Influence of Augmented Reality on Consumer Decision-Making Process: A Review of Literature

***Reetika Taneja[1] and Hitakshi Dutta[2]**

[1]Research Scholar, Commerce Department, Chandigarh University, Mohali, India

[2]Professor and Associate Director, Chandigarh University, Mohali, India

*reetikataneja2015@gmail.com

hitakshid@yahoo.co.in

Abstract : Immersive technologies have become increasingly popular, and consumers are beginning to recognize their benefits. However, the adoption of these technologies to make a purchase decision still remains a challenge. The current study reviews previous work on Augmented Reality (AR) in regards to the framework of consumer decision- making process, and related theories to better comprehend consumer behavior in the adoption and application of AR. The study tracks the evolution of AR since its inception in 1901 through literature review on applications of AR, consumer decision-making process in view of AR, and relevant existing theories to understand consumer behavior in AR. The impact of AR on various phases of consumer decision-making process has been researched. The consumer behavior theories that became apparent from the research are organized into a table that illustrates their application. The most prevalent one was the technology acceptance model, considered the most effective model for dealing with user acceptance of innovative technology. This study advances the field of literature by defining the research goals for researchers studying consumer decision making process in the framework of AR. Future studies should focus more on the five stages of consumer decision making model, and other relevant theories. Understanding consumer behaviour and how choices are made in the light of AR would help businesses to use innovative technologies in a more effective manner according to consumer's preference to maximize their sales. This evaluation takes into account each of the five phases of consumer decision- making procedure in the context of AR to maintain the study's uniqueness in this field. The recent theories used in the same context have also been discussed.

Keywords- Augmented Reality, Immersive Technology, Consumer Behaviour, Decision- making process, Influence of Augmented Reality

1. Introduction

Online purchasing has become a novel trend being and ease in the process of online buying

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to help consumers to have a more realistic idea about the product. Marketers are implementing immersive technologies for instance, Augmented Reality/Virtual Reality/ Mixed Reality (AR/VR/MR), however, the adoption of these technologies to make a purchase decision still remains a challenge. Researchers and academicians pay close attention to study how these technologies are evolving over the last few years.

AR is an innovative integration of various technologies that brings together the technological data and visuals on the real-life settings of the consumer, thereby establishing an innovative user experience between the online and physical worlds [1], besides enhancing user's perception of reality. It integrates virtual objects with the environment in which the consumer lives and engages with consumers in real-time enabling them to see the augmented information as a part of their physical environment [2].

According to [3], when consumers can examine details in context, it gives them more confidence to arrive at a purchase decision. However, the benefits of the technology can only be claimed if the consumer is willing to use thetechnology. There are several constraints such as lack of interaction, difficulty in forming the actual expectations about the product being purchased, digital fatigue, privacy concerns, installation difficulties, and slow response speed [4] owing to which the actual application of Augmented Reality Shopping Applications (ARSAs) hasn't yet reached the expectations and is still not being used widely [5]. Rapid advancement in technology has resulted in a substantial rise in AR and its retail applications, and the area has inevitably gathered significant attention in academic research as well. However, due to the topic's multidisciplinary backgrounds, the academic study is unfortunately fragmented [6]. This study gives a broad overviewof the growth and evolution of AR since it was first proposed, as well as its applications and influences on the five different phases of the consumer's decision-making cycle. It also discusses the existing theories that have been applied to AR in regard to the context of consumer behavior.

2. Literature Review

2.1 Evolution of AR in the market

2.1.1 Early Stage:

Although AR has been extensively more popular in recent years, the thought of AR has been around for much longer than one might imagine. In 1901, Lyman Frank Baum wrote an illustrated novel titled '*The Master Key*' which somewhat imagines an aspect of AR. He wrote about a 'character maker' that seems to resemble a pair of electronic eyeglasses, but when worn, displays a letter on the wearer's forehead that represents their character. The leading character made fun of the fact citing the technology 'a century ahead of the times' [7].

2.1.2 20th Century (1950 onwards):

In the 1950s, a cinematographer, Morton Heilig perceived the delight of watching a film that would involve all the five senses rather than just engaging audio and visuals. He presented a paper describing the concept in 1955, and in 1962 heintroduced *Sensorama*, an operational version of what he visualized as an immersive theatre experience. He is regarded as an early developer of modern AR as his work concluded before the advent of digital computing [8].

The first AR technology is believed to have surfaced in the 1960s, more specifically in 1968, with Ivan Sutherland being regarded as its father, a well-known IT researcher and Computer Science Professor, who servedas the former head of the US Defence Department ARPA's Information Processing Techniques Office. He engineered '*The Sword of Damocles*,' which is now regarded as the pioneering AR head-mounted display, in collaboration with his student, Bob Sproull, from Utah University. The technology behind the device was primitive both in terms of user interface and realism, and the depictions comprised of the virtual environment were primarily wireframe rooms. The system displayed the results from a computer code. Head tracking was essential since the software's perspective happens to be dependent onthe user's gaze position. Over time, '*The Sword of Damocle*s' lost its practical value as it was so large and heavy that it had to be suspended from the roof so that itcould be worn on someone's head.

Six years later, in 1974, a computer researcher and artist, Myron Kruger, established '*Video Place*' a research center at the University of Connecticut dedicated to the study of artificial reality. The system was designed in a way that, in one mode of operation, a shadow picture ofparticipant was projected onto a video screen that responded to their movement. This specialized computing environment allowed the participant analysis down to the movement at the finger level. Further to this was a graphic '*entity or critter*' to climb over and follow the shadow wherein the user was given an impression of being present within the virtual environment through the projected shadow, and one could interact with it directly. The shadowbecomes an abstract form of avatar [9].

Tim Caudell, a Boeing researcher,initially introduced the expression '*Augmented Reality*' in 1990 [10]. In 1992, Louis Rosenburg developed the first fully real operational AR system referred to as "*Virtual Fixtures*" comprise of a complex robotic system intended to overcome the lack of fast 3D graphics processing capacity and to maximize working efficiency and productivity. This technology was a prototype of what most AR systems do nowadays. In the same year, a group of Columbia University students developed a testbed system, termed *KARMA* (Knowledge-based Augmented Reality for Maintenance Assistance) to investigate the automated augmented reality design for tasks associated with maintenance and repair assignments.

Julie Martin, a writer and director, was the first to incorporate AR to the arts and entertainment business with the theatrical play '*Dancing in Cyberspace*' in 1994 wherein, acrobats performed while projected images of extinct animal species danced alongside them on the actual stage.

In 1998, Sports Vision broadcasted its very first live NFL game using the yellow yard marker which was revolutionary as the concept of overlaying images over a live image quickly spread to other sports broadcasting [11].

With the objective of improving visual navigation during flight tests, the NASA X-38 spacecraft was launched in 1999 deploying a hybrid synthetic vision technology that implemented AR to superimpose navigational information [7].

2.1.3 21st Century:

A year later, in 2000, Hirokazu Kato designed a free software library known as *ARToolKit,* a package designed specifically to help other programmers in creating AR software. Through video tracking, the library overlays virtual visuals on the physical world [7]. In the same year, Bruce Thomas created *ARQuake*, the world's first outdoor AR game [12].

Sports Vision launched the first computer graphic system forNFL season 2003 that could integrate the first and tenth lines from the prevalent Skycam, the NFL's portable camera believed to offer an aerial view of the field [13]. Wagner and Schmalstieg introduced the first ever portable AR framework on a personal digital assistant in the same year which paved the way for AR on mobile devices [14].

In an effort to make the printed pages more appealing, Esquire Magazine implemented AR forthe first time in print media, in 2009. The AR-enabled magazine's cover featured Robert Downey Jr. engaging with the users each time they scanned the cover. ARToolKit introduced AR to internet browsers in the same year [15].

Since then, there have been numerous advances in AR technology; Volkswagen debuted the *MARTA* app (Mobile Augmented Reality Technical Assistance) in 2013, to provide the technicians with an access toservice manual's comprehensive repair instructions [16]. AR attracted the attention of many users with the development of *Google Glass* in 2013. This kind of use of AR technology was revolutionary as it possibly can and will eventually be explored to align and optimize processes across an extensive number of sectors. Numerous applications, including Google Maps, Google+, Gmail, and others, were available to users of this gadget.

With the launch of *HoloLens*, an improved version of the earlier built Google Glass device, Microsoft leveled up the game in 2016 [17]. Pokemon Go introduced AR in 2016 and redefined the perceptions of regular customers of the revolutionarytechnology [18].

IKEA created the first AR retail application in 2017, known as *IKEA Place*. The application enables customers to virtually explore their home interiorsalternatives prior to making a decision to purchase [19]. The retail industry suffered greatly from the closure of physical stores due to COVID-19 that took a massive hit as it was nearly impossible for people to visit the stores. This made it much easier for AR to make its way into the retail industry as a significant number of retailers started using this technology in order to enable customers

to view and purchase their products.

2.2 Sector -Wise Adoption and Application of Augmented Realty

2.2.1

AR in Tourism: Numerous travel companies and hotels have adopted AR-based travel applications aimed at helping their consumers in exploring destinations without compromising the standard of transportation and dining options, with interactive food menus that precisely reflect the preferences of tourists. The smartphone applications provide tourists with much more personalized content and seek to improve tourists' enjoyment while travelling, as well as help them obtain information and gain a better understanding of the attractions at their location [20].

2.2.2

AR in Entertainment and Gaming: AR is being widely used to develop games and to increase the visibility of significant game elements during live sports broadcasts. When a large audience is involved, AR assists the advertisers by displaying virtual adverts and product placements [21]. When several live performances and concerts had to be postponed or canceled in 2019 and 2020 because to the unforeseen pandemic. Some entertainment firms have come up with a solution for fans by hostinga virtual internet concert where fans across the world can participate along the local ones [22].

2.2.3

AR in Education: The real world and the digital realm can be seamlessly blended with the support of AR technology, providing an opportunity for educators to present the information in a moreengaging way that improves student involvement and learning. It makes knowledge and information more accessible and attractive for learners, and is emerging as a new hub for information technology use in education [23].

2.2.4

AR in manufacturing: Manufacturers across different industries invests in AR solutions despite of challenges, and AR is versatile enough to handle them all. AR has assisted in improved comprehending product assembly tasks that need to be carried out. The AR technique is capable of reducing information overload and training needed for assembly procedures [21]. AR can further assist in intricate machinery installation, part maintenance, and professional support.

2.2.5

AR in medical: AR systems have the ability to assist surgeons with orientation and navigation before, during, and after surgery. The patients have significantly benefitted from appropriate therapies that calm their thoughts and remove all the toxins from their bodies. AR devices can create virtual overlay images in real-time by streaming input data. In addition to visual improvement, haptic tools like touch or vibration feedback tools can be incorporated into AR systems to enable surgeons to feel tumors or otherwise examine the patient's condition by touch instead of doing open surgical procedures. Moreover, challenging operations might potentially become minimally invasive with the use of an AR

system and reliable, constant force feedback [24].

2.2.6

AR in retail: Three primary applications of AR in the context of retailing have been highlighted by [25], **a) In-Store**, based on projection-based technologies and AR interfaces that can provide consumers with a better, more interactive, and immersive experiences [26]. For instance, L'Oréal and Sephora installed AR mirrored surfaces throughout their retail shops to provide customers the opportunity to try virtual makeup on their faces [27]; **b) Mobile Applications,** portable device like a mobile phone, recording devices, or tablet can be usedwith Mobile Augmented Reality (MAR) to learn more about the surroundings [28]. The consumers can combine actual and simulated features, engaged with the material that is digital, and identify and assess things in unique ways using smartphone camera; **c) Online Web-based,** with the help of web-based applications, customers indulge in a holistic shopping experience while relaxing in front of their electronic devices at home. Ray-Ban Virtual Mirror, which can be accessed on the company's global website, was among the initial web-based AR applications designed for retail [29].

3. Implication of AR at different stages of Consumer Decision Making Process:

The Five Stage Model, created by Dewey in 1910 [30] has been widely recognized as one of themost extensively used models of consumer decision-making process. The five distinct stages of the model are recognition of need or problem, information search, comparing the available alternatives, purchase decision, and post-purchase evaluation. This framework effectively describes and clearly demonstrates the decision-making process that customers use when making a purchase.

3.1 Need recognition: The first stage in the process of consumer decision-making process is recognizing the need for the product or service. Need recognition may be stimulated internally (caused by hunger, thirst or other basic human needs) or externally (causedby various formats of advertisement).

Implication of AR in Stage 1: Consumers can feed the details of their need for AR applications and technology can help the consumer in suggesting a suitable product or service as per their requirements. This results in the creating the need of product or service, and once the consumer realizes, he starts gathering information aboutthe product, resulting in Step 2.

3.2 Information Search: Once a consumer believes a product is required, he is likely to commence looking for information about the product before directly arriving at a purchase decision. Diverse sources of information are available [28]. These sources can be classified as follows: **personal** (family, close companions, and acquaintances); **commercial** (salespersons, distributors, web and mobile sites, packaging, displays); **public** (consumer rating organizations, social media, online searchers, and peer reviews); and **experimental** (testing and making use of the product).

Implication of AR in Stage 2: AR offers an immersive experience to consumers that sparks their interest in the product while also giving them all the additional product informationthat they may require. AR can convey information more effectively than any advertisement, image, or video by presenting the same thing in a more appealing way which helps the consumer to have a clear idea about the product in very little time.

3.3 Evaluation of Alternatives: The consumer now correlates and contrasts all the information accumulated through the search and compares numerous merchandise and amenities based on his requirements and preferences. The consumer builds a set of preferences for products, brands, and other features based on what he wants, prefers, and what suits his personality and lifestyle. A consumer can, at times, find the task of evaluating options to be challenging, exhausting, and troublesome. This is owing to the fact that it is quite challenging to identify the most appropriate product or service to meet a customer's demands as there are numerous effects that might influence the consumer purchasing decision-making process.At this stage, it is important for a brand to attract customers by providing some additional benefits or experiences in comparison to the competitors.

Implication of AR in Stage 3: AR enables the brands to add extra appeal to their social media strategy as well as overall shopping experience. Marketers can create social media content that goes viral and raises brand and product recognition, therefore attracting customer attention. Additionally, AR assists retailers in collecting vital information about customers' interests, preferences, and purchase behaviors as they examine or try things in AR before buying. Retailers can takeadvantage of these insights to create personalized marketing and advertising strategies. This helps retailers to stay in touch with the customers at all stages of their decision-making process with a chance to persuade customers to buy their products or brands.

3.4 Purchase decision: The consumer makes a purchase decision once the information search and evaluation process is completed. This is regarded as the most critical stage in the entire process as the consumer decides to make a final purchase at this moment after thoughtfully weighing all the available options and reaching at a conclusion. The brand or product that the consumer rates highly throughout the evaluation stage is the one they choose [31]. Almost 80% of all retail transactions take place in a physical store because customers want to experience the product before making the purchase. Till the time customer is satisfied with the physical examination of the product, it is quite difficult to persuade him to buy the product or service.

Implication of AR in Stage 4: AR offers a close or even better experience to the conventional buying process as in the case of IKEA. The IKEA app allows the customer to place the furniture virtually in their ownspace and check how well it would fit. The app provides a wide range of options to select and place virtually in consumer's setting, and buy the best-suited one [32].

3.5 Post-Purchase Evaluations: The relationship with a customer does not end after the product is shipped; rather, the businesses should keep track of how consumers act andfeel after making the purchase to ensure that they have an unforgettable shopping experience,

guaranteeing that the product's quality lives up to expectations, to encourage repeat business. The consumer's decision to purchase the same product in the future is potentially affected by this stage, making it the most significant. Consumer decision making process is a repetitive action, having a positiveexperience which plays a crucial role in minimizing uncertainty when the decision to purchase the same product or service is considered following the previous purchases [33].

Implication of AR in Stage 5: Recent research suggests that using AR in the marketing context has the potentialto increase customer retention, word-of-mouth recommendations, and consumer satisfaction and loyalty [19].

4. Existing Theories applied to AR in the context of consumer behavior

This section provides the literature about wide range of theories related to AR technology and consumer behaviour towards its acceptance and utilization. TAM, however, appears to be the theory that is most frequently applied in this context. It is remarkable that most of the theories have been validated three times or less on average. It is necessary to further validate the scarcely encountered theories to broaden the perspective byexploring them to obtain a detailed understanding of relevant factors related to adoption of AR along with the circumstances that may either encourage or hinder consumers' cognitive use of the technology.

Table 1: Existing Theories used in Consumer Behaviour and AR in the recent years

Theory	Application	Implication	References
Technology Acceptance Model (TAM)	TAM takes perceived usefulness, perceived ease of use, attitudes, and intentions to use into account while determining the willingness for adopting new technology [34].	Perceived usefulness and ease of use are predictors and mediators that allowexternal influences to affect a person's actual use and intentions [35]. TAM helps to understand the consumer's acceptance and adoption of AR technology.	[36] [37]
Uses and Gratification Theory	It focuses on the idea that people take advantage of specific media to meet certain requirements [38]	The theory is applied to examine the way in which AR accommodates utilitarian and hedonic need satisfaction, which is argued to translate into elements like purchase intentions.	[39]
Theory of Behavioural Reasoning (BRT)	The literature has employed BRT in a variety of scenarios, including buying	BRT is a well-known theory when it comes to comprehending the consumer behaviour.	[43] [37]

	behaviour, technology adoption, implementation challenges, and resistance intention [40] [41]	Using BRT is crucial to understanding behavioural responses as it tries to explain 'reasonfor' and 'reason against' in an integrated system [42].	
Mood Maintenance Theory	Mood maintenance is a phenomenon in psychology that applies to virtual environments as well as activities that include physical consumption. According to recent research, people are motivated to have strong goals to preserve their good mood when they are in a great mood in a digital environment [44].	As an illustration of AR service experiences, [45] and [26] reported that customers using internet can directly try on clothing and customize their appearance using intelligence features inherited in AR mirrored surfaces (e.g., synchronous sensation of ownership control). While receiving advantages for self-improvement during try-on experience online, the AR mirror's intelligence function may help users retain a positive attitude.	[46]
Theory of Reasoned Action(TRA)	TRA supports in the prediction of consumer's behavioral intentions, such as the willingness to make use of social media [47] or the intended purpose to communicate information on the internet [48].	Applying TRA to AR, help to predictconsumer behaviour and their intention to use the technology.	[48]
Theory of Planned Behaviour (TBP)	Icek Ajzen introduced TPB in 1985 as a theoretical framework for understanding usual human behaviour. An individual's behaviour intentions are influenced by three distinctive features,	TPB, when applied to AR, suggests that favourable attitudes towards AR, subjective norms that encourage its usage, and a sense of perceived behavioural control over AR technology can lead to adoption and use of AR bythe consumers.	[49] [50]

	involving 'one's perspective towards behaviour, subjective norms, and perceived behavioural control'.		
Diffusion of Innovation (DOI)theory	DOI integrates concepts like relative benefit, observability, complexity, compatibility, and trialability with socio-psychological theories.	DOI contributes to the explanationof the structure and patterns of technological adoption.	[51]
Innovation Resistance Theory (IRT)	Customers tend to resist new technology. This resistance can be categorised under active and passive resistance. Active resistance is a result of innovations' distinctive characteristics, and can potentially be examined using the functional barriers developed by IRT. Passive resistance arises as a result of the contradictions with the previous assumptions, and can be explored by psychological barriers proposedby IRT [52].	The theory study why people resist using AR and howthat can be improved.	[53]

5. Inference: AR and Consumer Decision Making

The present study provides an outline about evolution of AR, its applications in various sectors with reference to the consumerdecision making process in AR. It further provides the implication of relevant existing theories of consumer behaviour and AR that havebeen used recently. It is evident from the discussion that AR has a significant impact on the consumer experience, consumer behaviour, and often influences customer to choose a specificproduct or brand. In addition to saving consumers' time and effort by eliminating

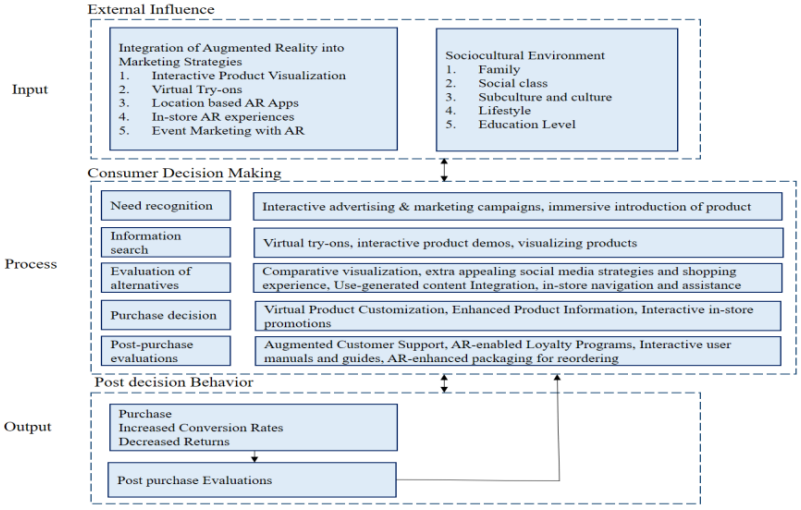
the need for them to physically visit a retail store, AR technology also makes it feasible to shop even after midnight, which is not conceivable at conventional stores.

According to previous research, convenience, enjoyment, and additional benefits are among the most significant factors that influence engaging with new technologies. Potential users of AR technology are presumably promised usefulness, enjoyment, and information value, and these components become essential for attracting consumers [54].

Among all the five stages in the consumer decision-making process; need recognition and information search are the two most challenging stages for firms in a highly competitive environment. AR can support in this situation by boosting external knowledge necessary for these two stages. When customers experience the media informational value of the latest innovations, they believe that the technology delivers perceived usefulness and delight, further increasing their willingness to make use of innovative technology as new purchase technique [55].

AR, if implemented in the decision-making process of consumers, can improve and transform customer engagement with products and services. AR has the potential to bridge the gap between real-world and virtual experiences with easier decision making for the consumers and increased satisfaction leading to improved sales for the businesses. Based on the review of Literature a Conceptual Model of Consumer Decision Making is proposed in Image 1 as AR provides consumers an abundance of options towards more personalized experiences with the goods they want to purchase. With the use of AR, each online interaction has the likelihood to become an effective sales channel as the customers aren't held back by a restricted number of product photographs and videos anymore.

Conceptual Model of Consumer Decision Making



Source: Proposed by the researcher

6. Conclusion: Future Research Directions

Future studies can implement other theories used in the *(Table 1)* or other relevant consumer behaviour theories in order to gain a better understanding of consumer responses with respectto AR or other immersive technologies. Future studies may also focus on impulsive purchasingpatterns driven through AR. Additionally, it is extremely important to understand that these revolutionary innovations can have adverse impacts on consumers as well. Loss of control, privacy issues, and the risk of being overly dependent on and addicted to these technologies are some of the major drawbacks [56] [57]. For this reason, it is essential that future studies address the shortcomings of new technologies in addition to providing a thorough evaluation of how emerging technologies will change the consumer experience.

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