Enabling Smart Retail Settings via Mobile Augmented Reality Shopping Apps

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ABSTRACT

Retail settings are being challenged to become smarter and provide greater value to both consumers and retailers. An increasingly recognised approach having potential for enabling smart retail is mobile augmented reality (MAR) apps. In this research, we seek to describe and discover how, why and to what extent MAR apps contribute to smart retail settings by creating additional value to customers as well as benefiting retailers. In particular, by adopting a retail customer experience perspective on value creation, analysing the content of MAR shopping apps currently available, and conducting large-scale surveys on United States smartphone users representing early technology adopters, we assess level of use, experiential benefits offered, and retail consequences. Our findings suggest that take-up is set to go mainstream as user satisfaction is relatively high and their use provides systematic experiential benefits along with advantages to retailers. Despite some drawbacks, their use is positively associated with multiple retail consequences. MAR apps are seen as changing consumer behaviour and are associated with increasingly high user valuations of retailers offering them. Implications for more effective use to enable smart retail settings are discussed.

Keywords:

Smart retailing; mobile augmented reality; experiential value; benefits

1. Introduction

A "smart" retail setting can be a beneficial way for a firm to generate greater customer and business value (Pantano and Timmermans, 2014). One "smart" approach that is increasingly recognised as having potential to create value for customers and retailers alike is the use of augmented reality (Pantano, 2014; Huang and Liu, 2014) in smart retail environments (Di Rienzo, Garzotto, Cremonesi, Fra and Valla, 2015). Augmented reality is a smart technology that adds value to retailers by being able to influence customer engagement (Pantano, 2009) as well as purchasing decisions (Pantano, 2014) and can be varyingly used in-store and out-of-store including at home (Valkynnen, Boyer, Urhemaa, and Nieminen, 2011).

Such studies, along with the broader research on augmented reality theory (Schmalsteig and Hollerer, 2016), mobile services (Saarijärvi, Mitronen and Yrjölä, 2014) and experiential customer value (Mathwick, Malhotra, and Rigdon, 2001; Huang and Liu, 2014; Salo, Olsson, Makkonen, Hautamäki, and Frank, 2013) are indicative of the potential for MAR to provide multiple benefits to both customers and the smart retailers that offer them. Yet, a review of the pertinent literature nevertheless find there is still much to describe and discover about MAR to enable smart retail. The present study, therefore, seeks to contribute to this aim by focusing on the phenomenon of MAR shopping apps on smartphones and how, why, and to what extent they enable smarter retailing. Specifically, the present study seeks to address the following research questions:

1. What is the nature of *experiential value* that currently available MAR shopping apps are offering users? Do such apps tend to emphasise particular types and/or combinations of experiential value? E.g., extrinsic and/or intrinsic experiential value?
2. To what extent are users expecting MAR shopping apps to provide them with novel experiential benefits in their retail shopping experiences?

3. To what extent are MAR shopping apps changing users' shopping behaviours as consumers? Is greater use of MAR shopping apps associated with increased valuations of retailers offering them?

To address these research questions, we first provide a theoretical background and conceptual development to understand how and why MAR as a service, a mobile service, and an augment reality-based service, can add value in retail. Three hypotheses and a conceptual model are developed and presented. Following the description of our methodology, we present and discuss findings of analyses of currently available apps as well as findings of two large-scale surveys of smartphone users in the United States representing early technology adopters. In doing so, we obtain multiple insights into the benefits provided as well as identify some limitations of MAR apps acknowledged by users. Conclusions and implications in support of their more effective use for enabling smart retail settings are then provided. Finally, areas for future research are indicated as are limitations of the present study.

2. Theoretical background and development

2.1 Theoretical Foundations

As MAR apps in and for retail are a relatively recent research phenomenon but also one of fast-growing interest, the purpose of our study is to describe and discover the phenomenon more completely as opposed to being concerned with its prediction and control (Laverty, 2003). Given research by Saarijärvi, Mitronen and Yrjölä (2014) on leveraging mobile services in the context of food retailing and its theoretical foundations of service and m-service, our research, too, shares these foundations as MAR apps are both service-based and mobile. Accordingly, the notion of service as business logic is therefore highly relevant, being aptly articulated by the views of Grönroos (2008, 2011) where value is something that

the customer controls (Grönroos, 2008) and where the company goes beyond simple exchange to support customers' value creating processes (Grönroos, 2011). As with Saarijärvi et al's (2014) research on m-services, we too see it as critical to understand *what kind of value* customers are able to create – and in the context of this research, value created through their MAR app service usage. Further, as MAR apps are mobile (via smartphones), they are m-services that increasingly liberate customers from time and place constraints and enable additional benefits as a result (Benou and Vassilakis, 2010). Describing and discovering the many ways in which MAR app services are used in retail practices can therefore contribute to not just the development of characterising MAR frameworks and models but also the development of further theory.

In addition to theoretical foundations of service and m-service, we also view the phenomenon of our research as grounded in *augmented reality theory* and the notion of *experiential value*. Theory on augmented reality (AR) views AR as: 1) combining real and virtual imagery, 2) being interactive in real time and 3) registering virtual imagery with the real world (Azuma, 1997). It is further seen as comprising one part of a "mixed reality continuum" that spans real and virtual environments (Milgram and Kishino, 1994), and is the part where the environment of AR is still real as opposed to virtual. AR therefore presents users with "information that is directly registered to the physical environment" where "the digital information appears to become part of the real world, at least in the user's perception" (Schmalsteig and Hollerer, 2016). In this research, AR is therefore taken to be a live, direct or indirect, view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data. As a result, AR functions by enhancing one's current perception of reality (Graham, Zook, and Boulton, 2013). In the context of retail, AR involves any approach that combines computer-generated and real world image and/or location information for a richer, more

immersive retail experience (Pantano, 2009; Liao, 2015). With the help of increasingly advanced AR (e.g., adding computer vision and object recognition), where artificial information about the environment and its objects are overlaid on the real world (Chen, Tsai, Vedantham, Grzeszczuk, and Girod, 2009), the information about the surrounding real world of the user becomes all the more interactive and digitally manipulable. MAR makes information about the surrounding real world of the user all this as well as increasingly liberated from time and place constraints.

In and for retail settings, MAR's immersion is accomplished via smartphone (camera, processor, display, and computer vision-based augmented reality) or other handheld device though it may also involve head-mounted see-through displays (Huang, Hui, Peylo, and Chatzopoulos, 2013; Billinghurst, Clark, and Lee, 2015). Perhaps due to the increasing ubiquity of smartphones, research on MAR is increasing and is viewed as a highly relevant area for future research (Pousttchi, Tilson, Lyytinen, and Hufenbach, 2015).

From a *value* perspective, MAR's ability to add value in and for retail, not to mention contributing to smart cities more broadly (Yigitcanlar and Lee, 2014), is multi-faceted. Prior research (Spreer, Kallweit, and Gutknecht, 2012; Spreer and Kallweit, 2014) finds, for example, MAR can support shoppers with improved information at the point of sale. Pantano and Naccarato (2010) argue that such advanced technologies in general add value in three ways: retailer advantages such as increased speed for obtaining information consumer behaviour; improvements in service at the point of sale; and positive influences on the consumer shopping experience. Elaborating on the latter, Dziewanowska's (2015) review of the literature on shopping experiences suggests there are multiple elements to shopping experiences ranging from sensory to escapist experiences. Research by Mathwick, Malhotra, and Rigdon (2001) and Bagdare and Jain (2013) also adopts the view that retail shopping is an experience and as such can involve multiple forms of *experiential value*. The importance

of an experiential perspective is further supported by research finding that consumer intentions to download and use retail apps in general is even greater among consumers with higher as opposed to lower *experiential* orientations (Kang, Mun, and Johnson, 2015). Collectively, these studies suggest potential for MAR to provide consumers with richer, more immersive shopping experiences while also benefiting retailers.

A useful means for conceptualising experiential value is Mathwick et al's (2001) typology of experiential value, a typology which has roots in Holbrook's (1996) framework or typology of customer value. Experiential and customer value perspectives have since been adopted in studies examining value in shopping and retail, of which Huang and Liu (2014) and Salo, Olsson, Makkonen, Hautamäki, and Frank (2013) are more recent examples that are closer to the context of this study and where Mathwick et al's (2001) and/or Holbrook's (1996) views have been adopted. Building on Holbrook's (1996) work on consumer value, Mathwick et al's (2001) view is that experiential value can be characterised by a 2x2 matrix of extrinsic-intrinsic value and active-reactive value. Specifically, the typology of experiential value comprises: 1) an extrinsic-active value quadrant that captures the "consumer's return on investment" or value associated with greater shopping efficiency and economic value in what is to be purchased, 2) an extrinsic-reactive quadrant that captures the value of service excellence, 3) an intrinsic-active value quadrant that captures value in "playfulness" or value associated with the intrinsic enjoyment of shopping and/or shopping as a form of escapism, and 4) an intrinsic-reactive quadrant that captures value in "aesthetics" or value associated with the visual appeal of a retail offer and/or its entertainment appeal.

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2.2. Conceptualising Mobile Augmented Reality's Experiential Value and Contribution to Smart Retailing

One MAR shopping app that usefully illustrates extrinsic-active value and is offered primarily as a means of providing greater shopping efficiency is a "home finder" app by Gardner Realtors. By using the smartphone camera to explore the user's surrounding area, objects looked at will be overlaid on the camera's display, offering additional interactive content and information that makes it "easier than ever to find your perfect home." An example of an extrinsic-reactive value app, i.e., one that emphasises service excellence, is the Deichmann shopping app for shoe buying. The app's augmented reality gives its user a digital shoe fitting service and an interactive foot measuring service. Additional services offered by the app (twelve in all) include a fast ordering service, barcode and QR scanning, and a "trendblog" service that gives users access to qualitative customer comments on products. Similarly, a service-focused business-to-business MAR shopping app is the "Dulux Paint Expert: Decorators" app where the augmented reality features lets the tradesperson "see realistic Dulux Trade paint colours appear on your walls with just a tap on the screen" and where the "experts at Dulux Trade give you a choice of colour schemes to go with the users chosen paint colours or existing furnishings."

There are also MAR shopping apps that offer intrinsic-active value or playfulness and/or escape, including UK retailer John Lewis' "Man on the Moon" Christmas shopping app. The app lets users play a game where they can go to another world: they "travel up to the moon" and where augmented reality and pointing users' devices at in-store posters—or the real Moon itself—brings either "to life" and where fun facts are further told by "The Man on the Moon" in a countdown to Christmas Day. Exemplifying playfulness and escape on an increasingly global scale is the widely downloaded (i.e., tens of millions of installations) "Pokemon Go" app, an adventure-based MAR app with in-app shopping and where country-specific versions of the game prominently feature McDonald's restaurants as "Pokestops" as a fun way to increase restaurant patronage.

Finally, there are some MAR apps that offer users intrinsic-reactive value involving visual appeal for a more "aesthetic" and/or passively entertaining shopping experience. The "L'Artisan Macaron" shopping app visually displays the shop's "beautiful handmade macarons" made with the company's own colourful food colorings made only from fresh herbs and vegetables. The app's 3D augmented reality feature treats the user to displays of "macaroon fireworks." While not shop-specific but rather shopping experience-specific, the PhotoMap-Geo Photo Gallery app lets users place their own photos on a world map "in a fascinating way" such that it helps the user visit "beautiful" moments again and describe "beautiful" moments including "real estate, homes, cars, and hotels" and where the map positions include those "at the mall," "while shopping," or "at a restaurant." The app provides augmented reality views of one's photos including a "true north" compass.

A key benefit of adopting Mathwick et al's (2001) typology of experiential value is not only the distinction between extrinsic or intrinsic value, but the implication for how each may ultimately be employed by retailers to provide better and smarter shopping experiences as the previous examples illustrate. For example, research by Kallweit, Spreer, and Toporowski

(2014) supports the view that customers' use of certain self-service information technologies offered by retailers is influenced by the extent such technologies have utilitarian, service-related (or *extrinsic*) value. Yet at the same time, based on research on the Technology Acceptance Model (Davis, 1989; Pantano and Di Pietro, 2012) and other studies examining the acceptance of interactive IT systems (Hassenzahl, Diefenbach, and Göritz, 2010; Van der Heijden, 2004) it is also user perceptions of hedonic (or *intrinsic*) value that motivate and/or may even be a stronger determinant than usefulness in acceptance of new interactive technologies, thereby supporting a need to examine more deeply both utilitarian and hedonic qualities in MAR shopping apps.

As the previous examples show, MAR shopping apps are able to fulfill a range of purposes. Research on non-AR retail apps finds they can be of types including tool-centric, game-centric, social-centric, m-commerce-centric and design centric (Zhao and Balagué, 2015) and where augmented reality is seen as a mobile feature that can be incorporated into game- and m-commerce-centric apps. Other research sees augmented reality as being able to feature prominently in other types of apps, e.g. tool-centric and social-centric apps (Guven, Oda, Podlaseck, Stavropoulos, Kolluri, and Pingali, 2009). Such views of MAR are useful as they highlight its ability to simultaneously offer both extrinsic and intrinsic value in retail settings. Given these views from the academic literature on the range of experiential benefits that smart retailers' various MAR shopping apps are able to offer those using them, it is therefore hypothesised:

H1: MAR shopping app users will mainly use them with the view that benefits offering a combination of extrinsic and intrinsic value will be obtained in their shopping experience.

Additionally, given the many novel ways that augmented reality shopping apps can be almost *uniquely* beneficial to a shopping experience, including more complete information on

products and increased choice (Rashid, Pous, Melia-Segui, and Morenzi-Cinos, 2014) as well as greater purchase certainty, being able to "try out" or see demonstrations of products before buying, and more personalised products (Huang and Liu, 2014), it is also hypothesised:

H2: MAR shopping app users will see such apps as being able to provide one or more benefits that they would not normally get in their shopping experiences.

2.3 Areas of MAR Shopping Apps' Value to Retailers

While traditional retailing methods such as promotions and inviting in-store environments can be vital to achieve customer satisfaction (Backstrom and Johannson, 2006; Grewal, Levy, and Kumar, 2009), favourable MAR shopping app experiences can also play an important role in the customer's decision making journey towards satisfaction. By orchestrating immersive experiences through smart technologies, a firm can create a deeper level of customer satisfaction and at the same time increase its ability to impact sales volumes (Kent, Dennis, Cano, Helberger, and Brakus, 2015). Further, beyond merely just satisfying customers, smart retailer's MAR shopping apps can create "delightful" experiences for customers as a means to drive high levels of satisfaction and loyalty such as when personalised content perfectly matches a customers' specific needs. Also, to the extent that MAR shopping apps offer customer benefits not offered elsewhere, such as by providing a seamless experience of integrated shopping across multiple channels, smart retailers may achieve competitive advantages over their lesser-integrated competitors (Shankar, Venkatesh, Hofacker and Naik, 2010).

A further review of the academic literature, along with a review of industry studies on the use of MAR shopping apps, finds a growing body of evidence that such apps are potentially beneficial for creating value to retailers as well as customers. Specifically, five benefits receiving particular attention, along with associated examples, are:

1. Improving conversion rates. Augmented reality technologies can potentially improve the conversion rates for offerings ranging from clothing to makeup. While some retailers such as J.C. Penny and Bloomingdales are testing the use of "virtual dressing rooms" which let customers "try on" outfits that appear when they are looking at themselves on a screen (Gaioshko, 2014), some beauty retailers are now planning to offer customers a new way to try out makeup with the help of a mobile "3D augmented reality makeup and anti-aging mirror" (Martínez, Skourneto, Hyppölä, Laukkanen, and Heikkilä, 2014).

2. Reducing return rates. One of the major issues retailers face is with returned goods and especially with items that are large. The cost of transportation for large and/or heavy items can sometimes exceed the cost of the items itself. Augmented reality technologies can be implemented to reduce such costs to retailers and bring down the rate of returns. For this and other reasons, furniture retailer IKEA introduced an "augmented reality catalogue" in 2013. The MAR shopping app allows customers to measure the width and height of a real-life room seen from the smartphone camera's objective and then render a very accurate picture of the furniture, in relation to the rest of the actual surrounding environment (Baier, Rese, and Schreiber, 2015). Other furniture retailers have since launched MAR apps which help to "bring products home" prior to actually making the real purchase (Tabusca, 2014).

3. Enlivening static retail inventories. One of the biggest challenges faced by many brick-and-mortar retailers is the management of inventory on the shelves and the lack of interaction with the products on these shelves. MAR shopping apps can be used to bring these products to life in a more-virtual environment thereby reducing the cost and management of physical inventory. Lowe's, for example, equips shoppers in some of its specially designed stores with iPads having pre-installed apps that turns specific dimensions of a virtual room into "a space that can be packed with Lowe's inventory." Shoppers then use a Lowe's augmented

reality app on their smartphone to fine-tune their chosen design and Lowe's inventories from home (Johnson, 2014). By using such an approach to engages visitors with inventories in-store as well as when returning home, smart retailers can more easily manage and revitalise extensive inventories.

4. Driving store footfall. MAR apps can facilitate stronger consumer connections with products (even mundane products) before they have thought of going to a retailer to buy such products (Singh and Singh, 2013). For example, Blippar, an augmented reality application development company, is able to bring to life for consumers content that is relevant to items as basic as apples. By 'blipping' an apple, a customer is able to know the type of apple and the various types of apples that exist, recipes relating to an apple, the provenance of the apple, the dietary contents of the apple, and more. Such specific content can aid in creating a connection between the customer and a product and to the extent the product is associated with a particular smart retailer, a connection is also made with the retailer. As retailers can use this type of content to engage consumers even before they enter their store by linking the purchase of a product (such as an apple) to their store, a smart retailer can potentially drive more store footfall.

5. Providing a means to offer personalised pre-purchase evaluations. As customers become more demanding, they increasingly expect products and services which cater to their specific needs. MAR shopping apps for some shoes brands offering such personalisation include not only Deichmann's MAR shoe fitting app but also Converse's sports shoe MAR app which lets customers choose different sneaker models from a catalogue and then "try them on" virtually. The user points the phone or tablet camera directly to his or her feet and the selected model appears on his or her feet (Tabusca, 2014). Similarly, there are examples of a jewellery business, De Beers Company, and a renowned skin care company, Shiseido,

that have introduced MAR apps to for customers to try on different models of jewellery and cosmetic products, respectively, based on a customers' skin colour. Taking personalisation a level further, at the Left Shoe Company, a customer can scan his or her feet at one of their pop-up stores, choose a shoe style and material, and have made-to-measure shoes cobbled and sent directly from craftsmen in Portugal.

At the same time, there are still other ways MAR apps can add value to retailers, though they receive less attention in the literature and industry studies than the five areas previously mentioned. Among these are MAR apps' abilities in demonstrating a retailer's offerings through created content and thereby supporting customer purchasing decisions; interactively offering customers elements of surprise to entertain and encourage further interaction; creating experiences that shoppers will share with their networks as a result of an MAR app's novelty value and the resulting virality creating a larger pull in the market; gathering information on customer preferences; supporting multichannel shopping; and providing a higher level of perceived service.

Thus, consistent with yet also complementing Mathwick et al's (2001) multi-dimensional view of experiential value, many elements of retail value are also seen as simultaneously supporting customer value. Smart retailers who improve conversion rates and reduce return rates are helping customers increase the certainty that what they are buying is what they really want and therefore has a justified economic value. Retailer efforts to enliven store inventories, increase footfall, and offer personalised pre-purchase evaluations are simultaneously appealing to customers' desire for greater value in both shopping process and its outcomes which includes trial, personalisation, product choice and variety, more complete information, demonstrations, and ultimately increased buyer certainty.

2.4 More Use of MAR Shopping Apps and Its Effect on Smart Retailer Valuations

The above discussion has emphasised the ways that MAR shopping apps can clearly add experiential value to customers and where retailers also benefit such as the possibility of increased customer satisfaction and retailer loyalty which are indicated as further possible outcomes. Yet, increasing use of MAR shopping apps may lead to other possible beneficial outcomes including higher shopper engagement and greater MAR shopping app user positive word-of-mouth about the retailer (Eyüboğlu, 2011). Given these many ways that such apps are able increase experiential customer value, greater use of such apps may therefore lead to higher valuations of retailers who offer them. Such a view is given credence by research by Keng, Huang, Zheng and Hsu (2007) on customer experiential value in retailing that finds a relationship between service-based experiential value and positive "behavioural intentions" (e.g., loyal patronage, positive word-of-mouth about the retailer, and more time and money spent at a retailer). Similarly but more broadly, research by Brakus, Schmitt and Zarantonello (2009) finds that a customer's favourable multi-faceted brand experiences directly contribute to both satisfaction and loyalty. Drawing upon such literature for support, we therefore hypothesise:

H3: Greater use of MAR shopping apps will be associated with increased valuations of retailers offering them.

To sum up pictorially, by drawing upon the above theoretical foundations and conceptualisation of MAR shopping apps' experiential value and contribution to smart retailing, we present a conceptual model of the role of MAR apps' role in smart retailing (see Figure 1).

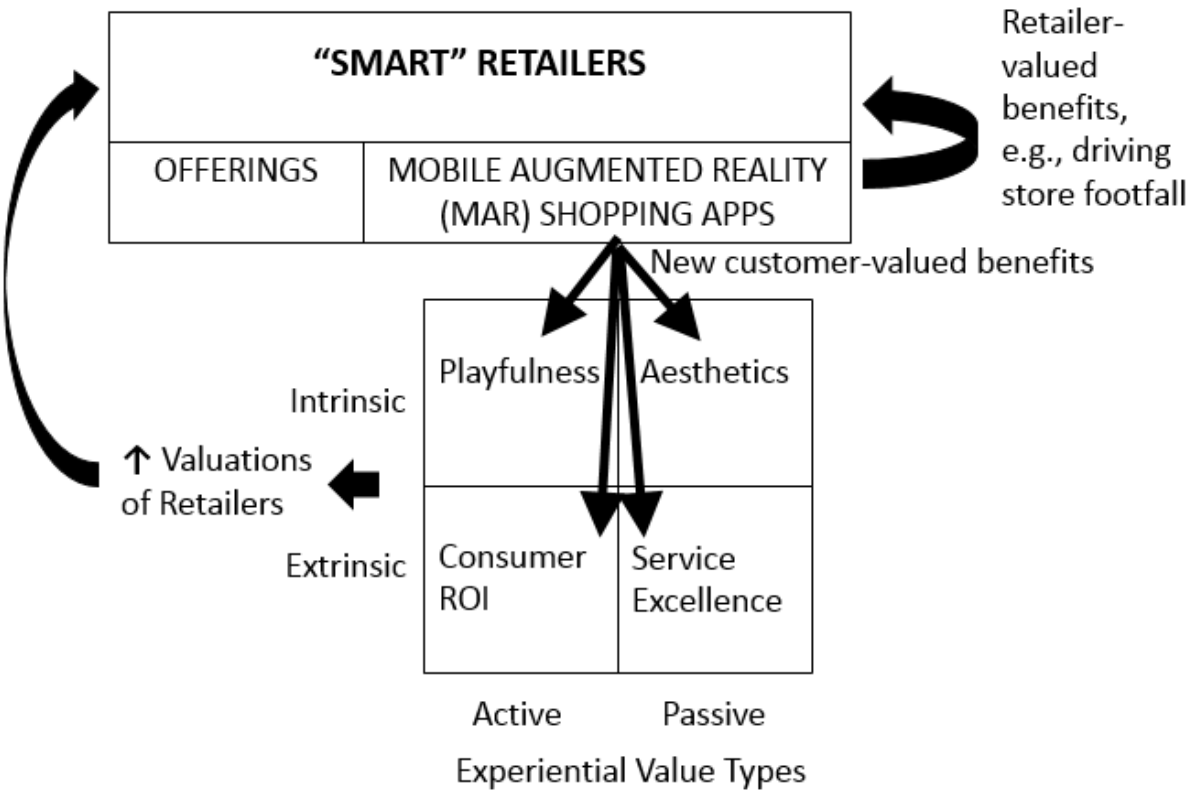

Figure 1. A conceptual model of the role of MAR apps in smart retailing and for providing customer value based upon Mathwick et al.'s (2001) typology of experiential value.

Of course, as with any new technology-based offering, there may additionally be some challenges to retailers in managing MAR shopping app's use and implementation. Pantano and Timmermans (2014) cite challenges retailers face ranging from how to manage dynamic capabilities given financial instability to how to enhance consumers' perceptions of new shopping experiences relative to traditional experiences in response to changes in consumption. From the shopper's perspective, there may also be issues associated with how easy, difficult or time-consuming an MAR shopping app is to learn to use or to repeatedly use. For certain shoppers, an MAR app may not be fast enough or reliable enough to use regularly (Ramakrishna, Srivastava, White, Rajput, Srivastava, Bhattachary, and Chaudhary, 2013). MAR shopping app compatibility with the user's smartphone's operating system may be an issue, particularly with older operating systems trying to run newly developed apps.

While MAR shopping app developers try to release apps that are bug-free, a user's discovery of a bug or incompatibility issue can be off-putting to the user. Finally, given the concerns of shoppers who may be reluctant to disclose personal information including their name and email address as a condition of using an app, some shoppers may deem MAR shopping apps as having limitations that are prohibitive to initial or ongoing use. Clearly then, it should be recognised that there may not only be many possible benefits of MAR but also challenges and issues facing MAR app development and implementation as such apps are still at a relatively early stage of market adoption. Discovering and describing more fully from user experience the extent of such negatives or drawbacks may therefore also be beneficial as a means to facilitate their ongoing development.

In order to empirically examine the hypotheses above and the associated conceptualisation of how and to what extent MAR shopping apps enable smart retail, we next describe the methodology followed by our findings, analysis and discussion.

3. Methodology

As a first step in understanding user views of MAR shopping apps, the scope of current offerings was examined and quantitatively analysed. Given both the quantity as well as quality of information on Android-based MAR shopping apps available for installation from Google Play's app store, this research looks specifically at Android-based MAR shopping apps. Keyword searches were used to identify the set of all *augmented reality shopping apps* available for installation as of January 2016. Data were collected and analysed on all such apps on offer – 272 in all, or based upon online searches, approximately 6% of all Android-based shopping apps, their app titles, their associated descriptions and categorisations, the number of installs for each, the mean user rating for each, and the spread of ratings for each.

Following collection and analysis of data on all such MAR shopping app offerings, including categorisations of the 272 apps into Mathwick et al's (2001) four quadrants of

experiential value, two large-scale surveys were conducted on users of MAR shopping apps in the United States.

In the first survey, 21,467 smartphone users in the US were given the opportunity to participate in a ten question survey involving an unspecified topic on their smartphone in exchange for approximately $2.50 shopping credit on Google Play. According to Google (2016), the sample – Android smartphone users who are user of Google Opinion Rewards – and Google's ongoing validations of this user base finds it "tends to represent earlier adopters and heavier technology users than the average person" in the US, that they are more highly educated, on average, and ultimately reflect a more "tech-savvy" respondent base. Thus, while the sampling methodology has an expected sampling bias relative to all smartphone users in the US, we see such a bias as beneficial to our study of MAR shopping apps in that the views expressed are of early adopters who are seen as knowledgeable and influential diffusers of marketplace information (Feick and Price, 1987).

The first question asked about the respondent's experience with augmented reality smartphone apps for shopping. This question was a screening question and was asked so that only those respondents who had at least some experience with MAR shopping apps would then participate in the rest of the survey. Accordingly, the question excluded the expected high proportion of smartphone users who as yet either had no experience with MAR shopping apps or were unsure about MAR as they did not sufficiently understand what it was and as a result would also not be in a position to offer their views on its benefits from experience. Subsequent questions, informed by a range of previous academic studies, then asked the remaining respondents about their experiences including how they found out about the MAR shopping apps they used, where they used them, the benefits they see in using them, the benefit they value the most, the unique benefits they see in using them, the effects of using them on their future retail preferences, and any negatives or drawbacks associated with their

use. Questions on benefits were primarily based on and drawn from Mathwick et al's (2001) constructs while also expanding the coverage of possible benefits given prior research on MAR specifically. The content of answer choices given respondents then reflected the benefits most commonly cited in the academic literature. The maximum number of answer choices and the choice of question and answer format provided to respondents was set by survey administration constraints, i.e., on the maximum number of questions that could be asked and the maximum number of answer choices allowed for a mobile survey. Finally, views were sought on the future of MAR shopping apps and descriptive information was gathered on specific MAR shopping apps they used.

Following the findings of the first survey which asked about a range of experiential benefits, a second survey of MAR app users was then conducted to ask more-detailed questions about particular benefits of MAR shopping app use as the aim was to understand better MAR benefits in terms of behavioural changes and retail outcomes. Specifically, 9,452 additional smartphone users in the US were presented with the opportunity to participate in a ten question survey on their smartphone also in exchange for approximately $2.50 shopping credit on Google Play. As a means to capture the views of those individuals with MAR app experience for any of a range of purposes, a first question was asked about their experience with augmented reality smartphone apps of any kind. An explicit definition of AR apps, "augmented reality (AR) apps combine computer-generated and real world image/location info for more immersive and/or product experience," was also given to respondents in this screening question so that those respondents who may be unsure about what AR is could further self-screen for subsequent exclusion or inclusion in the rest of the survey. For those who were screened in, the next question asked for descriptive information on the apps they have used.

Eight subsequent questions then asked for their views on the extent they believe MAR shopping apps are changing their shopping behaviours as reflected in their valuations of retail settings offering MAR shopping apps for benefits ranging from shopping experiences being more entertaining to making shopping more efficient. For each of the eight questions, respondents were asked to indicate their response to a statement on a 10-point scale ranging from "strongly disagree" to "strongly agree." As with the first survey, the choice of the benefits included in the questions asked was a combination of benefits drawn from Mathwick et al's (2001) constructs while also expanding the coverage to include the most commonly cited benefits in research on MAR specifically. The number of such questions asked, eight in all, was the result of a ten-question maximum constraint for administering the mobile survey, where screening and app use questions were also asked.

4. Findings, Analysis and Discussion

4.1 Analysis of Current MAR Shopping Apps

Online searches for augmented reality shopping apps on Google Play's app store found that there are 272 apps that explicitly indicate use of augmented reality for shopping of one kind or another (see Table 1 for a summary of aggregate descriptive information). A further analysis of online data for these AR shopping apps established that they have been installed more than 397,012,000 times in total onto Android devices since their introductions. Upon analyses of all 17,326,172 unique user reviews of these apps (equating to 4.4% of the users), we find there is a relatively high mean level of satisfaction with MAR shopping apps overall. On a ratings scale of 1 to 5, the mean rating given by reviewers is 4.02 (S.D.=0.59), where 67.2% of reviews were 5-rated, 15.7% were 4-rated, 7.1% were 3-rated, 3.4% were 2-rated, and 6.6% were 1-rated.

Table 1. Descriptive information on 272 MAR shopping apps on Google Play.

Google Play Category Aggregations	**Total No. of Apps (Percent)**	**Avg. Number of Installs (S.D.)**	**Avg. User Rating (S.D.)**
Shopping (24), Lifestyle (44)	68 25.0%	738,500 (3,746,900)	3.93 (0.60)
Travel & Local (106)	106 39.0%	408,100 (3,004,800)	4.09 (0.56)
Entertainment (25)	24 8.8%	168,200 (598,800)	3.98 (0.79)
Action & Adventure (3), Arcade (2), Card (1), Casual (5), Comics (1), Creativity (1), Puzzle (1), Simulation (2), Social (5), Sports (1), Trivia (1)	23 8.4%	47,556,400 (106,127,900)	3.90 (0.48)
Productivity (2), Tools (4), Transportation (10)	16 5.9%	1,997,000 (7,471,800)	4.01 (0.31)
Communication (3), Media & Video (2), News & Magazines (6), Photography (2)	13 4.8%	2,363,300 (8,304,500)	3.79 (0.74)
Books & Reference (3), Education (7), Libraries (2)	12 4.4%	56,700 (114,100)	4.33 (0.60)
Business (6), Finance (4)	10 3.7%	114,300 (242,100)	4.33 (0.44)
Total (Percent)	272 100%	4,284,800 (31,712,700)	4.02 (0.59)

The apps currently available cover a wide range of activities and purposes though are all shopping-related. We find 25.0% of the apps explicitly mention in their titles that they are "shopping" or "lifestyle" (e.g., brand or product) MAR shopping apps. Another 75.0% MAR emphasise shopping in one form or another in their descriptions even though their titles may include terms such as "travel and local" (39.0%), "entertainment" (8.8%), or any of 23 other terms (27.2%). Such categorisations may be potentially useful as travel and tourism, for example is seen as a significant category using MAR in support of city and related shopping (Jung and Han, 2014; Pradhan, Balashankar, Ganguly, and Mitra, 2014; Kourouthanassis, Boletsis, Bardaki, and Chasanidou, 2015) and where other categories involving augmented reality are known to directly facilitate shopping (Pavlik and Bridges, 2013). While some of

the more popular MAR shopping apps such as Layar and Ikea's Catalog AR app have been installed many millions of times, we find the mode for the number of installs for MAR shopping apps overall to be much lower at 1,000 to 5,000 times and where the least-installed apps have been installed a mere 10-50 times. In independent sample t-tests comparing user ratings for groups established based on the number of installs as well as their categorical descriptions, no significant group differences in mean user ratings of the apps were found. The implication of this finding is that the user ratings of MAR shopping apps appear to be reflecting their value to individual users rather than by their categorised purpose for use or relative popularity.

Analysing the 272 collected MAR apps further, we categorised the 272 identified MAR shopping apps according to the four quadrants of Mathwick et al (2001). Using Mathwick et al's (2001) descriptions of experiential value as a basis for coding and categorizing apps based on the content of their full online descriptions using two independent coders having an inter-coder reliability of 92.5% and where remaining discrepancies then discussed and resolved as per Miles and Huberman (2014), we find that the experiential value quadrant with the most MAR apps is Service Excellence (137/272, 50.4%) and where the others are CROI (52/272, 19.0%), Aesthetics (51/272, 18.8%), and Playfulness (32/272, 11.8%). Figure 2 provides illustrative examples of these apps. Collectively, the CROI and Service Excellence-based MAR apps are found to comprise 69.4% of the total number of MAR shopping apps and the Aesthetics and Playfulness apps comprise the remaining 30.6%. This analysis suggests that most MAR shopping apps at present are claiming in their marketing materials to provide *extrinsic* value more than *intrinsic* value. As with analyses of categorical descriptions on Google Play, no significant differences were found in mean app user ratings between quadrants, suggesting that user satisfaction is not related to the primary value emphasis of a particular quadrant of MAR shopping apps.

Intrinsic Value-Active Value (Playfulness): 32 (11.8% of all apps) ARMUSE – a real world AR-based treasure hunt game for shopping malls to deliver promotional messages to customers. SHOPPING RA – using AR, enjoy a fun, different shopping experience making and sharing adventure photos with unique characters. iBATTLE (AR) – using AR and a purchased educational book, bring your dinosaurs to life and challenge friends and family to a battle. MOSHI 3D – with a coloring book to purchase, using AR, design, control and move Moshi characters around a track. T-SHIRTS (AR) – every t-shirt to purchase gives different interactive AR experiences with different elements that come to life to surprise you and that you can then share with your friends.	**Intrinsic Value-Reactive Value (Aesthetics): 51 (18.8% of all apps)** ASTON VILLA AR VIEWER – AR with real world print media lets you view 3D digital content and videos. MARINA SQUARE AR – with AR experience festive characters come to life at the Shopping Mall. CHADSTONE'S WORLD OF CHRISTMAS – use AR to witness your world magically covered in snowflakes and sparkles. MUSIC GIRL – music player; through your phone camera and AR, your favorite character will dance for you while playing the music. AUDREYAR – X-ray app to view what lingerie the photographed Audrey models are wearing under their bathrobes. BLINKY – scan products and posters with the logo and images come to life with galleries; purchase items with your mobile.
Extrinsic Value-Active Value (CROI): 52 (19.1% of all apps) HOBBYTOWN – An easier way to shop for hobby gear in-store with AR using barcodes to discover latest and full product details also with needed accessories. BANK PEKAO – Map with AR to locate Bank branches, brokerage houses, and ATMs. MANGO MAN – simple and fast shopping along with special offers by scanning catalogues and directly obtaining full details of garments featured in the images. MENARDS – faster and easier shopping by visualizing and comparing interior-exterior doors before you buy. TELLMEPLUS – turns your phone into a bargain hunter with AR and geo-location to capture commercial promotions. COTTON ON – scan exclusive images to unlock AR and receive exclusive offers with 24/7 shopping.	**Extrinsic Value-Reactive Value (Service Excellence): 137 (50.3% of all apps)** CIAO FIAT MOBILE – take advantage of multiple services by viewing multimedia content in AR and full-page Fiat adverts. THE PEARL QATAR – your personal shopping assistant service with interactive map and AR for all information you need to know. PACIFIC PLACE MALL – the ultimate guide for exploring the Mall in Jakarta with AR for multiple services including a concierge service. YATES MY GARDEN – everything you need for your perfect garden using an AR Garden Visualiser to plan your garden. TRIPOLI GUIDE – Expert and comprehensive Tripoli guide with AR for shopping and accommodation services. VICE VERSA HOTEL PARIS – services to make an unforgettable trip, localised with interactive map and AR. GRIFFITH – full-service app with scalable maps with AR for students, staff, and visitors to explore Griffith University (Australia) including an online shopping cart.

Figure 2. 272 MAR shopping apps categorised according to the four quadrants of Mathwick et al's (2001) typology of experiential value: numbers (percentages) and examples.

However, additional analysis of these apps for evidence of secondary value finds that: 62.4% of those apps that primarily offer extrinsic value also offer at least some secondary intrinsic value, 33.7% of apps that primarily offer intrinsic value also offer at least some secondary extrinsic value, and where, overall, 54.4% of all MAR shopping apps offer at least

some elements of both intrinsic and extrinsic value. These findings support the views suggested from the literature (e.g., Guven et al., 2009; Zhao and Balagué, 2015) that MAR shopping are able to offer varying combinations of both extrinsic and intrinsic value.

We have further examined the categories of MAR shopping apps on Google Play to identify the extent of category representation for each of Mathwick et al's (2001) four experiential value types. The analysis finds that within each experiential value type, some categories of apps are present more than others. Specifically, the results (see Figure 3) show that a range of app categories corresponding to more-active engagement and immersion, along with Entertainment (75% in all) highly represent the Playfulness quadrant and that Shopping, Lifestyle and Entertainment (54% in all) represent the majority of the Aesthetics quadrant, reflecting more reactive than active visual pursuits. Additionally, Shopping, Lifestyle, Business and Finance category apps (79% in total) highly represent the CROI quadrant, reflecting emphasis on economic value and efficiency; and finally where Travel &

Intrinsic Value-Active Value (Playfulness): Action & Adventure, Arcade, Card, Casual, Comics, Creativity, Puzzle, Simulation, Social, Sports, Trivia (50%) Entertainment (25%) Books & Reference, Education, Libraries (13%) Other (12%)	**Intrinsic Value-Reactive Value (Aesthetics):** Shopping, Lifestyle (29%) Entertainment (25%) Communication, Media & Video, News & Magazines, Photography (16%) Books & Reference, Education, Libraries (8%) Other (22%)
Extrinsic Value-Active Value (CROI): Shopping, Lifestyle (67%) Business, Finance (12%) Travel & Local (11%) Other (10%)	**Extrinsic Value-Reactive Value (Service Excellence):** Travel & Local (69%) Shopping, Lifestyle (12%) Productivity, Tools, Transportation (9%) Other (10%)

Figure 3. Mathwick et al's (2001) typology of experiential value and Google Play categories represented in each quadrant (percent of 100% within each quadrant).

Local, Shopping and Lifestyle category apps (71% in total) highly represent the Service Excellence quadrant, reflecting comprehensive, multiple services of a relatively reactive nature.

4.2 Survey of MAR Shopping App Users

Of the 21,467 US smartphone users given the opportunity to participate in the first survey, 10,154 or 47.3% responded and answered the survey's screening question ("Thinking about all of the shopping you have done this past year, have you ever used an augmented reality shopping app on your smartphone…?). Of those participating, 48.7% were female, the most commonly indicated age range was 25-34 years (ages ranged from 18 to 65+) and the most commonly indicated annual income range was $25,000-$50,000 (see Table 2).

Table 2. Smartphone users' experience with MAR shopping apps (n=10,154).

MAR shopping app experience	**Female**	**Male**	**Overall**
Have experience (screened in)	**477 (9.6%)**	**605 (11.6%)**	**1,082 (10.7%)**
Do not have experience	1,985 (40.1%)	2,671 (51.3%)	4,657 (45.9%)
Not sure	2,483 (50.2%)	1,932 (37.1%)	4,415 (43.5%)
Total	4,945 (100%)	5,208 (100%)	10,154 (100%)

As the table shows, a relatively small percentage (10.7%) of smartphone users, and about equally small proportions of females and males, have experience with MAR shopping apps while the rest had no experience or were not sure as they were not familiar enough with augmented reality as a technology. Follow-on questions were then asked of 1,082 respondents who had experience with MAR shopping apps and where only those completing surveys with all questions answered (n=965) were analysed.

Given a question asking about the ways by which these MAR shopping app users learned of their apps, the results (see Table 3) find that for all—both females and males, social media dominates for initial learning and where this is followed by referrals and then a range of other means including unprompted search. Consistent with other studies on social media effects (Rapp, Beitelspacher, Grewal, and Hughes, 2013), these findings suggest that social media is

a powerful means, yet not the only means (see, for example, Jung, Chung, and Leue, 2015) for smart retailers to harness in expanding awareness and/or recommendation of MAR shopping apps to other users.

Table 3. Means by which users learned of MAR shopping apps by percentage of respondents and percentage within gender, in order of most to least frequent means.

How users learned about MAR apps	Females (n=427)	Males (n=538)	Total (n=965)
Social media	39.8%	31.2%	35.0%
Referrals by friends / family	22.5%	16.9%	19.4%
Unprompted search	7.7%	13.9%	11.2%
In-store advertising	10.3%	11.2%	10.8%
Brand advertising	7.3%	11.7%	9.7%
Other advertising	5.4%	7.1%	6.3%
Other	7.0%	8.0%	7.6%

When asked about the locations where MAR shopping app users use their apps, where users indicated all locations where used, respondents indicated as follows: at home (63.7%), in shop or store (41.6%), in shopping area or district (25.1%), at place of work or study (22.7%), in-transit (20.0%), at social gathering, café or restaurant (17.8%), and other location (1.3%). These findings show that MAR shopping app use spans multiple locations and that, in aggregate, home use is relatively more common than in-store use, though where the latter tends to receive much attention in the academic literature. The implication of these findings is that, beyond in-store, out-of-store use is also substantial and may be potentially beneficial for smart retailers to increasingly accommodate.

Two questions were asked of MAR shopping app users about the shopping benefits they believe they will receive from using an MAR shopping app and also which *one* shopping benefit they value the most (see Table 4).

The findings of the table show that the benefit associated with extrinsic value and active value – the utilitarian benefit of efficiency or better value ("consumer return on investment" according to Mathwick et al. (2001) – is dominant in the views of users. Such a finding of the value of efficiency is consistent with the research by Salo et al. (2013) examining

Table 4. Experiential shopping benefits (1) users believe they will receive from using an MAR shopping app and (2) the one experiential shopping benefit they value the most, in order of most- to least-valued benefits (n=965).

Experiential Shopping Benefit ((E) - extrinsic, (I) – intrinsic)	(1) Shopping benefits users will receive, %	(2) The one shopping benefit users value most, %
More efficient or better value shopping (E)	56.6%	42.3%
More entertaining shopping (I)	42.2%	15.3%
More visually appealing shopping (I)	40.0%	12.1%
Higher quality service when shopping (E)	26.9%	11.1%
More intrinsically enjoyable shopping (I)	27.3%	7.7%
Shopping is more like an escape (I)	23.5%	7.3%
None of the above	4.7%	4.2%

consumer views of "mobile interaction with the real world" (MIRW) technologies, where efficiency and excellence are seen to dominate in MIRW valuations. This is then followed by the intrinsically and passively valued benefits of entertainment and visual appeal. Lower on the list of benefits are a benefit of extrinsic value and reactive value, namely service excellence, as well as benefits of intrinsic value and active value – intrinsic enjoyment and escapism. These findings suggest that MAR shopping apps users in aggregate see them as being able to provide a range of experiential benefits, though primarily extrinsic followed by intrinsic. Yet upon further analysis of the data, we find that a relatively small proportion of users (23%) believe they will receive *both* extrinsic and intrinsic benefits from using them, whereas 42% believe they will be able to receive extrinsic benefits only and 35% believe they will receive intrinsic benefits only. These findings suggest that even though MAR shopping apps are able to provide multiple experiential benefits that are both extrinsic and intrinsic, most users (77%) do not believe this to be the case and thus there is a lack of support for H1. An implication of these findings is that retailers may benefit from not only giving even greater prominence to multiple experiential elements in their apps as opposed to developing multiple apps for multiple customer segments (Kim and Lee, 2015) as well as ensuring that

any MAR apps developed are effective in delivering the desired experiences to ensure their value is perceived by customers.

Beyond the experiential benefits above, users were also asked about the shopping benefits they will receive from MAR shopping apps that they would not normally get in a shopping experience (see Table 5).

Table 5. Shopping benefits users believe they will receive from MAR shopping apps that they would not normally get in a shopping experience, from highest to lowest % (n=965).

Shopping benefit	**Percent believing they would not normally get this benefit in a shopping experience**
More complete information on products	56.6%
More certain you are buying what you want	42.2%
Greater product choice and variety	40.0%
'Trying out' a product before buying it	27.3%
Seeing demonstrations of products	26.9%
Buying a product that is more personalised	23.5%
None of the above	3.2%

Findings suggest that prominent among the perceived "unique" benefits MAR shopping apps are believed to provide is completeness of information and the ability to be more certain that a shopper will be buying what he/she wants. The ability of MAR shopping apps to display choice and variety is also highlighted by users, suggesting that such apps can also allow shoppers to access more extensive and varied retailer inventories. At the same time, some users see further uncommon benefits including demonstration ability, "trialability" and personalisation as benefits they would receive and not normally get in a shopping experience. Upon further analysis, we find that while only about 3% saw none of these benefits, 62% of users saw one or two benefits and 35% saw three or more benefits. Along with the mean number of benefits indicated being 2.2, the findings give support to H2 and the view that MAR shopping apps offer one or more novel experiential benefits – ones that a user would not normally get in a shopping experience (Huang and Liu, 2014; Rashid et al., 2014) and thus having potential to add almost "unique" perceived value to a shopper's experience.

Possible retail consequences of using MAR shopping apps was sought to be understood better by asking about their effects on user's retail preference and future retail patronage intent (see Table 6).

Table 6. MAR shopping apps' effects on user's retail preference and future retail patronage intent, in order of most to least frequently indicated agreement (n=965).

Retail consequence	Agreement indicated, %
Happier with items purchased	48.8%
More likely to purchase from the retailer	41.2%
More likely to tell others about the retailer	41.1%
More likely to visit the retailer	39.0%
More satisfied with the retailer	37.2%
More loyal to the retailer	29.2%
None of the above	4.6%

The above results suggest that greater purchase satisfaction is a prominent consequence of using MAR shopping apps and that this is followed by several MAR app retailer-specific benefits including increased purchase likelihood, word-of-mouth, in-store visits and retail customer satisfaction. Increased retail loyalty is also indicated, however, this effect trails the other consequences. Accordingly, we consider these multiple areas of user agreement on retail-specific consequences of MAR shopping app use to be encouraging in support of smart retailer efforts to achieve tangible outcomes and possibly strengthen brand image as well (Dennis, Murphy, Marsland, Cockett, and Patel, 2002).

While MAR shopping app users surveyed clearly see multiple experiential shopping benefits and where multiple beneficial retail consequences are also indicated, it was also expected that the use of MAR shopping apps would not be without drawbacks or limitations in the user's shopping experience (see Table 7).

Table 7. User views on six possible negative or drawback aspects of MAR shopping apps, in order of most to least frequently indicated agreement (n=965).

Negative or drawback aspects of MAR shopping apps	Agreement indicated, %
I have to give too much personal information	31.4%
Not integrated enough with all my shopping	27.8%
Not fast enough to use regularly	26.9%
Not reliable enough to use regularly	21.6%
Time consuming to learn	20.1%
Difficult to use	9.5%
None of the above	17.3%

While 17.3% of users do not see any in the list as negatives or drawbacks, the findings show that the need to hand over personal details to retailers is seen as the main negative as it is voiced by 31.4% of MAR shopping app users and where other negatives are then cited with decreasing frequency. Clearly, there is scope for further smart retailer attention to each of these areas support of better objective as well as evaluations of user experience (Olsson and Salo, 2011; Redi, Zhu, de Ridder, and Heynderickx, 2015). At the same time, while certain negatives in the list refer to how MAR apps might be seen as "underperforming" (i.e., in terms of shopper expectations for speed, reliability, ease of learning or ease of use), the lack of insufficient integration with the user's shopping, on the other hand, may be viewed more as something missing rather than what is currently underwhelming users. As such, shopping integration may be viewed as an unexploited opportunity that smart retailers could pursue to increase MAR shopping app use among some shoppers. With additional analysis we find that 72% of all MAR app users indicated either one or two drawbacks and where another 11% indicated three or more drawbacks clearly suggesting there is a need for further improvement in order to meet most user expectations. Encouragingly, the results show that few MAR shopping app users indicate "difficult to use" as a drawback, which is important given research that finds that consumer satisfaction with immersive environments in traditional points of sale is influenced by the tool's perceived ease of use, among other factors (Pantano and Servidio, 2012). The implication of such research is that MAR shopping apps' increased adoption can be accelerated by greater attention to these factors which then also contribute to overall customer satisfaction in a retail setting.

Despite acknowledged drawback of MAR shopping apps, it is also beneficial to understand user views on the future of their take-up. As a means to understand this better, we

asked users to indicate their predominant view, selected from a set of possible future trajectories for their take-up (see Table 8).

Table 8. MAR shopping app user's view on the future of such apps (n=965).

User view of MAR shopping apps' future:	Indicated, %
They'll be no more than a passing fad	5.5%
They'll be no more than a niche offering	7.4%
They'll go mainstream in the next 1-2 years	39.6%
They'll go mainstream in the next 3-5 years	25.9%
They'll go mainstream in the next 5-10 years	13.5%
They'll go mainstream more than 10 years out	8.2%

The results show that most commonly cited future view of users is that MAR shopping apps will go mainstream in the next 1-2 years, suggesting widespread take-up in the very near future and where 65.5% indicate that it will be five years or less. The minority view is that they will be a fad, a niche offering, or will eventually go mainstream but not for over a decade. Overall, we find users expect mainstream adoption earlier than that anticipated by Gartner (2015) in their "Emerging Technology Hype Cycle." Gartner research sees augmented reality as being 5-10 years away from going mainstream, though their study looks at AR more generally and does not focus on MAR shopping apps specifically. The views of MAR shoppers are therefore relatively encouraging (given also that they may be spreading awareness of these apps through social media) and suggests perhaps earlier mainstream adoption than Gartner's broader study of AR indicates.

4.3 Survey Examining MAR Shopping Apps: Behavioural Changes and Retail Outcomes

Upon analysis of the results of the first survey, the second survey examining the behavioural changes and outcomes of MAR shopping app use was then conducted with a sample of 9,452 US smartphone users. Of these, 3,223 or 34.1% responded and answered the survey's screening question ("Augmented reality (AR) apps combine computer-generated and real world image/location info for more immersive shopping and/or product experience. What is your use of AR apps? Tick one…"). Demographics of respondents were similar to

that of the first survey other than second survey respondents having a higher proportion of females at 65.9% (see Table 9).

Table 9. Smartphone users' experience with MAR apps.

Smartphone user's MAR app experience	Female	Male	Total
Have used a little, mainly for entertainment	217 (10.2%)	293 (26.7%)	510 (15.8%)
Have used a little, mainly for shopping	164 (7.7%)	47 (4.3%)	211(6.5%)
Have used a lot, mainly for entertainment	51 (2.4%)	65 (5.9%)	116 (3.6%)
Have used a lot, mainly for shopping	40 (1.9%)	25 (2.3%)	65 (2.0%)
Have used mainly for some other purpose	44 (2.1%)	26 (2.4%)	70 (2.2%)
I am not really sure (screened out)	509 (24.0%)	103 (9.4%)	612 (19.0%)
I haven't used them (screened out)	1,099 (51.7%)	540 (49.1%)	1,639 (50.9%)
Totals	2,124 (100%)	1,099 (100%)	3,223 (100%)

Demonstrating consistency with the first survey for experience, the table shows that a relatively small proportion of users (8.5%) have experience with MAR shopping apps (with 2.0% "a lot" and 6.5% "a little"). However, upon further including experience with MAR apps for entertainment or some other purpose, the survey finds that 30.1% of smartphone users have used an MAR app of one kind or another. As in the first survey, there are smartphone users (males and females alike) who are unsure whether they have used MAR apps or not (albeit a smaller proportion at 19.0% in total) perhaps also as a result of their not fully understanding the nature of augmented reality even when a definition is provided. Consistent with the first survey there is also a sizeable proportion (50.9%) of smartphone users who have no experience with MAR apps and reflecting with MAR's state of development as not yet reaching "mainstream" status.

Additionally, of potential interest for future research are some observable differences between males and females in the extent and type of use of MAR apps. For the data summarised in Table 9, Chi-Square tests conclude that females use MAR apps more for shopping than entertainment in comparison to males (χ^2=74.275, p<.001) though males use MAR apps for any purpose more than females (χ^2=50.444, p<.001), proportionally more females than males have used MAR shopping apps "a little" than "a lot" (χ^2=7.752, p=.009),

and also proportionally more females than males report being unsure about MAR app use (χ^2=100.251, p<.001). Other comparisons find non-significant differences, including the proportion of non-usage of MAR apps by males and females not being significantly different (χ^2=1.665, p=.197). While recognising the presence of at least some significant differences between females and males, we nevertheless deem it beneficial to subsequently perform analyses on aggregate data (male and female combined) to provide for greater generalisability in reporting and interpreting the results, especially since there is a lack of theory and prior empirical study examining gender differences in this context. Accordingly, questions were then asked of the 972 users, male and female combined, who had experience with MAR apps (as opposed to being unsure or not having used them) and follow-on included questions on shopping apps used and on the shopping benefits they obtained. Of these, there were 779 users (80.1%) who participated in remainder of the survey and where subsequent findings are reported.

With the key research question addressed in the second survey being on the extent MAR shopping app use is changing users' shopping behaviour as consumers, eight statements on possible changes in consumer behaviour were presented to MAR shopping app users. Participants were asked to indicate their disagreement/agreement to each statement on a 10-point scale that ranged from "strongly disagree" to "strongly agree" (see Table 10). As the response data are not normally distributed as determined by Kolmogorov-Smirnov tests for normality, Mann-Whitney U tests are performed to enable specific comparisons of "light" vs. "heavy" MAR shopping app users and "light" vs. "heavy" MAR app users for any purpose.

In comparing retail setting valuations of two experience groups—those who are "light" ("a little") MAR shopping app users vs. those who are "heavy" ("a lot") users we find that "heavy" MAR shoppers assign retail setting valuations which are significantly higher than

Table 10. App user views on how their shopping behaviours have changed: All MAR app users for any purpose, "light" vs. "heavy" MAR shopping users, and "light" vs. "heavy" MAR for users for entertainment (1=strongly disagree, 10=strongly agree), Mann-Whitney U test comparisons.

Area of shopping behaviour change: "Increasingly, I value those retail settings where AR-based shopping apps are being offered as…"	**All MAR Users, Any Purpose** Mean (S.D.)	**"Light" MAR Shopping Users** Mean (S.D.)	**"Heavy" MAR Shopping Users** Mean (S.D.)	**Mann-Whitney U (Asymp. Sig., 2-tailed)**	**"Light" MAR Users, Enter-tain-ment** Mean (S.D.)	**"Heavy" MAR Users, Enter-tain-ment** Mean (S.D.)	**Mann-Whitney U (Asymp. Sig., 2-tailed)**
1. "… ways for me to be more certain I am buying what I want."	6.88 (2.17)	6.70 (2.23)	7.41 (1.89)	2224.0 (.001)	6.55 (2.22)	7.07 (2.32)	17072.5 (.037)
2. "… ways to allow me to see product demonstrations or to try out products before buying."	6.80 (2.26)	6.72 (2.33)	7.01 (2.01)	2418.0 (.001)	6.56 (2.35)	7.28 (2.31)	16183.0 (.005)
3. "… ways for me to access more complete information when I am shopping."	6.79 (2.16)	6.59 (2.25)	7.38 (1.73)	2492.0 (.002)	6.39 (2.22)	7.13 (2.39)	15836.5 (.000)
4. "… ways to make my shopping more efficient."	6.63 (2.24)	6.44 (2.29)	7.19 (2.01)	2402.5 (.002)	6.19 (2.26)	7.11 (2.32)	15233.0 (.000)
5. "… ways for me to access more product choice and variety."	6.54 (2.18)	6.36 (2.24)	7.07 (1.91)	2520.5 (.002)	6.15 (2.16)	7.00 (2.47)	15467.0 (.000)
6. "… ways to integrate all my shopping."	6.43 (2.26)	6.24 (2.33)	6.98 (1.93)	2423.5 (.001)	6.09 (2.25)	6.81 (2.55)	15972.5 (.004)
7. "…ways to introduce better value into my shopping."	6.31 (2.20)	6.12 (2.25)	6.86 (1.95)	2520.5 (.002)	5.93 (2.17)	6.74 (2.46)	15950.0 (.001)
8. "… ways to make my shopping experiences more entertaining or the products visually appealing."	6.25 (2.10)	6.09 (2.18)	6.71 (1.81)	1833.5 (.000)	5.87 (2.05)	6.80 (2.50)	15889.5 (.000)

"light" shoppers for all MAR shopping benefits offered (p<.002). The multiple significant findings at p<.05 support H3 and the view that the greater use of MAR apps by users, the *more* retailers are increasingly valued in multiple specific ways.

Another important finding in this study that is related to H3 is that among MAR app users more broadly, increased use of MAR apps for other purposes – not just shopping – is associated with *more positive* user valuations of retail settings that offer MAR shopping apps

for its many benefits. Specifically, Table 10 also shows that in Mann-Whitney U tests comparing responses for those who use MAR apps "a lot" vs. "a little" for *entertainment*, "a lot" MAR users are found to assign retail setting valuations that are significantly higher than the "a little" user group for *all* MAR shopping benefits offered ($p<.037$). The implication here is that it is not just greater use of MAR *shopping* apps but *MAR as a technology* that also contributes to user's increasing valuations of those retail settings offering MAR shopping apps. Smart retailers may therefore find it useful to see *MAR use* for other purposes as a viable entry way in ultimately encouraging *shopping* with MAR.

Lastly, while we do not report the results here in detail, we also find from additional Mann-Whitney U tests comparing responses of individuals who mainly use MAR apps for shopping *versus* entertainment (whether either are used a lot or a little), more than the MAR *entertainment* users, *MAR* app *shoppers* are found to give significantly higher valuations to those retail settings offering MAR shopping apps for all of the shopping benefits as well ($p<.05$). The implication here is that, with increased use of MAR apps for a range of purposes being found to be associated with increasingly positive retail setting valuations, smart retail valuations will also be strengthened by using MAR for *shopping* as opposed to mainly for *entertainment*. That said, for the reasons mentioned earlier, those who are using MAR apps mainly for *entertainment* can be viewed by smart retailers as desirable to reach and then converted to MAR shoppers.

Overall, in looking at the responses of MAR app users, the values across a *range* of benefits offered lends credence to the view that MAR shopping app use increasingly supports greater user valuations of those retailers that offer them. Importantly, such retail setting valuations are related to AR-based shopping apps enabling users a way to increase the *certainty* that what is to be bought is ultimately what is wanted. The ability to seeing product demonstrations, try out products and access more complete information when shopping

further supports the shopping behaviour change of increasingly valuing retail settings by reducing purchase uncertainty. MAR app users increasingly value retail settings enabling "purchase uncertainty reduction," perhaps even more often than those enabling "shopping efficiency" as well as all other shopping benefits shown in the table with lower mean values for agreement. These findings are important as they suggest that smart retail settings may be increasingly valued by shoppers when the retail setting supports *uncertainty reduction* for the purchase more than other benefits. Of the two sources of extrinsic-active value in shopping, namely *shopping efficiency* and *better value*, shopping efficiency may also be valued by MAR app shoppers more than better value itself, suggesting that smart retail settings may add more experiential value when they emphasise *efficiency* over *value* and consequently may find a less-compelling need to reduce prices as a way of providing better value.

The above findings, analysis and discussion have examined multiple experiential perspectives on how and to what extent MAR shopping apps enable smart retail. In the following section, we summarise our contributions and main conclusions as well as indicate areas for future research.

5. Conclusions and Future Research

5.1 Contributions and Main Findings

This research has sought to provide a better understanding of how, why, and to what extent MAR shopping apps can enable—and are enabling—smart retail settings. Toward this aim, our study can be said to make contributions in six areas, each encompassing specific findings:

First, to understand better how and why MAR shopping apps can add experiential value to consumers in their shopping as well as value to retailers, we have reviewed the extant literature on augmented reality and experiential value. Both shopper and retailer perspectives

are examined to enable further evaluation for—and adoption by—smart retail settings, recognising that MAR's acceptance by retailers will hinge on the extent that they see value in the approach given knowledge that technology-based innovations are adopted by retailers to the extent that they see value in the technology (Pantano and Viassone, 2014). This knowledge will be useful in support of retailer's development of the necessary organisational and individual competences for such a new technology's expanded use (Kamprath and Mietzner, 2015). In further support of the above, we have illustrated our findings with current examples of MAR shopping apps and have presented hypotheses as well as a summary conceptual model.

Second, we have developed a clearer understanding of the nature of current MAR shopping app's emphasis on the different types of Mathwick et al's (2001) experiential value, current levels of their use and future direction for take-up by reviewing the current offerings, the state of their use, learning, satisfaction, and user expectations for future take-up. Specifically, we find that such apps span online categorisations well beyond shopping—26 on Google Play alone, including lifestyle, travel & local and entertainment, suggesting that such apps are often promoted as facilitating smarter shopping as part of a broader purpose. In looking at the experiential value emphasis of these apps relative to Mathwick et al (2001), we find that while an extrinsic value emphasis is dominant in 69.4% of all such apps and where "service excellence" more specifically is primary for 50.4%, more than half (54.4%) of all apps are also found to offer primary and secondary *combinations* of both extrinsic and intrinsic value, a finding in support of views suggested from the literature (e.g., Guven et al., 2009; Zhao and Balagué, 2015). In terms of current take-up, we find that only 10.7% of smartphone users in the US have used these apps though 30.1% of smartphone users have some experience using MAR apps for any purpose. Most users, and males and females alike, have learned about them through social media, though less-common means of learning,

including referrals by friends and family, are also contributors. In terms of user satisfaction with such apps, we quantitatively find there is currently a relatively high overall level of satisfaction with MAR shopping apps of all kinds (currently averaging a 4.02 on a 5-point scale for Android-based MAR shopping apps). Additionally, independent of but complementing these findings, we subsequently find through a survey of MAR shopping app users that 65.5% of users expect these apps to go "mainstream" in 5 years or less, with some users (39.6%) indicating as early as 1-2 years. Such findings, which are earlier than anticipated by Gartner's (2015) study, are certainly encouraging for suggesting a larger-scale take-up in the near-future. In either case, increasingly prevalent in-store internet access and availability of high-speed internet access in many homes will at least be facilitating increased ease of MAR app use for both locations.

Third, in order to build upon previous studies on experiential value in shopping and to test the associated hypotheses, we have conducted large-scale surveys to understand better how, why and to what extent MAR shopping apps can and do provide experiential value in shopping. We find that MAR shopping apps are seen by users as being able to offer an array of experiential shopping benefits spanning extrinsic and intrinsic as well as active and passive. Experiential shopping benefits are perceived that cover all quadrants of Mathwick et al's (2001) typology of experiential value, though MAR shopping apps' ability to provide high quality service, intrinsic shopping enjoyment or a means of escape are not as strongly perceived as other experiential benefits. We find that users see such apps as being able to provide high extrinsic value (e.g., efficiency or better shopping value) and where this benefit is highly valued. While users see these apps as also being able to entertain, entertainment is not rated as highly by users as efficiency. Additionally, the predominant view among current users is also that most MAR shopping apps are able to provide extrinsic or intrinsic benefits rather than both, where a possible opportunity is suggested for smart retailers to offer an

expanded range of experiential benefits if the aim is to increase an app's appeal to a wider base of shoppers.

Importantly, we also find that MAR shopping apps are seen by users as being able to provide benefits that they would not normally get in a shopping experience. More complete information and the ability to be more certain that what they are buying is what is wanted rates highly in terms of the almost unique value provide by these apps, suggesting to smart retailers that such benefits be given even more attention in their MAR shopping app development.

Fourth, in an effort to extend research on the outcomes of using smart technologies, we have examined in more detail the immediate shopper and retailer outcomes of using MAR shopping apps. We find that MAR users are happier about their purchases, where purchase satisfaction is the predominant view, though where multiple retailer-specific outcomes are also evident ranging from increased purchase likelihood from a retailer to increased in-store visits though where increased retail loyalty appears to be a less-likely outcome.

Fifth, in order to understand better the longer-term outcomes of MAR shopping app use in terms of how they are changing consumer behaviours, we have examined to what extent users are increasingly valuing retail settings that offer MAR shopping apps for their specific benefits. Our findings suggest that MAR shopping apps are changing the behaviours of shoppers in distinct ways. Retail settings are found to be increasingly valued by MAR shopping app users for the range of benefits these apps offer. In particular, retail settings are found to be increasingly valued when the apps offer users benefits including increased certainty that what users are buying is what is wanted and as well as the abilities to see product demonstrations and to receive more complete information. The benefit of increased purchase certainty is found to substantially increase user's retail setting valuations and where

the benefits of shopping efficiency and better shopping value (where the latter may include better prices) rate less highly.

Importantly, we find that retail valuations increase the more MAR shopping apps are used. Further, we find that retail setting valuations increase the more users have experience with MAR apps of any kind. At the same time, while heavier use of MAR *entertainment* apps is associated with higher retail valuations, heavier use of MAR shopping apps is associated with *even higher* retail valuations.

Sixth, to advance previous research (Martinez et al., 2014) and understand better the perceived drawbacks of MAR shopping apps and identify user's most pressing concerns, we surveyed users on a range of issues. Our research finds that having to give out too much personal information is the most frequently cited drawback, with additional drawbacks present to a lesser extent, and where the app's greater integration with the user's shopping may be seen as an opportunity for smart retailers to pursue as many users also see this as a negative.

In sum, our findings show that MAR shopping apps clearly add much experiential value to retail settings and these apps are able to do so by providing specific benefits. While benefits of extrinsic value such as efficiency and better shopping value are prominent in user's views, intrinsic benefits (e.g., entertainment) are also present and valued to an extent. Importantly, in terms of beneficial shopping outcomes not normally found in a shopping experience, MAR shopping apps are seen as increasing the user's certainty that what is bought is what was wanted.

5.2 Future Research

While this research can be seen to have contributed much to our understanding of how, why and to what extent smart retail settings can be enabled through the use of MAR shopping

apps, additional research is needed. Building upon this research as well as that of Pantano and Servidio, 2012), more research is needed on the ways smart retailers can not only further accelerate installations (currently at over 397,012,000 for Android MAR shopping apps alone) but also encourage ongoing, repeated use.

It will also be beneficial to perform further research that examines MAR shopping app *provider* (retailer and developer) perspectives so as to enable comparisons with MAR *shopper* perspectives. For example, while not reported in this study, a smaller-scale survey by the authors on MAR shopping app *providers* involving similar questions to those given to MAR shopping app users finds that the app *providers* agree *far less* than *users* that users have to give too much personal information. At the same time, more encouragingly, app providers agree *far more* than users that such apps are difficult to use and that they are also not integrated enough with a user's shopping. By comparing the views of app providers and developers, insights may therefore be gained for both and for the further enablement of smart retail settings. Qualitative and quantitative analyses of online shopping app reviews – a method used by Baier, Rese and Schreiber (2015) to assess user acceptance of IKEA's interactive mobile app – could also be performed to understand better MAR shopping app user views on app strengths and weaknesses. Analyses of both a qualitative and quantitative nature could also be performed on online MAR shopping app descriptions given by providers in terms of MAR benefits emphasised as well as on information pertaining to their ongoing updates.

Beyond MAR shopping apps, the findings of this study can also be usefully applied and extended to other smart and interactive technologies including 3D virtual reality applications for retail that hold much promise for enhancing consumer's shopping choice modes and their subsequent shopping experiences (Pantano and Naccarato, 2010; Laria and Pantano, 2012).

5.3 Limitations

As with all research, our study is not without limitations. Beyond the theoretical perspectives included in this study, a relative lack of theory in relation to the phenomenon examined has of course limited the scope of our analyses. With additional theory, the development and use of a more sophisticated research model would support correspondingly more-detailed analyses. In terms of the data used, while large-scale survey data on smartphone user views are extensively drawn upon, behavioural data in the form of user time spent on MAR shopping apps or product purchase information is not examined. Indeed, the lack of such data is a major challenge in research on MAR shopping app use to directly link actual use of such apps to quantified retail outcomes ranging from increased sales revenues to increased purchase frequency at retailers. Both academic researchers and MAR app developers are eager to obtain such app-specific and retail-specific data for analysis and it is something that should be pursued in future research. That said, such research should recognise that MAR shopping app use may not consistently correlate with sales or even greater purchase satisfaction, as their use may be mostly for entertainment, for example, and as a consequence contribute to increased brand equity more than sales.

From a measurement perspective, a limitation of our approach is that some important issues have been examined by questions enabling the collection of categorical data only, largely being a result of constraints of the survey's administration to the respondents via smartphone. Future research may therefore involve alternative methods of data collection overcoming such constraints, e.g., computer-based surveys. In addition, the two large-scale surveys conducted in this research have obtained the views of United States smartphone users who are representative of earlier adopters and heavier technology users. While it is deemed beneficial to obtain the views of early adopters for their knowledge and influential diffusion of marketplace information (Feick and Price, 1987), to the extent there are differences

between the US and other countries in terms of MAR shopping apps on offer or smartphone user characteristics, the results may be less generalisable beyond the current context. Accordingly, future research in other countries will also be beneficial. Further, the views of adults only are examined. To the extent children are MAR shoppers, such views are not included and where possible differences with adults (Lagerstam, Olssen, and Harviainen, 2012) may be worth investigating in future research.

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