	N/A (Grounded)	This study examined how consumers incorporate a branded AR app into their intimate space and into their sense of self. 3 main themes were found – ***Theme 1***: This 'outside-in' effect of the wider context is matched by an 'inside-out' effect of the inner context. The integration of branded content with consumers' own facial features, as well as other embodied interactions with the app and the media object collapses the distance between both relationship partners. In the resulting consumer/brand fusion, consumers' interests come to the foreground, while the brand recedes into the background. ***Theme 2:*** Both 'outside-in' and 'inside-out' effects open a hedonic, personal space that allows for fluid self-experimentation and self-expression, enactment of social relationships, as well as play, relaxation, and escape. ***Theme 3***: If the brand's economic and commercial interests come to the fore, or if the AR content is perceived as a wholly artificially layer that does not correspond to one's real face, the consumer does not incorporate the AR content into their self, shifting the dynamics where consumer reverts to treating the branded app as a task space to interact with a commercial outsider.

Poushneh (2018)	Development of augmentation quality scale that measures output quality of AR	Survey and interview	N/A	User satisfaction; User's control of personal information; Augmentation quality	When AR is unable to deliver virtual content precisely where users want it, augmentation quality will be diminished Augmentation quality and users' ability to keep personal information private shape satisfaction.
Dacko (2017)	Offline; mobile AR (MAR) shopping apps in smart retail	Survey	Experiential value	Experiential shopping benefits; Future retail patronage intent; Perceived drawbacks	Although MAR shopping apps are claimed to provide extrinsic value more than intrinsic value, only a small proportion of users believe that they can obtain both extrinsic and intrinsic benefits from using MAR shopping apps. Users view that these apps can offer one or more novel experiential benefits. Survey results also show that greater purchase satisfaction is a consequence of using MAR shopping apps.
Rese et al. (2017)	Marker-based (marker presented on print) and marker-less (via webcam) AR apps	Lab experiment	TAM	Perceived informativeness; Perceived enjoyment; Perceived usefulness; Perceived ease of use; Attitude toward using; Behavioural intention to use	Marker-less apps fared better than marker-based apps in terms of the TAM constructs, as findings indicated stronger recommendation and usage intentions.
Pantano et al. (2017)	Online; Comparison of AR try-on in Germany and Italy	Lab experiment	TAM	Perceived ease of use; Usefulness; Enjoyment, Attitude; Quality of information; Aesthetic quality, Interactivity,	Data collected from Italy and Germany both showed that TAM variables of the virtual try-on had a positive influence on attitude and attitude on purchase intention. Newly introduced constructs such as

		Response time; Purchase intention	quality of information, aesthetic quality, interactivity and response time as antecedents of the TAM variables were also found to be significantly influencing the TAM variables. Both Italian and German markets showed cross-market similarities but dissimilarities in consumer motivation to use AR in making online purchase decision.

Appendix B: Participant information sheet for Study 1

Participant Information Sheet

Augmented Reality Technology Use Behaviour in Offline Retail: A Goal-Directed Approach

Dear Participant,

Thank you for agreeing to participate in this interview in connection with my PhD research at the University of Nottingham Ningbo. The project is a study of augmented reality (AR) technology use in offline shopping, specifically the goals consumers seek to achieve by using AR technology in their offline shopping activities.

Your participation in the interview is voluntary. You are able to withdraw from the interview at any time and to request that the information you have provided is not used in the project. Any information provided will be confidential. Your identity will not be disclosed in any use of the information you have supplied during the interview.

The research project has been reviewed according to the ethical review processes in place in the University of Nottingham Ningbo. These processes are governed by the University's Code of Research Conduct and Research Ethics. Should you have any question now or in the future, please contact me or my supervisor. Should you have concerns related to my conduct of the interview or research ethics, please contact my supervisor or the University's Ethics Committee.

Yours truly,

Camen Teh

Contact details:

Student Researcher: Camen Teh (Camen.Teh@nottingham.edu.cn)

Supervisor: Chee Wei Phang (CheeWei.Phang@nottingham.edu.cn)

University Research Ethics Committee Coordinator, Ms Joanna Huang

(Joanna.Huang@nottingham.edu.cn)

声明

论文题目：Augmented Reality Technology Use Behaviour in Offline Retail: A Goal-Directed Approach

尊敬的参与者：

谢谢您参与这次面谈。这次面谈是我在宁波英国诺丁汉大学 博士研究相联系的。研究题目是 augmented reality (AR) technology use in offline shopping, specifically the goals consumers seek to achieve by using AR technology in their offline shopping activities.

您是自愿参与此次面谈的。您可以在任何时候选择放弃这次的面谈，并要求您提供的信息不被使用在调查中。您提供的所有信息都是保密的。在使用您提供的信息时不会涉及您的身份以及个人信息。

宁波诺丁汉大学已根据研究道德检查程序对这项研究项目进行检查。这一程序是在学校关于研究行为和研究道德的行为标准的指导下进行的。如果您现在或将来有任何疑问，请联系本人或我的导师。如果您对我在面谈中的研究行为或研究道德有任何质疑，请联系我的导师或者英国诺丁汉大学的道德委员会。

Camen Teh

联系方式：
研究员：Camen Teh (Camen.Teh@nottingham.edu.cn)
导师：(CheeWei.Phang@nottingham.edu.cn)

诺丁汉大学研究道德委员会秘书：Ms Joanna Huang
(Joanna.Huang@nottingham.edu.cn)

Appendix C: Participant consent form for Study 1

PARTICIPANT CONSENT FORM

Project title: Augmented Reality Technology Use Behaviour in Offline Retail: A Goal-Directed Approach

Researcher's name: Camen Teh

Supervisor's name: Chee Wei Phang

- I have read the Participant Information Sheet and the nature and purpose of the research project has been explained to me. I understand and agree to take part.
- I understand the purpose of the research project and my involvement in it.
- I understand that I may withdraw from the research project at any stage and that this will not affect my status now or in the future.
- I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential.
- I understand that the interview will be recorded.
- I understand that data will be stored in accordance with data protection laws.
- I understand that I may contact the researcher or supervisor if I require more information about the research, and that I may contact the Research Ethics Sub-Committee of the University of Nottingham, Ningbo if I wish to make a complaint related to my involvement in the research.

Signed [redacted] (participant)

Print name [redacted] **Date** 9/05/2020

Contact details

Researcher: Camen.Teh@nottingham.edu.cn

Supervisor: CheeWei.Phang@nottingham.edu.cn

UNNC Research Ethics Sub-Committee Coordinator:

Joanna.Huang@nottingham.edu.cn

参与者同意书

项目标题 Augmented Reality Technology Use Behaviour in Offline Retail: A Goal-Directed Approach

研究者姓名 Camen Teh

导师姓名 Chee Wei Phang

- 本人已阅读声明，项目组织者已经我解释了研究项目的性质和宗旨。本人理解并同意参与。
- 本人理解项目的目的和在项目中的参与作用。
- 本人明白可以在研究项目的任何阶段退出，不会因此影响现在以及将来的状况。
- 本人明白研究过程中信息可能会被公开，但本人身份不会被确认，个人的调查结果始终是被保密。
- 本人知道面谈将会被录音。
- 本人了解数据会根据数据保护相关法律进行存储。
- 本人知道，如果需要进一步有关研究的信息可以联系研究者或者导师，如果需要对参与研究提出投诉则可以联系宁波诺丁汉大学科研伦理小组委员会。

参与者签名..

日期..

联系方式
研究者：Camen Teh (Camen.Teh@nottingham.edu.cn)
导师：Chee Wei Phang (CheeWei.Phang@nottingham.edu.cn)

诺丁汉大学研究道德委员会秘书：Ms Joanna Huang (Joanna.Huang@nottingham.edu.cn)

Appendix D: Ethics approval for Study 1

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University of Nottingham Ningbo

Research Ethics Checklist for Staff and Research Students

[strongly informed by the ESRC (2012) *Framework for Research Ethics*]

A checklist should be completed for **every** research project or thesis where the research involves the **participation of people**, **the use of secondary datasets or archives relating to people and/or access to field sites or animals**. It will be used to identify whether a full application for ethics approval needs to be submitted.
<u>You must not begin data collection or approach potential research participants until you have completed this form, received ethical clearance, and submitted this form for retention with the appropriate administrative staff.</u>

The principal investigator or, where the principal investigator is a student, the supervisor, is responsible for exercising appropriate professional judgement in this review.

Completing the form includes providing brief details about yourself and the research in Sections 1 and 2 and ticking some boxes in Sections 3 and/or 4, 5, 6. **Ticking a shaded box in Sections 3, 4, 5 or 6 requires further action by the researcher**. Two things need to be stressed:

- Ticking one or more shaded boxes does **not** mean that you cannot conduct your research as currently anticipated; however, it does mean that further questions will need to be asked and addressed, further discussions will need to take place, and alternatives may need to be considered or additional actions undertaken.
- Avoiding the shaded boxes does **not** mean that ethical considerations can subsequently be 'forgotten'; on the contrary, research ethics - for everyone and in every project – should involve an ongoing process of reflection and debate.

The following checklist is a starting point for an ongoing process of reflection about the ethical issues concerning your study.

SECTION 1: THE RESEARCHER(S)

1.1: Name of principal researcher: Camen Teh

1.2: Status: ☐ Staff

☒ Postgraduate research student

1.3: School/Division: Nottingham University Business School China (NUBS China)

1.4: Email address: Camen.Teh@nottingham.edu.cn

1.5: Names of other project members (if applicable): N/A

1.6: Names of Supervisors (if applicable): Chee Wei (David) Phang

	Yes	No
1.7: I have read the University of Nottingham's *Code of Research Conduct and Research Ethics* (2010) and agree to abide by it: http://www.nottingham.edu.cn/en/research/researchethics/ethics-approval-process.aspx	☒	☐
1.8: (If applicable) I have read the University of Nottingham's *e-Ethics@Nottingham: Ethical Issues in Digitally Based Research* (2012) and agree to abide by it. http://www.nottingham.edu.cn/en/research/documents/e-ethics-at-the-university-of-nottingham.pdf	☒	☐
1.9: When conducting research on people (Section 5) I will prepare both a *participant consent form* as well as a *participant information sheet.* I am aware that the following templates are available on the Ethics webpage: http://www.nottingham.edu.cn/en/research/researchethics/ethics-approval-process.aspx • Participant consent form 1 • Participant Information Sheet English and Chinese	☒	☐

SECTION 2: THE RESEARCH

2.1: **Title of project:** Augmented Reality in Retail

Please provide brief details (50-150 words) about your proposed research, as indicated in each section

2.2: **Research question(s) or aim(s)**

This study seeks to answer the following research questions:

1. How can AR enable offline retail shoppers?
2. Why do shoppers use AR?

2.3: **Summary of method(s) of data collection**

This study will employ the laddering method, which is an in-depth one-on-one interviewing technique. We have identified an agency in Ningbo that have agreed to offer their services to recruit our study's participants for an agreed fee. The agency will remunerate the participants according to their service plan. The agency will make it clear to participants that they will watch 10 videos and be interviewed subsequently based on the videos watched (content of video described in below table in this section). These videos will be prepared in advance by the interviewer. Each interview will begin by asking participants to watch a series of videos related to Augmented Reality use in offline retail. The videos will be played by the interviewer for the participants to watch on a laptop. The video watching session will be held in the same venue of the interview, and immediately after the video session, participants will be interviewed in-depth according to the laddering method.

Description of AR videos and the AR application featured in the 10 videos

AR application	Brief description
Supermarket shopping AR (Acquia Labs)	Features of AR app include: in-store navigations, customer ratings, nutritional information and personalized recommendations.
AR product packaging (SIG-W-in-a-Box)	Interactive content on packaging allowing users to tap on information to view narratives of water's health benefits.
AR product packaging (Shazam-Bombay Sapphire)	Users can scan the label on the beverage to watch animated content. Content includes three different videos showcasing different recipes.
AR in apparel store (American Apparel)	AR app features include: showing customer reviews of products, slideshow of pictures of modelled clothing, video of modelled clothing, sharing function and colour assortment of product.
Supermarket shopping AR (Hansel)	AR app features include: in-store navigation, product discount information and personalized recommendations.
AR magic mirror in apparel store (UNIQLO)	Magic mirror displaying virtual clothing of different colour selections onto customer's camera view. Contains sharing function.
LEGO store AR	Displays a 3D animated version of LEGO kit when customers hold up boxed products in front of a display screen.
AR guidebot in furniture store	Voice recognition AI chatbot that guides customers with AR navigation. Also provides seller recommendation.
Treasure hunt AR in shopping mall	Gamified AR that involves a virtual bird navigating users around the mall to "unlock" discounts provided by stores in the mall.
AR store window (VyuAR)	Displays camera view of the store interior that creates a "transparent screen" effect, allowing both passer-bys and in-store customers to view virtual content such as 3D dragons and promotional information.

2.4: **Proposed site(s) of data collection**

At the recruitment agency's office in Ningbo. Agency's name is 宁波灵达商务服务有限公司. Address of the agency's office: 宁波江北区人民路 189 号中东欧大厦 409-410.

2.5: **How will access to participants and/or sites be gained?**

As mentioned in section 2.3, we have engaged with a recruitment agency in Ningbo to help us recruit 30 participants based on the below set of criteria for a service fee:

1. Young participants age 25-35 years old;

2. Are online shoppers/consumers;
3. Agree to a face-to-face interview at the venue of your agency's arrangement;
4. Agree to watch videos and answer interview questions, total duration of 45 minutes to 1 hour and 30 mins.

The agency will target participants who meet all of the above criteria located in the same office building as the agency's, or in close vicinity of their office building. This is to increase likelihood that participants will agree to a face-to-face interview. We will be paying a blanket fee to the agency that covers both the service and remuneration for interviewees' participation. The agency will be dealing with the remuneration process on top of arranging the time and venue of the interviews based on the participants' availability.

This agency is therefore the gatekeeper as indicated in Section 5.3 below. They are a local company in Ningbo that provide recruitment services for market surveys, and can recruit participants for face-to-face interviews.

All participants will be presented with the participant consent form and participant information sheet as enclosed with this application form. It will also be made clear that participants are free to withdraw from the research project at any point without any repercussion on their part.

Participants will be informed explicitly that the interview will be recorded and transcribed. Furthermore, they will be informed that all data collected will remain strictly confidential and any mention of the participant in published work will be made anonymous. All data collected will be kept safe and protected. After making these points clear, participants will be asked to read the consent form and information sheet. If participants have no further questions, they will be asked to sign both documents before proceeding with the interview. Participants are free to ask any questions that pertain to the research, and all questions will be answered truthfully by the researcher.

SECTION 3: RESEARCH INVOLVING USE OF SECONDARY DATASETS OR ARCHIVES RELATING TO PEOPLE

If your research involves use of secondary datasets or archives relating to people all questions in Section 3 **must** be answered. If it does not, please tick the 'not relevant' box and go to Section 4.

NOT RELEVANT	☒

Please answer each question by ticking the appropriate box.

	Yes	No
3.1: Is the risk of disclosure of the identity of individuals low or non-existent in the use of this secondary data or archive?	☐	☐
3.2: Have you complied with the data access requirements of the supplier (where relevant), including any provisions relating to presumed consent and potential risk of disclosure of sensitive information?	☐	☐

SECTION 4: RESEARCH INVOLVING ACCESS TO FIELD SITES AND ANIMALS

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If your research involves access to field sites and/or animals all questions in Section 4 **must** be answered. If it does not, please tick the 'not relevant' box and go to Section 5.

NOT RELEVANT	☒

Please answer each question by ticking the appropriate box.

	Yes	No
4.1: Has access been granted to the site?	☐	☐
4.2: Does the site have an official protective designation of any kind?	☐	☐
If yes, have the user guidelines of the body managing the site a) been accessed?	☐	☐
b) been integrated into the research methodology?	☐	☐
4.3: Will this research place the site, its associated wildlife and other people using the site at any greater physical risks than are experienced during normal site usage?	☐	☐
4.4: Will this research involve the collection of any materials from the site?	☐	☐
4.5: Will this research expose the researcher(s) to any significant risk of physical or emotional harm?	☐	☐
4.6: Will the research involve vertebrate animals (fish, birds, reptiles, amphibians, mammals) or the common octopus (*Octopus vulgaris*) in any capacity?	☐	☐
If yes, will the research with vertebrates or octopi involve handling or interfering with the animal in any way or involve any activity that may cause pain, suffering, distress or lasting harm to the animal?	☐	☐

SECTION 5: RESEARCH INVOLVING THE PARTICIPATION OF PEOPLE

If your research involves the participation of people all questions in Section 4 **must** be answered.

Please answer each question by ticking the appropriate box.

A. General Issues

	Yes	No
5.1: Does the study involve participants age 16 or over who are unable to give informed consent? (e.g. people with cognitive impairment, learning disabilities, mental health conditions, physical or sensory impairments?	☐	☒
5.2: Does the research involve other vulnerable groups such as children (**<u>aged under 16</u>**) or those in unequal relationships with the researcher? (e.g. your own students)	☐	☒
5.3: Will this research require the cooperation of a gatekeeper* for initial access to the groups or individuals to be recruited?	☒	☐

5.4: Will this research involve discussion of sensitive topics (e.g. sexual activity, drug use, physical or mental health)?	☐	☒
5.5: Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?	☐	☒
5.6: Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind?	☐	☒
5.7: Will this research involve people taking part in the study without their knowledge and consent at the time?	☐	☒
5.8: Does this research involve the internet or other visual/vocal methods where people may be identified?	☒	☐
5.9: Will this research involve access to personal information about identifiable individuals without their knowledge or consent?	☐	☒
5.10: Does the research involve recruiting members of the public as researchers (participant research)?	☐	☒
5.11: Will the research involve administrative or secure data that requires permission from the appropriate authorities before use?	☐	☒
5.12: Is there a possibility that the safety of **the researcher** may be in question?	☐	☒
5.13: Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?	☒	☐

**Gatekeeper- a person who controls or facilitates access to the participants*

B. Before starting data collection

	Yes	No
6.12: My full identity will be revealed to all research participants.	☒	☐
6.13: All participants will be given accurate information about the nature of the research and the purposes to which the data will be put. (*An example of a Participant Information Sheet is available for you to amend and use* at xxxxx) *http://www.nottingham.edu.cn/en/research/documents/participant-information-sheet-in-english-and-chinese.doc*	☒	☐
6.14: All participants will freely consent to take part, and, where appropriate, this will be confirmed by use of a consent form. (An example of a Consent Form is available for you to amend and use at: http://www.nottingham.edu.cn/en/research/researchethics/ethics-approval-process.aspx)	☒	☐
6.15: All participants will freely consent to take part, but due to the qualitative nature of the research a formal consent form is either not feasible or is undesirable and alternative means of recording consent are proposed.	☐	☒
6.16: A signed copy of the consent form or (where appropriate) an alternative record of evidence of consent will be held by the researcher.	☒	☐

6.17: It will be made clear that declining to participate will have no negative consequences for the individual.	☒	☐
6.18: Participants will be asked for permission for quotations (from data) to be used in research outputs where this is intended.	☒	☐
6.19: I will inform participants how long the data collected from them will be kept.	☒	☐
6.20: Incentives (other than basic expenses) will be offered to potential participants as an inducement to participate in the research. (Here any incentives include cash payments and non-cash items such as vouchers and book tokens.)	☒	☐
6.21: For research conducted within, or concerning, organisations (e.g. universities, schools, hospitals, care homes, etc) I will gain authorisation in advance from an appropriate committee or individual.	☒	☐

C. During the process of data collection

	Yes	No
6.25: I will provide participants with my University contact details, and those of my supervisor (*where applicable*) so that they may get in touch about any aspect of the research if they wish to do so.	☒	☐
6.26: Participants will be guaranteed anonymity only insofar as they do not disclose any illegal activities.	☒	☐
6.27: Anonymity will not be guaranteed where there is disclosure or evidence of significant harm, abuse, neglect or danger to participants or to others.	☒	☐
6.28: All participants will be free to withdraw from the study at any time, including withdrawing data following its collection.	☒	☐
6.29: Data collection will take place only in public and/or professional spaces (e.g. in a work setting	☒	☐
6.30: Research participants will be informed when observations and/or recording is taking place.	☒	☐
6.31: Participants will be treated with dignity and respect at all times.	☒	☐

D. After collection of data

	Yes	No
6.32: Where anonymity has been agreed with the participant, data will be anonymised as soon as possible after collection.	☒	☐
6.33: All data collected will be stored in accordance with the requirements of the University's Code of Research Conduct	☒	☐
6.34: Data will only be used for the purposes outlined within the participant information sheet and the agreed terms of consent.	☒	☐
6.35: Details which could identify individual participants will not be disclosed to anyone other than the researcher, their supervisor and (if necessary) the Research Ethics Panel and external examiners without participants' explicit consent.	☒	☐

E. After completion of research

	Yes	No
6.37: Participants will be given the opportunity to know about the overall research findings.	☒	☐
6.38: All hard copies of data collection tools and data which enable the identification of individual participants will be destroyed.	☒	☐

*If you have **not** ticked any shaded boxes,* please send the completed and signed form to the School's Research Ethics Officers, with any further required documents, for approval and record-keeping.

If you have ticked any shaded boxes **you will need to describe more fully how you plan to deal with the ethical issues raised by your research**. Issues to consider in preparing an ethics review are given below. Please send this completed form to the Research Ethics Officer who will decide whether your

project requires further review by the UNNC Research Ethics Sub-Committee and/or whether further information needs to be provided.
Please note that it is your responsibility to follow the University's ***Research Code of Conduct*** and any relevant academic or professional guidelines in the conduct of your study. **This includes providing appropriate information sheets and consent forms, and ensuring confidentiality in the storage and use of data. For guidance and UK regulations on the latter, please refer to** the *Data Protection Policy and Guidelines* of the University of Nottingham:

Policy - http://www.nottingham.ac.uk/%7Ebrzdpa/local/dp-policy.doc

Guidelines -http://www.nottingham.ac.uk/~brzdpa/local/dp-guidance.doc

Any significant change in the project question(s), design or conduct over the course of the research should be notified to the School Research Ethics Officer and may require a new application for ethical approval.

Signature of Principal Investigator/Researcher:

CAMEN TEH

Signature of Supervisor (where appropriate):

Chee Wei (David) Phang

Date: 28 July 2020

Research Ethics Panel response

☒ the research can go ahead as planned

☐ further information is needed on the research protocol (see details below)

☐ amendments are requested to the research protocol (see details below)

Augmented Reality in Retail

School REO... Jin Chen .... Yang Yang Zhang .... Date ...July 31st 2020...

A. LIST OF POINTS TO CONSIDER WHEN SUBMITTING AN ETHICS REVIEW (taken from ESRC (2012) *Framework for Research Ethics*).

Risks
1. Have you considered risks to:

the research team?
the participants? *Eg harm, deception, impact of outcomes*
the data collected? *Eg storage, considerations of privacy, quality*
the research organisations, project partners and funders involved?

2. Might anyone else be put at risk as a consequence of this research?
3. What might these risks be?
4. How will you protect your data at the research site and away from the research site?
5. How can these risks be addressed?

Details and recruitment of participants

6. What types of people will be recruited? *Eg students, children, people with learning disabilities, elderly?*
7. How will the competence of participants to give informed consent be determined?
8. How, where, and by whom participants will be identified, approached, and recruited?
9. Will any unequal relationships exist between anyone involved in the recruitment and the potential participants?
10. Are there any benefits to participants?
11. Is there a need for participants to be de-briefed? By whom?

Research information

12. What information will participants be given about the research?
13. Who will benefit from this research?
14. Have you considered anonymity and confidentiality?
15. How will you store your collected data?
16. How will data be disposed of and after how long?
17. Are there any conflicts of interest in undertaking this research? *Eg financial reward for outcomes etc.*
18. Will you be collecting information through a third party?

Consent

19. Have you considered consent?
20. If using secondary data, does the consent from the primary data cover further analysis?
21. Can participants opt out?
22. Does your information sheet (or equivalent) contain all the information participants need?
23. If your research changes, how will consent be renegotiated?

Ethical procedures

24. Have you considered ethics within your plans for dissemination/impact?
25. Are there any additional issues that need to be considered ? *Eg local customs, local 'gatekeepers', political sensitivities*
26. Have you considered the time you need to gain ethics approval?
27. How will the ethics aspects of the project be monitored throughout its course?
28. Is there an approved research ethics protocol that would be appropriate to use?
29. How will unforeseen or adverse events in the course of research be managed? *Eg do you have procedures to deal with any disclosures from vulnerable participants?*

Appendix E: Codebook

AUGMENTED REALITY (AR) MEANS-END-CHAIN STUDY

Codebook for attribute-consequence-value codes

INSTRUCTIONS

- The NVivo data has been coded by the principal investigator. This codebook is to guide subsequent coders through a systematic process of reliability check.
- Coders will be given a code scheme accompanied with this codebook. In the coding scheme, coders will mark "1" in the cell that coincides with a given code (e.g. A01, A02; C01, C02, V01, V02…) and a highlighted reference (e.g. R1, R2, R3…).
- For instance, if coder observes that R1 falls under code C4, coder will mark "1" in the cell that coincides with R1 and C4.
- In the event that coder finds that a reference can be coded into two codes, all coders will discuss together to decide on one single code.

CODE DEFINITIONS AND EXAMPLES

Group 1: Attributes

Attributes refer to the basic-level tangible characteristics of AR that were observable by participants during the comparison between AR videos.

Code	Aggregated codes and summary (with sample citations)	Raw codes
A01	**Virtual-real integration** Virtual items (e.g. virtual clothes, virtual animations, virtual version of boxed products) presented onto the real environment or real objects (e.g. customers' body, store, real products). *e.g. "... so I can see what I'll look like in the clothes with the virtual clothes on my own body.."*	
A02	**3-Dimensional (3D)** Three-dimensionality of the AR content. *e.g. "It was 3D, and the 3D presentation really catches our attention."*	
A03	**Recommendation** AR applications' recommending system elements. *e.g. "It's a lot like Siri, when I have a request or when I am unsure about what to buy, it will give me some appropriate recommendations"*	

<table>
<tr><td>A04</td><td colspan="2">Navigation
Virtual signals provided by AR app for consumer navigation and identification of product location.
e.g. “It helps you find the corresponding products and bring you to the corresponding location. I think this is very convenient, yes, first, because sometimes go there, especially with big shopping malls, you want to find products that you need, but there are just too many, making it difficult to find and choose.”</td></tr>
<tr><td rowspan="3">A05</td><td rowspan="3">Amplified product information
Additional and more detailed information about products presented through AR app.</td><td>Discount information
Information on sales, discounts and coupons.
e.g. “"It's like a treasure chest of discounts. It's very attractive to most people."</td></tr>
<tr><td>Product feature information
Information about features of products (e.g. nutrition, background, origins etc.)
e.g. “All that nutrition information on top of the drink box. Many detailed info on it. That’s pretty good."</td></tr>
<tr><td>Product guide
Information provided by AR app to guide users on how to use products.
e.g. "The third one [AR app], we seem to have something like this now… it will tell you how to use it or how to do it."</td></tr>
<tr><td>A06</td><td colspan="2">Integrated resources
The “one-stop” characteristic of AR apps allowing users to quickly access multiple types of information all in one app.
e.g. “Without apps like this, I would have to physically go to each and every store one by one, look through discount information on billboards outside their store or even go into the store to get information one by one. If I use this app, I can just see everything at a glance.”</td></tr>
<tr><td>A07</td><td colspan="2">Customer reviews
Reviews or information about the product from other individuals who have bought and used the product.
e.g. “... with customer reviews, I’m able to get other people’s opinion about the quality of the product after buying it.”</td></tr>
<tr><td>A08</td><td>Interactivity
Three-dimensionality and animation of virtual items that facilitate consumer interaction.</td><td>Dynamic content
AR content that is animated and dynamic.</td></tr>
</table>

		e.g. "It's basically the animation that makes it different I guess? It's easier for people to understand this than like a guide on a manual"
		User-content interaction User/consumer can interact (e.g. touch, speak, control) with the AR system and its content. *e.g. "It's a good thing .... Everywhere in the store is a salesperson, and if there is a small robot* [in the AR app]*, I think it's a pleasure to talk to it."*
A09	**Assortment** Users have access to an extended variety of product options. *e.g. "I have more variety, and I can see if the colour I want that looks good on me exists."*	
A10	**Realism** The ability for AR to produce a sensorially rich environment, allowing for the perceptual fidelity of the "real".	**Vividness** Perception of a sensorially rich environment. *e.g. "One is kinda flat like 2D, but the three-dimensional one will be more vivid and may attract you more."*
		Fidelity to the real The degree of perceptual fidelity of the real or "realness". *e.g. "I think it's the AR that makes it feel real. It's different from viewing it on a piece of paper.."*

Group 2: Consequences

Consequences refer to the outcomes that the tangible characteristics of AR were mentioned to lead to when participants were asked why a certain AR attribute was important to them. Coders can understand this as the immediate answer to the question “Why is [AR attribute] important to you?”.

<table>
<tr><th>Code</th><th>Aggregated codes and summary (with sample citations)</th><th>Raw codes</th></tr>
<tr><td rowspan="2">C01</td><td rowspan="2">Autonomy
User has control over information displayed and shopping experience with minimal assistance from services staff</td><td>Control
User has control over information displayed.
e.g. “Why do I like it, as I said just now, maybe it is an app and if I want to see something, something I don't know very well, then I can click on it, and then it will introduce it to me in is detail. I can close it when I don't need it.”</td></tr>
<tr><td>Self-service
e.g. “Why do I like it, as I said just now, maybe it is an app and if I want to see something, something I don't know very well, then I can click on it, and then it will introduce it to me in is detail. I can close it when I don't need it.”</td></tr>
<tr><td>C02</td><td colspan="2">Product impression
Consumers have a deeper and stronger impression of the product with AR experience, making it more memorable.
e.g. “... I can say the product presentation makes it feel very direct and intuitive. And I will remember this product and feel good about the product.</td></tr>
<tr><td>C03</td><td colspan="2">Immersiveness
Consumers are engaged and engrossed in an environment embedded with virtual elements.
e.g. “It’s hard to explain... so for example, some books have pictures and illustrations but with AR you can create a whole scene you know, and it transports me into this scene, into the plot.”</td></tr>
<tr><td>C04</td><td>Ability to visualise</td><td>Visualise product outcomes of product</td></tr>
</table>

	The ability for users to have a vivid visualisation of a product, of its potential use scenarios, and of its ownership.	Users are able to visualise how a product is used and/or the effects of product use. *e.g. "... it* [the toy product] *is unopened, and then, under this* [AR] *screen, you can see its final shape, and how to play it..."*
		Visualise product use experience Users are able to visualise the experience of using the product and how it feels like to use to product. *e.g. "It can be moved around to see how it looks like from all angles… it's definitely more effective than a regular paper manual, isn't it? After seeing it, I can imagine what it would be like if I was playing it."*
		Vivid and concrete visualisation Users are able to visualise the product in a more vivid and detailed manner. *e.g. "With just a picture, I don't really know what the product would look like. But with this, you can really see its real size. You see the 3D model, with a 360 angle view. I will have a more concrete idea about what the product looks like."*
C05	**Cost saving** Users can save money. *e.g. "By making a good judgment and good choice, I don't have to buy another product. It saves my money."*	
C06	**Efficiency** Ability for consumers to achieve maximum productivity with minimal time as well as cognitive and physical effort.	**Convenience** Shopping process and experience becomes more convenient. *e.g. "It tells you how to do it, and and without you would have to search how to make*

		it and all these steps. But with this I just need to scan and it will give you, which is very convenient..."
		Efficient shopping Shopping experience is made more efficient and effective. *e.g. "The fifth one, for example, if you make a list to buy something, then you can use the navigation line to greatly improve the efficiency of shopping..."*
		Save effort Saves cognitive and physical effort for consumers. *e.g. "I won't need to make so much effort to guess how it will turn out in real life."*
C07	**Time saving** Users can save time. *e.g. "If this app tells me where to go, it's not as time consuming as trying to find it myself."*	
C08	**Product knowledge** Users have more in-depth and clearer knowledge of the products, including its uses and potentials as well as an understanding of what to expect of the product.	**Product uses** AR app presents how the product should or can be used. *e.g. "From the information, I'll know the correct way of using it. It's directly from the producer of the product. That way I know how to use it the way I'm supposed to."*
		Product potentials Consumers are informed of the different potential uses of the product, which may be new to the consumers. *e.g. "...Or I buy something, but I didn't know the other possible ways to use it, and it would be big waste. This app shows the other scenarios I can use it for."*
		Product expectations

		Consumers have a better idea of the product and know what to expect from the product. *e.g. "Because sometimes I am afraid that it looks different in the beginning from what it actually is after you buy it. If you have this* [AR app], *you can see if it is really what you want it and then you can buy what you want..."*
		Product understanding Consumers can understand products and how to use the products in more depth, with clarity, less effort and less time. *e.g. "In our regular shopping when we have to make decisions, sometimes it's hard for us to get all the information in our heads. But this way of showing information makes people want to absorb the information and in a way, lets us absorb more knowledge."*
C09	**Product evaluation** AR facilitates the process of users evaluating a product by making choices easier to make, providing assurance through product credibility, product comparison, product fit and perceived product worth and overall reduced uncertainty.	**Choice optimisation** Users can choose the best product out of other product options and the process of making such a choice is made clear and easy by AR app. *e.g. "Because, for example, there are two colours, and I am hesitating which one should I choose... For example, the red has many shades like bright red or rose red. I will be confused. Whether to buy this red or rose red, but this AR machine allows me to see the*

		difference on myself more clearly."
		Product credibility Consumers have higher trust towards the product, brand and/or retailer. *e.g. "For example, if I really wanted to buy this thing, I will definitely pay for it, but after you show me this thing [AR overlaid info], I may have more confidence in you, or I may have more confidence in your product."*
		Product comparison AR app allows consumers to make comparisons between products. *e.g. "Then it [the app] shows you all the price info … which will save you time, if you really want to compare prices of products…"*
		Product fit Consumers can determine whether or not the product fits their needs, expectations and preference. *e.g. "...I just stand there, just put it [virtual clothes] on my body for a while, I just have to look at it and I will know which colour suits me better..."*
		Product worth Consumers' evaluation of the product's value and usefulness, as well as whether it is/was worthy of purchase and the resources (e.g. time and money) spent into purchasing it. *e.g. "I think details are important, so I spent this money, right? I must know its*

		value, whether it is worth my money..."
		Reduced product uncertainty Consumers feel more confident about a product, and that there is less risk in purchasing the product. *e.g. "I feel secure in my heart. I can make the decision ...whether this product is worth buying"*
C10	**Positive customer experience** Experiential retail shopping where users are offered a different shopping experience beyond traditional ones through the elicitation of hedonic elements such as novelty, comfort and curiosity.	**Novelty** Feeling and/or experience of newness and uncommonness that sparks interest in users. *e.g. "It's not something we experience or see every day. It's very interesting."*
		Good experience Shopping experience is improved, more enjoyable, memorable and interesting. *e.g. "It's such a fun experience... when you find something like this, you remember it. It's different."*
		Comfortable shopping Consumers have a comfortable shopping experience. *e.g. "People don't like having to think too much. They [The AR] shows everything directly. You don't have to think about anything and it just comes out right away. Makes me feel like it's more comfortable..."*
		Curiosity AR application arouse consumers' interest and attracts their attention. *e.g. "Just having something different in life that maybe is*

		something that maybe you don't really understand what's going on. It makes you curious and we experience that in this environment, like it gives you something to be curious about, right?"
C11	**Purchase intention** Users' intent to make a purchase. *e.g. "Actually that was one of the things that would probably make me buy it, because I'll be able to see how it looks like and how you can play with it."*	
C12	**Retailer appeal** Users are attracted to the store or mall. *e.g. "I will go into the store to try the AR app. And perhaps I will look around the store too... why not shop around to see if there are any shoes I'm interested in."*	

Group 3: Values

Values refer to the abstract personal values that are followed by why the *consequences* mentioned by respondents were important to them. In other words, these could be the personal values that guide their general life decisions and choices. Coders should be aware that these may not seem like they are directly related to AR attributes but requires interpretation of the whole laddering process – hence, when checking the assigned codes, coders should read these in the context of laddering and revisit the full interview transcript.

Code	Aggregated codes and summary (with sample citations)	Raw codes
V01	**Negative emotion avoidance** Users want to avoid negative emotions such as feelings of regret or guilt. *e.g. "So like maybe I buy the clothes I thought would fit me well, but once I put it on, it's not what I thought it would look like. So I feel bad and disappointed. My mood gets ruined and I don't want that."*	
V02	**Avoid wastefulness** Users values avoiding wasting precious money, time and effort. *e.g. "If I buy something I will never wear, I will feel like it's a waste of money."*	
V03	**Maximise resources** Users can allocate their time and money on other priorities in their lives.	**Maximise time** Consumers can allocate their time to other priorities in their lives. *e.g. "For example, it usually takes me take an hour for me to shop and to try on clothes, but if I can use this app and change colours like this, I*

		may finish it in half an hour, and I can do other things in the other half an hour…"
		Maximise money Consumers can allocate their money to other priorities in their lives. *e.g. "For example, there are some items that can be discounted, which is great for me, and I can spend what I saved from the discount on another item..."*
V04	**Happiness and satisfaction** Feelings of joy and satisfaction derived from product and experience. *e.g. "It affects how I feel. If I see something cool and interesting, it just makes me enjoy my shopping experience and it makes me feel happy."*	**Happy or satisfied with product** Consumers are satisfied and/or happy with product. *e.g. "I mean, we buy things because it's for ourselves right? If we are happy with the product, we're happy with ourselves."*
		Happy or satisfied with experience Consumers are satisfied and/or happy with their experience. *e.g. "When you buy something, and you have a good time, you also get a feeling of happiness in that process of buying. It puts you in a good mood, you know?"*
V05	**Improve life quality** Life is better for users. *e.g. "Living comfortably is very important to me."*	
V06	**Enhancement of self-esteem** Users feel good about themselves, through self-confidence and the ability to accomplish something and develop themselves (e.g. knowledge). *e.g. "When I learn about something new, I am very happy and I feel proud of myself."*	**Self-confidence** Relates to individual's confidence in one's self and self-esteem. *e.g. "Of course it's important. If I'm in a good mood, I'm more confident"*
		Self-development

		Personal growth, expansion of individual's capabilities, potential and knowledge. *e.g. "I guess gaining knowledge is a big part of life. You constantly want to improve yourself, right?"*
		Sense of accomplishment Feeling of pride and/or pleasure in obtaining or completing something. *e.g. "When you learn something new, you'll feel happy, and proud of yourself."*

Appendix F: Coding scheme

		ROUND 1: FIRST ROUND CODING		ROUND 2: INTERCODER AGREEMENT						ROUND 3: RESOLVING DISAGREEMENTS	
		Coder 1		Coder 2				Coder 1		Coder 2	
File	Reference label	Code label	Raw code	0=Disagree; 1=Agree	Suggested code label	Suggested code	Comments from Coder 2	Resolve	Comments from Coder 1	0=Disagree; 1=Agree	If disagree, please comment
	R1	A04	Navigation	1							
	R2	C07	Time saving	1							
	R3	C06	Efficient shopp	1							
	R4	V02	Avoid waste	1							
	R5	V02	Avoid waste	0	V01	Avoid feeling bad	participant wants to avoid waste to avoid feeling bad	Y			
	R6	A01	Virtual-real int	1							
	R7	C04	Visualise poter	1							
	R8	C07	Time saving	1							
	R9	V06	Self-confidenc	1							
	R10	A10	Realness	1							
	R11	C09	Product fit	1							
	R12	A01	Virtual-real int	1							
	R13	V01	Avoid feeling b	0	V01 & V02	Avoid feeling bad & Avoid waste	Could be both	N	V01 only, as V01 is the main value discussed and V02 is just an exa	1	
	R14	A03	Recommendati	0	A04	Navigation		Y			
	R15	C06	Convenient	1							
	R16	C07	Time saving	1							
	R17	A08	Dynamic conte	1							
	R18	A08	User-content ir	1							
	R19	C08	Product proten	1							
P1	R20	V04	Satisfied or hap	1							
	R21	V04	Satisfied or hap	1							
	R22	A05	Discount inforr	1							
	R23	C07	Time saving	1							
	R24	A05	Extensive prod	1							
	R25	A07	Customer revie	1							
	R26	C09	Choice optimis	1							
	R27	V06	Sense of accom	1							
	R28	C09	Product fit	1							
	R29	A09	Assortment	1							
	R30	C09	Choice optimis	1							
	R31	V02	Avoid waste	1							
	R32	V01	Avoid feeling b	1							
	R33	C08	Enhance produ	0	V05	Maximize money		N	Doesn't sound like it's a terminal value, but rather a consequence of being able to maximise the value of a product, not so much maximise cost. I suggest C08 - Enhance product value	1	
	R34	C10	Novelty	1							
	R35	V04	Satisfied or hap	1							
	R36	A10	Vividness	0	C09	Positive customer experience	participant talks about experience as a result of the app	Y			
	R37	V06	Sense of accom	1							

Note: Above is a coding scheme sample taken from Participant P1. Reference labels are used to refer to the reference texts from interview transcripts that were taken for analysis. Round one involves original coding that was conducted by Coder 1, where the code labels referring to individual aggregated codes are assigned to the reference texts. Raw codes were also noted next to the code label of aggregated code labels. Round 2 involves Coder 2 indicates their agreement whether the codes were appropriately assigned (0=Disagree; 1-Agree). If Coder 2 indicates disagreement, a suggested code is given with justification for the disagreement and suggested alternative code. If Coder 1 agrees with suggestion to assign new code, the disagreement is resolved and a new code is assigned. If Coder 1 disagrees, justification is given for disagreement in. Coder 2 indicates if justification is valid or not in Round 3. All disagreements were resolved by Round

Appendix G: Ethics approval for Study 2

Some changes were made to the experiment design and data collection procedure from when this approval was received. Only experiment groups 1 to 4 were kept and only one round of data collection was conducted for this thesis.

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Research Ethics Checklist for Staff and Research Students

[strongly informed by the ESRC (2012) *Framework for Research Ethics*]

A checklist should be completed for **every** research project or thesis where the research involves the **participation of people**, **the use of secondary datasets or archives relating to people and/or access to field sites or animals**. It will be used to identify whether a full application for ethics approval needs to be submitted.
You must not begin data collection or approach potential research participants until you have completed this form, received ethical clearance, and submitted this form for retention with the appropriate administrative staff.

The principal investigator or, where the principal investigator is a student, the supervisor, is responsible for exercising appropriate professional judgement in this review.

Completing the form includes providing brief details about yourself and the research in Sections 1 and 2 and ticking some boxes in Sections 3 and/or 4, 5, 6. **Ticking a shaded box in Sections 3, 4, 5 or 6 requires further action by the researcher**. Two things need to be stressed:

- Ticking one or more shaded boxes does **not** mean that you cannot conduct your research as currently anticipated; however, it does mean that further questions will need to be asked and addressed, further discussions will need to take place, and alternatives may need to be considered or additional actions undertaken.
- Avoiding the shaded boxes does **not** mean that ethical considerations can subsequently be 'forgotten'; on the contrary, research ethics - for everyone and in every project – should involve an ongoing process of reflection and debate.

The following checklist is a starting point for an ongoing process of reflection about the ethical issues concerning your study.

SECTION 1: THE RESEARCHER(S)

1.1: Name of principal researcher: Camen Teh

1.2: Status: ☐ Staff

☒ Postgraduate research student

1.3: School/Division: Nottingham University Business School China (NUBS China)

1.4: Email address: Camen.Teh@nottingham.edu.cn

1.5: Names of other project members (if applicable): N/A

1.6: Names of Supervisors (if applicable): Chee Wei (David) Phang

	Yes	No
1.7: I have read the University of Nottingham's *Code of Research Conduct and Research Ethics* (2010) and agree to abide by it: http://www.nottingham.edu.cn/en/research/researchethics/ethics-approval-process.aspx	☒	☐
1.8: (If applicable) I have read the University of Nottingham's *e-Ethics@Nottingham: Ethical Issues in Digitally Based Research* (2012) and agree to abide by it. http://www.nottingham.edu.cn/en/research/documents/e-ethics-at-the-university-of-nottingham.pdf	☒	☐
1.9: When conducting research on people (Section 5) I will prepare both a *participant consent form* as well as a *participant information sheet.* I am aware that the following templates are available on the Ethics webpage: http://www.nottingham.edu.cn/en/research/researchethics/ethics-approval-process.aspx • Participant consent form 1 • Participant Information Sheet English and Chinese	☒	☐

SECTION 2: THE RESEARCH

2.1: **Title of project:** Using Augmented Reality Technology For Schema Incongruent Products

Please provide brief details (50-150 words) about your proposed research, as indicated in each section

2.2: **Research question(s) or aim(s)**

This study seeks to answer the following research questions:

1. Does AR product presentation assist shoppers in the incongruity resolution of a schema-incongruent product?
2. How do different styles of AR presentation (cartoon vs. realistic) affect incongruity resolution for schema-incongruent products?

2.3: **Summary of method(s) of data collection**

This study will employ 2 (AR cartoon vs. AR non cartoon) x 2 (AR control vs. AR no control) +1 (without AR) between-group experiment design. Each group will consist of at least 50 participants per group (at least 250 participants in total). The data collection will consist of two rounds. The first round will take place over the span of 2 weeks at the end of October at UNNC. The second round will take place in November at Fudan University.

Round 1

Week 1 (no on-site participation is needed)

1. **[Online]** Participants who have consented to the participating in the experiment will first be asked to watch several videos about the use of AR product packaging and answer a short online survey about the videos:

   Links to videos:

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- https://youtu.be/Lf2xJ4Os_pY
- https://youtu.be/j8NWVtCD_nA
- https://youtu.be/Cfvkm6-ruqM

Participants will be issued the first part of their remuneration (20 RMB) after the completion of the survey. This will be issued by an external market research company, Findoout.*

2. Participants will be asked to confirm their availability to participate in the on-site experiment at a store on the UNNC campus, Food Basket on campus's High Street on a stipulated weekend in Week 2 of the data collection timeline.

Week 2

1. After confirming their availability, on the day of experiment, participants will enter the store where they will see a promotion on a new product (JUST Eggs product) that is the schema-incongruent stimulus for our experiment.

2. **[On-site]** Participants in Group 1, 2, 3 and 4 will scan a code on the product that will trigger a corresponding AR presentation as shown in the table below. Participants in Group 5 will watch a non-AR video presentation of the product. AR Cartoon refers to a cartoonised version of the AR presentation, AR non-cartoon refers to a realistic version of the AR presentation. AR control refers to AR presentation where participants can control what they see with interactive buttons, AR no control refers to AR presentation without interactive buttons.

<table>
<tr><td>Group 1
AR Cartoon + AR control</td><td>Group 2
AR Cartoon + AR no control</td><td rowspan="2">Group 5
No AR</td></tr>
<tr><td>Group 3
AR Non-cartoon + AR control</td><td>Group 4
AR Non-cartoon + AR no control</td></tr>
</table>

3. After receiving the treatment, participants will answer an online survey accessible via their mobile phone. Participants will be issued the remaining part of their remuneration (60 RMB) after the completion of the survey. This will also be issued by an external market research company, Findoout.*

*all online surveys will be done on Findoout's survey platform

<u>Round 2</u>

Round 2 will follow the above experiment procedure, but this will be coordinated by the external market research company, Findoout and the experiment will take place in Fudan University.

2.4: **Proposed site(s) of data collection**

First round will be at Food Basket on UNNC High Street. Second round will be in Fudan University.

2.5: **How will access to participants and/or sites be gained?**

Data collection site

- Round 1: We have already discussed the arrangement with the store owner on campus, and she agreed to let us conduct our experiment there.
- Round 2: Access to the site will be arranged by a market research company and they will coordinate participant recruitment and on-site experiment set up.

Participant recruitment

- Target participants: UNNC and Fudan University students
- UNNC students will be recruited internally. Call for participants posts and ads on UNNC student WeChat mini program forum AllLink. This mini program is a student-led platform targeted to students of UNNC. For the participants in Fudan university, we will be engaging an external market research company (Findoout) to recruit and coordinate student participants.
- All participants will receive 80 RMB as compensation, split into 20 RMB and 60 RMB at two stages of the data collection process as explained in Section 2.3. The external market research company Findoout will arrange the compensation to all the participants.

  Please see introduction pdf used in our participant recruitment attached to this ethics form.

SECTION 3: RESEARCH INVOLVING USE OF SECONDARY DATASETS OR ARCHIVES RELATING TO PEOPLE

If your research involves use of secondary datasets or archives relating to people all questions in Section 3 **must** be answered. If it does not, please tick the 'not relevant' box and go to Section 4.

NOT RELEVANT	☒

Please answer each question by ticking the appropriate box.

	Yes	No
3.1: Is the risk of disclosure of the identity of individuals low or non-existent in the use of this secondary data or archive?	☐	☐
3.2: Have you complied with the data access requirements of the supplier (where relevant), including any provisions relating to presumed consent and potential risk of disclosure of sensitive information?	☐	☐

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SECTION 4: RESEARCH INVOLVING ACCESS TO FIELD SITES AND ANIMALS

If your research involves access to field sites and/or animals all questions in Section 4 **must** be answered. If it does not, please tick the 'not relevant' box and go to Section 5.

NOT RELEVANT	☒

Please answer each question by ticking the appropriate box.

	Yes	No
4.1: Has access been granted to the site?	☐	☐
4.2: Does the site have an official protective designation of any kind?	☐	☐
If yes, have the user guidelines of the body managing the site a) been accessed?	☐	☐
b) been integrated into the research methodology?	☐	☐
4.3: Will this research place the site, its associated wildlife and other people using the site at any greater physical risks than are experienced during normal site usage?	☐	☐
4.4: Will this research involve the collection of any materials from the site?	☐	☐
4.5: Will this research expose the researcher(s) to any significant risk of physical or emotional harm?	☐	☐
4.6: Will the research involve vertebrate animals (fish, birds, reptiles, amphibians, mammals) or the common octopus (*Octopus vulgaris*) in any capacity?	☐	☐
If yes, will the research with vertebrates or octopi involve handling or interfering with the animal in any way or involve any activity that may cause pain, suffering, distress or lasting harm to the animal?	☐	☐

SECTION 5: RESEARCH INVOLVING THE PARTICIPATION OF PEOPLE

If your research involves the participation of people all questions in Section 4 **must** be answered.

Please answer each question by ticking the appropriate box.

A. General Issues

	Yes	No
5.1: Does the study involve participants age 16 or over who are unable to give informed consent? (e.g. people with cognitive impairment, learning disabilities, mental health conditions, physical or sensory impairments?	☐	☒
5.2: Does the research involve other vulnerable groups such as children (**aged under 16**) or those in unequal relationships with the researcher? (e.g. your own students)	☐	☒
5.3: Will this research require the cooperation of a gatekeeper* for initial access to the groups or individuals to be recruited?	☒	☐
5.4: Will this research involve discussion of sensitive topics (e.g. sexual activity, drug use, physical or mental health)?	☐	☒
5.5: Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?	☐	☒
5.6: Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind?	☐	☒
5.7: Will this research involve people taking part in the study without their knowledge and consent at the time?	☐	☒
5.8: Does this research involve the internet or other visual/vocal methods where people may be identified?	☒	☐
5.9: Will this research involve access to personal information about identifiable individuals without their knowledge or consent?	☐	☒
5.10: Does the research involve recruiting members of the public as researchers (participant research)?	☐	☒
5.11: Will the research involve administrative or secure data that requires permission from the appropriate authorities before use?	☐	☒
5.12: Is there a possibility that the safety of **the researcher** may be in question?	☐	☒
5.13: Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?	☐	☒

**Gatekeeper- a person who controls or facilitates access to the participants*

Notes

5.3 – There will be no gatekeepers for UNNC data collection. Food Basket, the store on High Street will be providing the experiment site. Store owner can be reached at 18268261050 (Name: 张崇燕). **As for our data collection in Fudan University, the gatekeeper is the market research agency Findoout (http://www.findoout.com/index.html), who**

will arrange for the site access, recruitment and communicating with participants.

5.8 – For the UNNC data collection, only we, the principal researchers, will have access to participants' identity. We will generate a random code for each individual participant and give these to the market research agency when coordinating the online survey for the experiments. As for the Fudan University data collection, the market research agency will recruit the participants and will ensure the participants' identity information will not be disclosed.

B. Before starting data collection

	Yes	No
6.12: My full identity will be revealed to all research participants.	☒	☐
6.13: All participants will be given accurate information about the nature of the research and the purposes to which the data will be put. (*An example of a Participant Information Sheet is available for you to amend and use* at xxxxx) *http://www.nottingham.edu.cn/en/research/documents/participant-information-sheet-in-english-and-chinese.doc*	☒	☐
6.14: All participants will freely consent to take part, and, where appropriate, this will be confirmed by use of a consent form. (An example of a Consent Form is available for you to amend and use at: http://www.nottingham.edu.cn/en/research/researchethics/ethics-approval-process.aspx)	☒	☐
6.15: All participants will freely consent to take part, but due to the qualitative nature of the research a formal consent form is either not feasible or is undesirable and alternative means of recording consent are proposed.	☐	☒
6.16: A signed copy of the consent form or (where appropriate) an alternative record of evidence of consent will be held by the researcher.	☒	☐
6.17: It will be made clear that declining to participate will have no negative consequences for the individual.	☒	☐
6.18: Participants will be asked for permission for quotations (from data) to be used in research outputs where this is intended.	☒	☐
6.19: I will inform participants how long the data collected from them will be kept.	☒	☐
6.20: Incentives (other than basic expenses) will be offered to potential participants as an inducement to participate in the research. (Here any incentives include cash payments and non-cash items such as vouchers and book tokens.)	☒	☐
6.21: For research conducted within, or concerning, organisations (e.g. universities, schools, hospitals, care homes, etc) I will gain authorisation in advance from an appropriate committee or individual.	☒	☐

C. During the process of data collection

	Yes	No
6.25: I will provide participants with my University contact details, and those of my supervisor (*where applicable*) so that they may get in touch about any aspect of the research if they wish to do so.	☒	☐

6.26: Participants will be guaranteed anonymity only insofar as they do not disclose any illegal activities.	☒	☐
6.27: Anonymity will not be guaranteed where there is disclosure or evidence of significant harm, abuse, neglect or danger to participants or to others.	☒	☐
6.28: All participants will be free to withdraw from the study at any time, including withdrawing data following its collection.	☒	☐
6.29: Data collection will take place only in public and/or professional spaces (e.g. in a work setting	☒	☐
6.30: Research participants will be informed when observations and/or recording is taking place.	☒	☐
6.31: Participants will be treated with dignity and respect at all times.	☒	☐

D. After collection of data

	Yes	**No**
6.32: Where anonymity has been agreed with the participant, data will be anonymised as soon as possible after collection.	☒	☐
6.33: All data collected will be stored in accordance with the requirements of the University's Code of Research Conduct	☒	☐
6.34: Data will only be used for the purposes outlined within the participant information sheet and the agreed terms of consent.	☒	☐
6.35: Details which could identify individual participants will not be disclosed to anyone other than the researcher, their supervisor and (if necessary) the Research Ethics Panel and external examiners without participants' explicit consent.	☒	☐

E. After completion of research

	Yes	**No**
6.37: Participants will be given the opportunity to know about the overall research findings.	☒	☐
6.38: All hard copies of data collection tools and data which enable the identification of individual participants will be destroyed.	☒	☐

If you have ***not*** *ticked any shaded boxes,* please send the completed and signed form to the School's Research Ethics Officers, with any further required documents, for approval and record-keeping.

If you have ticked any shaded boxes **you will need to describe more fully how you plan to deal with the ethical issues raised by your research**. Issues to consider in preparing an ethics review are given below. Please send this completed form to the Research Ethics Officer who will decide whether your project requires further review by the UNNC Research Ethics Sub-Committee and/or whether further information needs to be provided.
Please note that it is your responsibility to follow the University's ***Research Code of Conduct*** and any relevant academic or professional guidelines in the conduct of your study. **This includes providing appropriate information sheets and consent forms, and ensuring confidentiality in the storage and use of**

data. For guidance and UK regulations on the latter, please refer to the *Data Protection Policy and Guidelines* of the University of Nottingham:

Policy - http://www.nottingham.ac.uk/%7Ebrzdpa/local/dp-policy.doc

Guidelines -http://www.nottingham.ac.uk/~brzdpa/local/dp-guidance.doc

Any significant change in the project question(s), design or conduct over the course of the research should be notified to the School Research Ethics Officer and may require a new application for ethical approval.

Signature of Principal Investigator/Researcher:

CAMEN TEH

Signature of Supervisor (where appropriate):

Chee Wei (David) Phang

Date: 18 October 2021

Research Ethics Panel response

☒ the research can go ahead as planned

☐ further information is needed on the research protocol (see details below)

☐ amendments are requested to the research protocol (see details below)

Using Augmented Reality Technology For Schema Incongruent Products

School REO... Jin Chen Yang Yang Jiang Date ...26/10/2021........................

A. LIST OF POINTS TO CONSIDER WHEN SUBMITTING AN ETHICS REVIEW (taken from ESRC (2012) *Framework for Research Ethics*).

Risks

1. Have you considered risks to:
   - the research team?
   - the participants? *Eg harm, deception, impact of outcomes*

the data collected? *Eg storage, considerations of privacy, quality*
the research organisations, project partners and funders involved?
2. Might anyone else be put at risk as a consequence of this research?
3. What might these risks be?
4. How will you protect your data at the research site and away from the research site?
5. How can these risks be addressed?

Details and recruitment of participants
6. What types of people will be recruited? *Eg students, children, people with learning disabilities, elderly?*
7. How will the competence of participants to give informed consent be determined?
8. How, where, and by whom participants will be identified, approached, and recruited?
9. Will any unequal relationships exist between anyone involved in the recruitment and the potential participants?
10. Are there any benefits to participants?
11. Is there a need for participants to be de-briefed? By whom?

Research information
12. What information will participants be given about the research?
13. Who will benefit from this research?
14. Have you considered anonymity and confidentiality?
15. How will you store your collected data?
16. How will data be disposed of and after how long?
17. Are there any conflicts of interest in undertaking this research? *Eg financial reward for outcomes etc.*
18. Will you be collecting information through a third party?

Consent
19. Have you considered consent?
20. If using secondary data, does the consent from the primary data cover further analysis?
21. Can participants opt out?
22. Does your information sheet (or equivalent) contain all the information participants need?
23. If your research changes, how will consent be renegotiated?

Ethical procedures
24. Have you considered ethics within your plans for dissemination/impact?
25. Are there any additional issues that need to be considered ? *Eg local customs, local 'gatekeepers', political sensitivities*
26. Have you considered the time you need to gain ethics approval?
27. How will the ethics aspects of the project be monitored throughout its course?
28. Is there an approved research ethics protocol that would be appropriate to use?
29. How will unforeseen or adverse events in the course of research be managed? *Eg do you have procedures to deal with any disclosures from vulnerable participants?*

Appendix H: Pre-experiment survey

Page 1

Please type in your experiment Participant ID.

1. Participant ID

Page 2

Dear Participant,

Thank you for agreeing to participate in this experiment study in connection with my PhD research at the University of Nottingham Ningbo. The project is a study of information technology use in introducing new products.

For this study, you will be required to first complete an online questionnaire. Then, you will be participating in an on-site experiment where you will also answer another online questionnaire.

Your participation in this study is voluntary. You are able to withdraw from the experiment at any time and to request that the information you have provided is not used in the project. Any information provided will be confidential. Your identity will not be disclosed in any use of the information you have supplied during the interview.

The research project has been reviewed according to the ethical review processes in place in the University of Nottingham Ningbo. These processes are governed by the University's Code of Research Conduct and Research Ethics. Should you have any question now or in the future, please contact me or my supervisor. Should you have concerns related to my conduct of the interview or research ethics, please contact my supervisor or the University's Ethics Committee.

Yours truly,
Camen Teh

Contact details:
Student researcher: Camen Teh (Camen.Teh@nottingham.edu.cn)
Supervisor: Chee Wei Phang (CheeWei.Phang@nottingham.edu.cn)
University Research Ethics Committee Coordinator: Ms Joanna Huang (Joanna.Huang@nottingham.edu.cn)

- I have read the Participant Information Sheet and the nature and purpose of the research project has been explained to me. I understand and agree to take part.

- I understand the purpose of the research project and my involvement in it.

- I understand that I may withdraw from the research project at any stage and that this will not affect my status now or in the future.

- I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential.

- I understand that my survey data will be recorded.

- I understand that data will be stored in accordance with data protection laws.

- I understand that I may contact the researcher or supervisor if I require more information about the research, and that I may contact the Research Ethics Sub-Committee of the University of Nottingham, Ningbo if I wish to make a complaint related to my involvement in the research.

2. Do you consent to the above?

☐ Yes, I would like to proceed.

☐ No, I would like to withdraw from this study

Page 3

This questionnaire contains 3 videos, about 1 minute in duration. You are required to watch them all and answer 3 multiple choice questions for each video (9 questions in total). This should take you less than 30 minutes to complete.

Each page will have 1 video with 3 corresponding questions. You can go back to the previous page where you can change your answers if you need to. However, once you click "Submit" in the final video page, you will not be able to change your answers again.

You are required to score at least 7 out of 9 of these questions correctly in order to proceed with Part 2 of our experiment. If you score less than 7, you will receive only the first part of the remuneration (20 RMB).

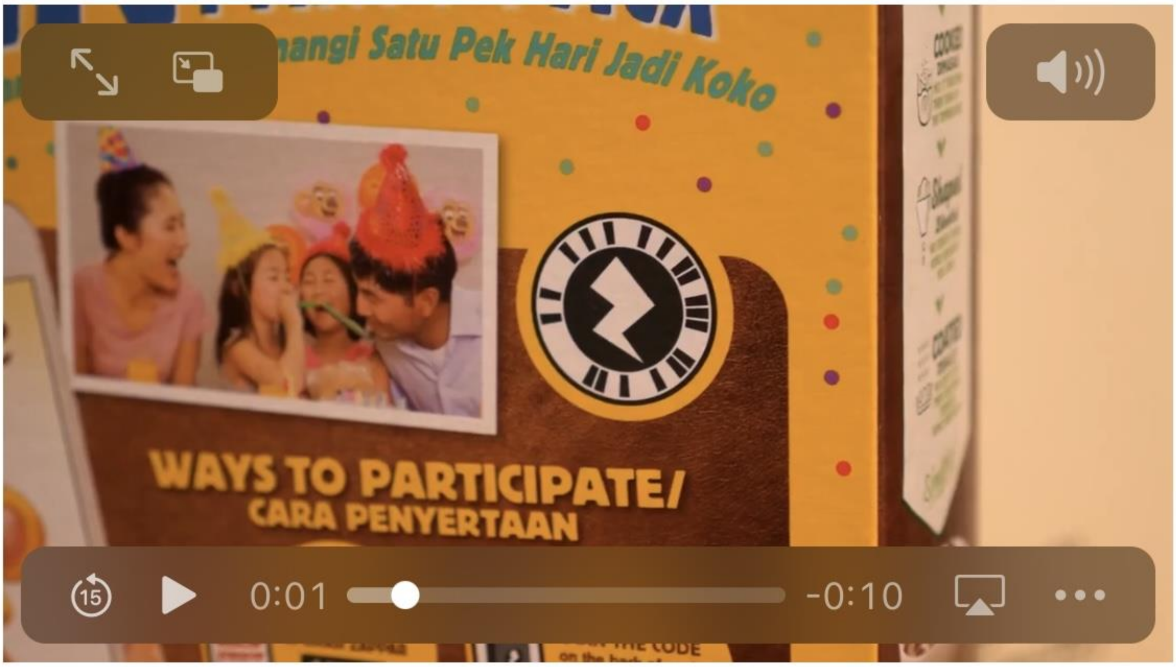
3. Have you read the above instructions and agree to participate?

☐ Yes

☐ No

Page 4

Please watch the below video carefully. You will answer 3 questions based on this video.



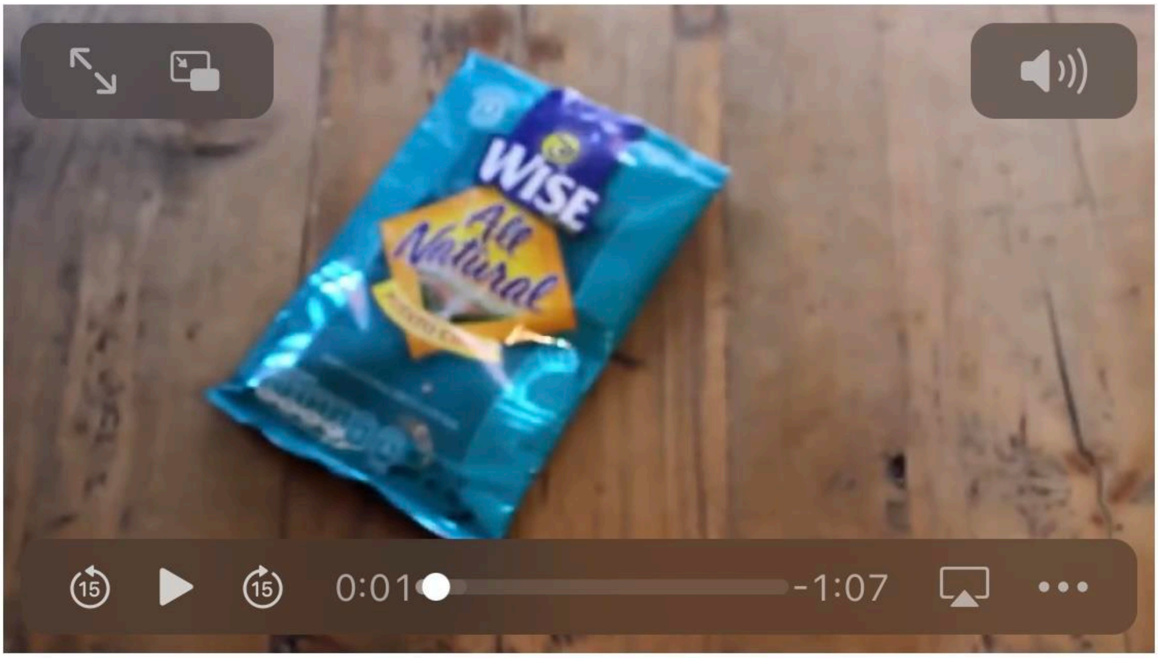
4. The user scanned a code on a product to start the game. What was this product?
☐ A beverage bottle
☐ A bag of potato chips
☐ A cereal box

5. Which of the following is NOT in the video?
☐ Balloons
☐ A singing elephant
☐ A dancing bear

6. What was the user score in the game?
☐ 24
☐ 52
☐ 45
☐ 32

Page 5

Please watch the below video carefully. You will answer 3 questions based on this video.



7. Which of the following are colours found on the packaging of the product?
☐ Blue and yellow
☐ Pink and black
☐ Black and white

8. Which of the following is FALSE?
☐ The user can move the virtual owl around.
☐ The product in the video is a bag of potato chips.
☐ The user is in a supermarket.
☐ There is a camera function to take pictures.

9. Which of the following can be found in the video?
☐ An owl
☐ A dinosaur
☐ A bear

Page 6

Please watch the below video carefully. You will answer 3 questions based on this video.

10. What was the product advertised in the video?
☐ Coca cola
☐ Fanta
☐ Sprite
☐ Pepsi

11. Which of the following is TRUE?
☐ There are 4 people in the video.
☐ Users can take photos of themselves with the digital/virtual filters.
☐ The hashtag used in this video is #ilovefanta.
☐ The user used an iPad to scan the product.

12. How many photos did the users take at the end of the video?
☐ 5
☐ 6
☐ 7

Appendix I: Field experiment pictures

Picture of advertisement poster and product stimulus displayed in the store

Picture of research assistant (on the right) and participant (on the left) executing experiment procedure

Picture of participant interacting with the AR product presentation (with AR presentation control feature)