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Enhancing the Retail Experience Through Augmented Reality: The Role of Flow in Brick-and-Mortar Stores

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Abstract: The retail sector is increasingly confronted with challenges arising from digital disruption and shifts in consumer behaviour. Amidst this transformation, the integration of augmented reality (AR) has been identified as a promising avenue to revitalise the in-store shopping experience, offering a means to engage customers more effectively and enhance competitiveness. This study investigates the extent to which AR applications can improve the shopping experience in physical retail settings, with particular emphasis on their capacity to foster customer flow states. A survey of 239 participants, comprising both general consumers and retail professionals, was conducted to explore the impact of AR on the shopping process. The findings suggest that AR significantly enhances the shopping experience, contributing to heightened customer engagement and immersion. However, while AR is found to influence flow states, the flow experience itself does not mediate the relationship between AR use and the shopping experience. These results offer important insights into the application of AR in brick-and-mortar retail environments, providing a management-oriented perspective on how its strategic implementation can generate sustainable competitive advantages. Moreover, the study contributes to existing AR literature by extending the understanding of its role in traditional retail, highlighting practical considerations for retailers aiming to adopt such technologies. The evidence also underscores the potential of AR in fostering behaviours and experiences that are essential for maintaining the competitiveness of physical stores in the digital age. Therefore, the adoption of AR technologies is not only recommended for enhancing the customer experience but also for driving innovation within the retail industry.

Keywords: Augmented reality (AR); Smart mirror; Flow; Retail; Brick and mortar; Shopping experience

1 Introduction

1.1 Relevance and Objectives

Brick-and-mortar retail is facing one of the most significant transformation challenges. This is because the technological and social changes, as well as the newly emerging market and competitive structures resulting from the digital transformation, require an active response [1]. In view of the changes in consumer behavior triggered by the continuous flood of stimuli and information from the media, companies must make additional efforts to attract the limited attention of consumers to themselves and their products [2]. In addition, the general introduction of new technologies and the rise of online competitors are increasing customer expectations of the shopping experience in traditional stores [1]. In order to remain competitive, retailers must therefore focus more on their customers' shopping experience. In this context, they are constantly faced with the decision of whether to introduce new technologies [3]. For management, this situation requires a comprehensive strategic response that is not limited to operational adjustments, but also includes long-term, customer-centered transformation plans. Management is faced with the challenge of integrating technology in a meaningful way that is in line with the company's core objectives and strikes a balance between innovation and brand identity. One technology trend that has recently gained in importance is the use of AR in shopping [4].

AR enables a digitally enhanced perspective on reality and overlays it with visual elements and information [5]. This technology opens up new opportunities for brick-and-mortar retailers to advertise products and bring the brand to life in a new way [6]. There are numerous definitions of AR. However, most share a common understanding of the functions described, which are characterized as interactive, simultaneous, vivid and unique to the environment in which they are used [7]. The definition by Azuma et al. [8] states that AR technology enriches the real environment with virtual, computer-generated objects that appear in the same space as the real world. Faust et al. [9] confirm this statement and define AR as the superimposition of virtual elements such as computer-generated texts, images, sounds and more onto the real environment. Numerous advances have been made in the field of AR in recent years, and the first applications are now technically feasible. Nevertheless, experience with implementation in a real-world context is still limited [10]. Many implementations are therefore often test or pilot projects. The relevance of AR is reflected in forecasts that indicate that global sales in the field of AR and virtual reality (VR) will reach around 36.9 billion euros in 2024. The largest market segment will be AR software, with a forecast volume of EUR 11.8 billion in the same year. The forecast indicates that the market volume will increase to EUR 53.5 billion by 2028, which corresponds to expected annual sales growth of 9.71% [11].

With the increasing use of AR in the marketing sector, scientific efforts in literature and research have also increased to explore the impact of this technology on the consumer experience and customer behavior. It can be seen that retail, tourism and advertising are the central application areas of AR marketing research. Retail is defined as the earliest and most popular area of research. The majority of studies to date have focused on AR applications in online environments, while only a small amount of literature has examined AR in on-site scenarios. The most widespread forms of AR in these three areas include mobile and web-based AR applications. In contrast, on-site AR applications, wearable AR technologies and AR applications based on somatosensory devices have received little academic attention in some areas [12]. Helpful insights have already been gained in research that explicitly relates to brick-and-mortar retail. In one of their studies, Heller et al. [5] conducted an experiment in which a restaurant visit was simulated and an interactive dessert menu was used as an AR application. It was found that AR mimics the cognitive processes of customers and transfers them into the digital space. This improves customers' decision-making comfort, promotes positive word-of-mouth (WOM) and facilitates the selection of high-quality products. In their study, Javornik et al. [13] focused on the virtual try-out of make-up using AR technology. The so-called Magic Mirror application was installed on two tablets and tested in the cosmetics department of a physical store. It was found that the AR application offers customers a fascinating experience that is characterized by usefulness, realism, playfulness and moments of surprise. A recent study by Kataria et al. [14] examines the use of AR in retail marketing. The results demonstrate that AR fosters customer engagement, enhances the in-store shopping experience, and ultimately leads to increased sales – as vividly illustrated by concrete case examples. Arena et al. [15] provide a comprehensive overview of AR in their study, highlighting its key applications as well as the hardware and software components employed. Additionally, the technical limitations and potential future areas of application of this technology are discussed. A complementary study by Dargan et al. [16], provides a comprehensive overview of AR, explaining its fundamental technologies, architectures, application areas, and its advantages and limitations compared to VR.

In the context of AR marketing, the concept of flow is a critical theoretical framework, alongside models like the Technology Acceptance Model (TAM) and the Stimulus-Organism-Response (S-O-R) model [12]. Csikszentmihalyi first introduced the concept of flow in 1975 [17]. It describes a state of deep immersion and intrinsic motivation in an activity, often associated with feelings of control and enjoyment. Csikszentmihalyi's research identified autotelic activities, tasks performed for their own sake, driven by intrinsic rewards rather than external incentives [18]. Later adaptations by Hoffman and Novak [19, 20] expanded flow theory to the digital sphere. They defined flow as an intrinsically rewarding state, characterized by self-reinforcing immersion facilitated by interactivity and a loss of self-consciousness. Similarly, Barhorst et al. [7] defined flow as a profound detachment from the external world, resulting in an intense and pleasurable out-of-body experience. While there has been extensive study of flow in online environments, there is still much to be done in applying flow theory in traditional retail. Wang and Hsiao [21] were the first to apply flow theory in physical retail. They demonstrated that flow dimensions such as concentration, pleasure, and control positively correlate with future purchase intentions. Similarly, Riedl [22] explored flow in textile retail and found that flow experiences significantly enhance customer loyalty, shopping enjoyment, and emotional attachment to the store environment. Despite the growing importance of flow theory in research on consumer behavior, especially online, it is clear that its application in physical retail remains a relatively underexplored area.

The integration of AR with the flow experience in retail is a significant and growing area of academic and practical interest. First, Pathak and Prakash [23] extend traditional flow dimensions by exploring how AR-facilitated immersion can deepen consumers' psychological ownership of products, ultimately enhancing decision-making comfort and positively influencing purchase intentions and the "wow" experience. Their study focuses on experienced AR shoppers, demonstrating the significantly increased impact of AR on individuals already familiar with the technology. Secondly, Chen and Lin [24] definitively show how AR affects consumer decision-making through perceived realism and technological fluidity. The experimental findings show that high perceived realism and fluidity in AR tools strengthen the flow experience, which positively impacts consumers' cognitive and emotional responses toward both the brand and AR medium, leading to higher purchase intentions. Third, Barhorst et al. [7] use flow theory to demonstrate the optimal application of AR in a wine shopping context. Their research proves that an AR-enhanced shopping experience increases the flow state, which heightens consumers' enjoyment, engagement with information, and perceived learning. These factors significantly elevate overall satisfaction, proving that AR is a valuable tool for immersive retail experiences.

The identification of the dimensions for measuring the flow experience, the focus of different AR applications and the distinction between the use in stationary retail and online shopping are currently the subject of intensive research [7, 23, 24]. However, the exact mechanisms and interactions between AR, flow, and the shopping experience have not yet been sufficiently explored. This research addresses these gaps by leveraging existing potentials and addressing previous limitations. Against this background, the study contributes to the existing literature by systematically analyzing the role of AR in brick-and-mortar retail. In particular, it examines how AR influences customers' flow experiences and the interactions between these factors. This research goes beyond previous studies by not only considering the direct effects of AR but also investigating the role of the flow state as a potential mediator in this context. The central objective of this study is to analyze the impact of AR in physical retail. In this context, the following research questions are examined: Does the use of AR enhance the shopping experience for customers? Does the AR application have a positive influence on the customers' flow state? What impact does the flow state have on the shopping experience? And finally, does the flow state mediate the relationship between the AR application and the shopping experience?

The structure of this study is as follows (Figure 1): First, in Section 1.2, the hypotheses are derived based on current research. Section 2 outlines the research methodology, including the data collection process, sample characteristics, and the measurement of key constructs such as AR, flow, and the shopping experience. Section 3 presents the results, detailing the applied methods, potential biases, and hypothesis testing. Section 4 discusses the findings in the context of existing research, addresses limitations, explores future research opportunities, and highlights practical implications. Finally, Section 5 provides a summary of the study's key insights.

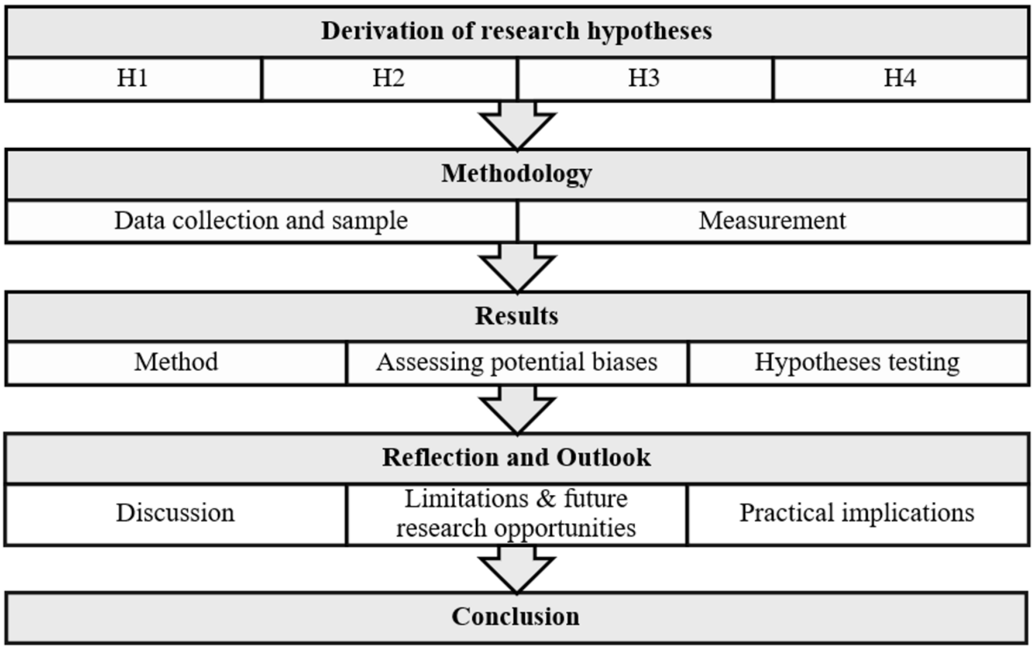

Figure 1. Structure of the study

Note: This figure was prepared by the author

1.2 Derivation of Research Hypotheses

1.2.1 The role of AR in relation to the shopping experience

One conclusion supported by many studies is that the use of AR enriches the general consumer experience [12]. More precisely, AR applications enable customers to have a fascinating experience on-site [7]. Javornik et al. [13] specify this in their research by describing a comprehensive AR experience that is characterized by usefulness, realism, playfulness and moments of surprise. While they analyzed a beauty mirror in their study using the cosmetics industry as an example, this research paper presents a similar AR application, the smart mirror, based on the fashion industry. In addition, the shopping experience is measured in its entirety, considering satisfaction and shopping intention. Based on these considerations, the following hypothesis was formulated:

Hypothesis 1: *The AR application has a positive influence on the shopping experience.*

1.2.2 The role of AR in relation to the flow state

Some studies have already demonstrated the direct and indirect positive influence of AR on the flow experience, especially in comparison to traditional shopping contexts [7]. In contrast to the other studies, this research does not use a mobile AR application. Instead, the influence of a stationary AR system (smart mirror) is analyzed in an on-site scenario. It is assumed that this type of AR application can also promote the user's flow experience due to its immersive and interactive properties. This is intended to expand the level of knowledge in stationary retail. Based on this, the following second hypothesis was formed:

Hypothesis 2: *The AR application has a positive influence on the flow state.*

1.2.3 The role of the flow state in relation to the shopping experience

Measured in stationary retail, a direct positive influence of the flow experience on various constructs has already been demonstrated, including purchase intention [21], loyalty, shopping enjoyment, emotions [22], immersion [23], affective and cognitive reactions towards the brand and the AR medium [24] and consumer outcomes [7]. The influence of flow, measured using the dimensions of control, concentration and pleasure, on the summarized construct of the shopping experience has not yet been comprehensively researched, especially with regard to satisfaction and shopping intention. The following hypothesis was therefore put forward:

Hypothesis 3: *The flow state has a positive influence on the shopping experience.*

1.2.4 The role of the flow state as a mediator between the AR application and the shopping experience

The integration of AR applications in stationary retail has the potential to profoundly change the shopping experience [25]. In this context, the flow experience can be seen as an enhancing component. The role of flow as a mediator can be assumed for the following reasons: AR applications have the potential to trigger a heightened state of flow. This flow state plays a key role in improving the shopping experience. By achieving a flow state, additional positive effects can be gained, including improved cognitive processing, as users can absorb and process information more efficiently, an increased enjoyment of shopping, which is promoted by the exciting and appealing AR experience, and an overall higher satisfaction with the shopping experience [7]. In summary, Flow can act as a mediator by transforming the conditions created by AR into an optimal and satisfying shopping experience, as it influences the way users interact with the AR application. The role of flow as a mediator has already been demonstrated in several studies with a similar context. For example, in Chen and Lin's [24] work, flow experience proved to be a significant mediator of the effect of perceived technology fluidity and augmented realism on cognitive responses towards the brand, affective responses towards the brand and the AR platform, and purchase intention. The work of Hsu et al. [26] also confirmed that the flow experience has a mediating or reinforcing effect between the website qualities and user beliefs and social shopping behavior. Based on the theoretical and empirical findings outlined above, the following hypothesis can be formulated for this paper:

Hypothesis 4: *The flow state mediates the positive association between the AR application and the shopping experience.*

Based on the results of the literature review and the derived hypotheses, the research model shown in Figure 2, consisting of the constructs AR, flow and shopping experience, can now be created:

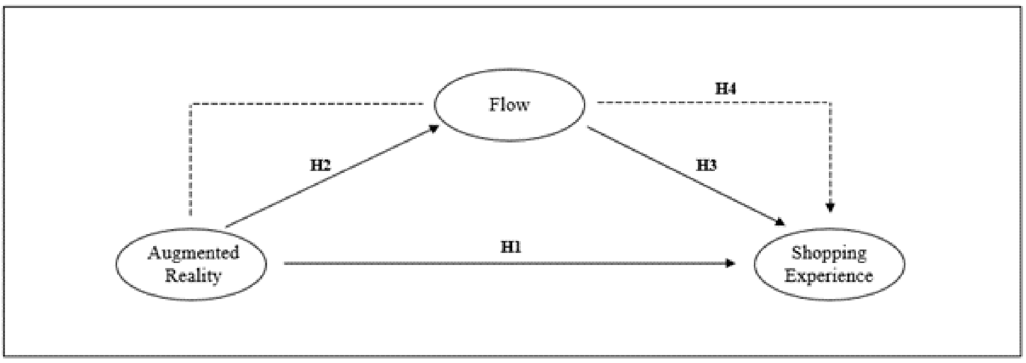

Figure 2. Research model
Note: This figure was prepared by the author

2 Methodology

2.1 Data Collection and Sample

After the questionnaire was designed and subsequently revised during the pretest, the official field phase began on April 4, 2024. In the first step, the corresponding survey link, obtained from the online questionnaire tool SoSci Survey, was shared with the personal network. Social networks and messenger services were utilized to reach a broader target group. Study groups also proved to be an effective tool and means of recruiting additional participants for the survey. Furthermore, experts from the professional environment were included alongside the public. The LinkedIn platform was therefore used to disseminate the survey link within the professional network. In addition, numerous managers and employees from the marketing and sales sectors were recruited as participants. After almost two weeks of the field phase, the survey link was shared again on the previously utilized channels to recruit the remaining respondents.

The survey was active from April 4 to May 20, 2024, and thus spanned 47 days. A total of 252 respondents participated. Of these, 13 individuals did not complete the questionnaire in full. Due to insufficient data, these participants could not be included in the empirical analysis, which is why these cases were removed as part of the data cleansing process. The remaining 239 completed submissions were fully processed up to the last page. The data represents the opinions and views of the respondents and therefore forms the basis for the analysis in this research.

The female gender clearly predominates among the respondents, with a relative frequency of 75.7%. In contrast, 23.4% of respondents are male, and 0.8% identify as diverse. At 12.6%, the age of 25 is the most common age in this data set. The minimum and maximum ages are 20 and 80 years. The arithmetic mean age in this survey is 32.96, approximately 33 years. The most common educational qualification among the participants is a Bachelor's degree, with a total of 37.7%. No one selected the option 'no educational qualification,' making a secondary school-leaving certificate the lowest and a doctorate the highest qualification. A total of 1.7% did not provide any information. In terms of monthly net disposable income, the highest frequency in this dataset is EUR 3,000 or more, representing 18.8% of respondents. The lowest characteristic is an income of less than 500 euros, and the highest characteristic is 3,000 euros or more. Overall, 10.0% of respondents did not provide information on their monthly disposable income.

2.2 Measurement

For the design of the questionnaire, all scales were derived from reliable and empirically validated literature and adapted to the context of this study. The Smart Mirror, including its functions, was presented as an exemplary AR application for stationary retail. These functions were illustrated using images to give the participants the best possible impression of the AR application. A seven-point Likert scale was used for the entire study, ranging from 1 (strongly disagree) to 7 (strongly agree). This scale forms the basis for the subsequent structural equation modeling (SEM), which is particularly suitable for analyzing complex relationships between variables such as AR, flow and shopping experience. It also enables a review of the model fit and an assessment of possible biases.

2.2.1 AR

The scales from the works of McLean and Wilson [27], as well as Barhorst et al. [7], were used to measure AR. These are based on the research by Yim et al. [28]. The scale consists of 13 items, divided into three dimensions of interactivity, vividness and novelty. The scale was selected based on its proven validity and its ability to comprehensively capture the three key characteristics of AR. Example items included "The augmented reality technology has the ability to respond to my specific needs quickly and efficiently" (interactivity), "The visual display through the AR technology was clear" (vividness), and "Using the augmented reality technology offers something new each time" (novelty).

2.2.2 Flow

A scale consisting of the dimensions of control, concentration and enjoyment was used to assess the flow experience. The corresponding questions were derived from the research conducted by Wang and Hsiao [21], as well as Kautish and Khare [29]. The work of Ghani and Deshpande [30], in particular, serves as the original source. The following examples were used as statements "I feel confused when using the AR technology" (control), "My attention is focused on the AR technology while using it" (concentration), and "I find the AR technology enjoyable" (enjoyment).

2.2.3 Shopping experience

The shopping experience was measured using scales for satisfaction and purchase intention. The questions regarding satisfaction with the experience were also adapted from McLean and Wilson's [27] study. These in turn were derived from a previous study by McLean and Osei-Frimpong [31]. The questions related to purchase intention were based on the study by Pfeifer et al. [32], drawing on the work of Poushneh and Vasquez-Parraga [33] and Papagiannidis et al. [34]. For example, the following items were included: "I am satisfied with the AR functions presented" (satisfaction) and "I would be willing to buy products using AR technology" (purchase intention).

3 Results

3.1 Method

Before the hypotheses are tested, the reliability and validity of the measurements are evaluated step-by-step to ensure the consistency of the research model.

At the beginning, an exploratory factor analysis (EFA) is conducted using the maximum likelihood method and promax rotation in SPSS to demonstrate the convergent validity of the constructs [35]. In this research, items with a factor loading of .40 or higher are used for the constructs [36]. A total of five items were removed from the data due to low factor loadings. With a factor loading of .397, item EK01_03 is slightly below the guideline value of .40. Due to the minimal deviation, it was decided to retain the item. This decision can be justified by the fact that significant factor loadings can be defined differently. Some studies already consider loadings of .35, .30, .20 or even .15 and higher to be significant. However, the majority use .40 as the cut-off value, which is why this value also serves as the basis for this paper [36].

In the second step, the Bartlett test is conducted for further verification, using the Kaiser-Meyer-Olkin (KMO) score as a reference [37]. The results confirm the suitability of the data, as the p-value is below .05 and the KMO value is above .8 (KMO = .933; p = .000).

In the third step, the constructs are tested using Cronbach's alpha (α) $\geq$ .7 [38], composite reliability (CR) $\geq$ .6 [39], and average variance extracted (AVE) $\geq$ .5 [40]. For the first two measures, all constructs show values above the threshold, as can be seen in Table 1. The average variance extracted only reaches the recommended value of .50 for most of the constructs in this study, although augmented_reality_interactivity and augmented_reality_novelty fall below this threshold, with values of .46 and .41, respectively. However, Fornell and Larcker [40] argue that the average variance extracted may represent a more conservative estimate of the validity of the measurement model. Based on the composite reliability alone, researchers can conclude that the convergent validity of the construct is sufficient, even if more than 50% of the variance is caused by errors. Since all CR values in this research clearly exceed the recommended limit, the average extracted variance of the measured variables can be considered acceptable.

Table 1. Key parameters of our model

	Number of Items	Cronbach's Alpha	AVE	CR
AR - Interactivity	3	.738	.462	.719
AR - Vividness	5	.897	.624	.891
AR - Novelty	4	.820	.411	.735
Flow - Control	2	.887	.748	.852
Flow - Concentration	3	.775	.518	.763
Flow - Enjoyment	4	.858	.536	.814
Shopping experience	7	.935	.589	.903
Acceptable values	-	$\geq$ .70	.50	$\geq$ .60

Note: AVE = Average variance extracted [40]; CR = Composite reliability [39]

Furthermore, the discriminant validity is confirmed by Table 2, as the square root of the average extracted variance exceeds the corresponding bivariate correlation between the variables in all cases [41].

Table 2. Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) AR - Interactivity	. 680						
(2) AR - Vividness	. 575	. 790					
(3) AR - Novelty	. 423	. 557	. 641				
(4) Flow - Control	. 521	. 516	. 336	. 865			
(5) Flow - Concentration	. 351	. 443	. 465	. 264	. 720		
(6) Flow - Enjoyment	. 405	. 522	. 561	. 446	. 478	. 732	
(7) Shopping Experience	. 444	. 606	. 604	. 513	. 522	. 713	. 768

Notes: The square root of the AVE is shown in the diagonal.

Finally, a confirmatory factor analysis (CFA) is conducted using AMOS to examine the model fit between the collected data and the theoretical model [35]. The values of the criteria chi-square ($\chi2$ = 689.833), degrees of freedom (df = 341), minimum discrepancy ($\chi2$/df = 2.023), comparative fit index (CFI = .920), Tucker-Lewis index (TLI = .911), and root-mean-square error of approximation (RMSEA = .066) show a reasonable agreement with the reference values [42–44].

3.2 Assessing Potential Biases

Finally, further steps were taken to check the common method bias. Firstly, ambiguous wording was removed during the development of the questionnaire and during the pre-test phase, and any potential comprehension problems were resolved. Secondly, the respondents were assured at the beginning of the questionnaire that their data would be treated anonymously and that there would be no right or wrong answers when answering the questions. Thirdly, the measured values or scales used for the dependent and independent variables were largely sourced from different references and clearly distinguished in the questionnaire [45]. In the fourth step, early and late responses from participants were compared [46]. In the context of this research, the answers showed no significant differences, suggesting that a non-response bias is unlikely. Fifthly, the Harman single factor test was performed, which provided no evidence of a possible bias in the data [47]. In the final step, a marker variable was integrated into the questionnaire that had no connection to the existing constructs. The participants were asked about their favorite color. In a subsequent test, correlations were analyzed both with and without the inclusion of this marker variable. For this purpose, six dummy variables were created for the nominal variable "favorite color", which comprises a total of seven categories. According to theory, a variable with x values is represented by x-1 indicator variables. In this case, x-1 = 7-1. These dummy variables are binary indicators, each taking a value of 0 or 1 [48]. The results of the comparison showed that neither the coefficients nor the significance levels have changed due to the inclusion of the marker variable. This suggests that the common method bias does not excessively influence the data [49].

3.3 Hypotheses Testing

With the help of structural equation modeling in AMOS, the hypothetical relationships of this research model will be estimated and analyzed. This approach allows for examining the direct effects from hypotheses 1 to 3, as well as the indirect effect from hypothesis 4 (Figure 3).

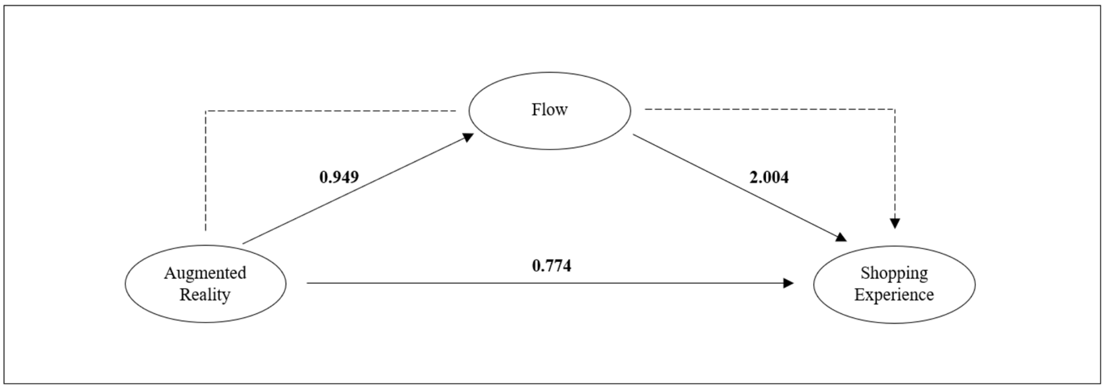

Figure 3. Result model

Note: This figure was prepared by the author

Hypothesis 1 states that the AR application has a positive influence on the shopping experience. The corresponding results of the SEM analysis are listed in Table 3 below and show that this direct effect is positive and significant (β = .774; p = .000), which supports H1.

Table 3. Correlation matrix

Hypotheses Testing	Std. Est.	S.E.	C.R.	p***
AR → Shopping Experience	.774	.186	7.823	.000***
Controls	Std. Est.	S.E.	C.R.	p***
Gender → AR	-.182	.112	-2.499	.012
Age → AR	-.118	.004	-1.653	.098

Notes: Abbreviations: Std. Est., standardized estimate; S.E., standard error; C.R., critical ratio. *p < .05, **p < .01, and ***p < .001

Hypothesis 2 states that the AR application has a positive influence on the flow state. The respective results of the SEM analysis are shown in Table 4 and indicate that this direct effect is positive and significant (β = .949; p = .000). This supports H2.

Hypothesis 3 assumes that the flow state has a positive influence on the shopping experience. The results, also listed in the following table, show that this direct effect is not significant (β = 2.004; p = .112), which refutes H3.

Before the indirect effect assumed in hypothesis 4 is tested, a comparative analysis of the model fit values is carried out. Here, the model without the mediator (Model 1) is compared with the model that includes the mediator

(Model 2) [35]. The results show that the integration of flow as a mediator leads to only a partial improvement in the values (Model 1: $\chi 2$/df = 1.823; RMSEA = .059; CFI = .950; TLI = .942; IFI = .951; Model 2: $\chi 2$/df = 1.714; RMSEA = .055; CFI = .937; TLI = .929; IFI = .937). However, it is advantageous that the control variables, gender and age show no significant influence on the AR application in either model, as can be seen in Table 3 and Table 4.

Table 4. Structural equation modelling including the mediating variable - Model 2

Hypotheses Testing	Std. Est.	S.E.	C.R.	p^{***}
AR → Shopping Experience	-1.124	2.312	-.916	.359
AR → Flow	.949	.171	6.852	$.000^{***}$
Flow → Shopping Experience	2.004	1.927	1.590	.112
Controls	Std. Est.	S.E.	C.R.	p.
Gender → AR	-.176	.110	-2.465	.014
Age → AR	-.142	.004	-2.000	.046

Notes: Abbreviations: Std. Est., standardized estimate; S.E., standard error; C.R., critical ratio. $^*p < .05$, $^{**}p < .01$, and $^{***}p < .001$

In the following, the approach of Baron and Kenny [50] is used to estimate the indirect effect of Hypothesis 4. In order to prove the mediation effect of flow, the following four criteria must be met: First, there must be a relationship between the independent variable and the dependent variable. Second, the independent variable must have a relationship with the mediating variable. Third, the mediating variable must be related to the dependent variable. Fourth, if the mediating variable is included, the previously significant direct relationship between the independent and dependent variables must no longer be significant. This indicates complete mediation. Hypothesis 4 in this research paper posits that the flow experience positively reinforces the relationship between the AR application and the shopping experience. The study was able to demonstrate a positive relationship between the AR application (independent variable) and the shopping experience (dependent variable), as well as between the AR application (independent variable) and the flow experience (mediating variable). Therefore, the first two conditions are fulfilled. Regarding the fourth criterion, the results show that the direct relationship between the AR application and the shopping experience is no longer significant when flow is considered as a mediating variable (β = -1.124; p = .359). However, since Hypothesis 3 was refuted, no significant relationship between the flow experience (mediating variable) and the shopping experience (dependent variable) could be demonstrated. Consequently, the third criterion for a mediation effect was not met. Based on this, it can be concluded that the flow experience does not mediate or strengthen the relationship between the AR application and the shopping experience [50], which refutes Hypothesis 4.

4 Reflection and Outlook

4.1 Discussion

This study confirmed the hypothesis that the AR application positively influences the shopping experience. The AR technology presented, the Smart Mirror, offers consumers various helpful features, such as displaying product information and providing suitable recommendations [51] or enabling requests for additional items from sales staff [52]. These functions allow customers to experience the AR characteristics of interactivity, vividness and novelty, which can enable a personalized, optimized, and more efficient shopping process overall. Specifically, by experiencing products in AR, consumers can gain a more precise understanding of the items. Overall, AR addresses changing consumer behavior, where customers are developing a growing sensory capacity and increasingly seek detailed and extraordinary experiences. The Smart Mirror creates a unique shopping environment that fulfills the desire for personalized, diverse, and emotionally engaging offers [53]. These findings align with the study results of Javornik et al. [13], which show that useful AR features can enhance the consumer experience and make it more vivid. Pathak and Prakash [23] also confirm in their study that AR applications improve the shopping process in multiple ways by making it more immersive, convenient, enriching, experimental, engaging and participatory. Overall, AR technologies significantly enhance the shopping experience by going beyond purely physical perception and incorporating additional digital elements. The various AR functions contribute to a more comprehensive, engaging, and informative shopping experience, which positively influences consumers' behavioral outcomes. For management, this suggests that AR technologies such as the Smart Mirror could be employed in a targeted manner to enhance the shopping experience through interactive and personalized functions. By creating an immersive and emotionally appealing environment, companies may be able to sustainably increase purchase intention and customer satisfaction. In addition, the AR applications developed could aim to offer customers added value, making the shopping process more efficient and information-rich, which may in turn promote customer loyalty.

The results also confirm that the AR application in stationary retail makes an important contribution to creating an immersive flow state for consumers. The diverse functions of AR provide a sensory-rich environment. With AR applications in stationary retail, the sensory impressions of real objects can be enhanced with additional information generated by computers [8]. In contrast, in purely digital environments, such as online shopping, users have to supplement the limited sensory experience of the displayed objects with their own imagination to form a complete picture of a product. A similar situation exists in brick-and-mortar stores, where consumers perceive the products in a real environment but often lack additional information [54]. The combination of computer-generated and real elements therefore promotes a more intensive flow state. Such a comprehensive environment provides numerous sensory impressions, significantly reducing the effort required by consumers to form an idea of the products or search for additional information [7]. This allows consumers to concentrate better on the respective activity, focus their attention more specifically on it, and become more involved in the process. Keller and Block [55] support this assumption by arguing that a detailed and vivid product presentation, as achieved in this case through AR, influences the cognitive processing of consumers. This increased appeal leads to a flow experience, where the product and its information are rated more highly than in less impressive presentations. The confirmation of this hypothesis aligns with previous research, which has also shown that immersive technologies such as AR can promote the flow experience [7, 24]. Overall, the findings expand the understanding of how AR not only enhances the shopping experience but also creates a particularly immersive environment, enabling consumers to engage more deeply in their activities. These findings make it clear that AR in bricks-and-mortar retail serves as a strategic tool for improving the customer experience and can also promote customer loyalty. The application strategy of AR should therefore focus on features that maximize interactivity, vividness and sensory stimulation to provide customers with not only a practical but also an emotionally engaging experience. These findings provide management with valuable insights into the design of immersive shopping experiences that cater to modern consumer behavior and have the potential to sustainably increase purchase intention and customer satisfaction.

The hypothesis that the flow state has a positive and significant influence on the shopping experience could not be confirmed. Although several studies have already demonstrated that the flow state promotes positive experiences in stationary retail [21, 22], the specific situation in this study does not provide comparable support for these correlations. One possible explanation could be that the shopping experience in stationary retail is strongly influenced by factors such as shopping atmosphere, service or pricing [56]. These aspects may be more decisive for consumer satisfaction and shopping intentions. Furthermore, shopping is often characterized by distractions that make it difficult to achieve a state of flow. For example, customers often visit stores with family members and friends, which leads to additional conversations and social interactions. In addition, there are often multiple customers in a store at the same time, resulting in crowded spaces and potential [56]. These distractions could disrupt consumers' concentration and thus hinder the flow state, which in turn can negatively impact satisfaction and willingness to make a purchase decision. Another aspect that could help to explain this result is the motivation of consumers when shopping. Customers have different goals and expectations that can affect their experience [56]. While some customers may aim to achieve the state of total immersion in a shopping experience, others may simply seek to satisfy basic needs, reducing the relevance of the flow state to their desired shopping experience. In summary, the shopping experience appears to be influenced by many interrelated factors, which may overall be more significant than the individually experienced flow state. The diversity of these factors could therefore overshadow the influence of the flow state on customer satisfaction and purchase intention. For those in managerial roles, this outcome indicates that the concept of flow should not be regarded as the primary determinant of a positive shopping experience in the context of physical retail stores. Consequently, organizations should prioritize the creation of an appealing shopping environment, the delivery of excellent customer service and the offering of competitive pricing, as these factors are more influential in determining customer satisfaction and purchase intent. It is similarly crucial to minimize potential sources of distraction through the implementation of effective space management and queue optimization strategies, with the objective of enhancing the overall shopping experience.

The fourth hypothesis, suggesting that the flow state as a mediator strengthens the positive connection between the AR application and the shopping experience, could not be confirmed in this study. Although the flow state represents a particularly positive and personal experience [18], it can be assumed that it does not necessarily influence the entire AR-based shopping process for the following reasons. One key characteristic of the flow state is the focus of attention on a limited stimulus area [18]. During the flow experience, users could be so intensely engaged with the AR application that they perceive other important aspects of the shopping experience, such as store design, music, or scents [56], less intensively. This one-sided focus could explain why the overall experience is not consistently perceived as positive, despite the intensive interaction with the AR application. Another reason why the hypothesis was not confirmed could be the inherent complexity of the flow experience. Flow is a dynamic state that depends on various factors, such as the balance between a person's skills and the demands of the situation, which often exceed the individual's average level. As flow is an extremely subjective state, it can be perceived differently from person to person [57]. This implies that the perception of the shopping experience depends heavily on the personal experiences and abilities of the consumer. While some users may achieve a particularly intense flow state with the AR application, others may experience stress or overwhelm, which could negatively affect their overall shopping process. This suggests that the flow state is not equally positive for all users and therefore cannot be considered a reliable mediator. To summarize, although the AR application has a positive influence on the shopping experience and on the flow state, the flow state does not act as a mediator between the AR application and the shopping experience. This indicates that enhancing the shopping experience through AR technologies is not necessarily amplified by an intense flow experience. Furthermore, it highlights that the relationship between AR, flow experiences, and the shopping experience is complex and context-dependent.

4.2 Limitations and Opportunities for Future Research

Although this study provides a solid basis for further research, certain limitations should be taken into account. The combination of the fields of AR, flow and shopping experience represents an expansion of the previous research area, which is why the empirical part of the study is based on a separate survey. The sample of 239 participants provides a solid basis. The low drop-out rate of only 13 people should also be noted positively. However, AR is a very extensive subject area, which necessitated content restrictions. Future research should further examine critical aspects of AR, such as data protection and security risks. It would also be advisable to aim for a larger sample to enhance the validity of the result. The development of the questionnaire could be optimized by using timers to ensure that the introductory pages are read and understood thoroughly. This would prevent participants from skipping through too quickly before they have sufficiently grasped the content of the AR application. A stronger focus on participants with AR experience could also be beneficial to enable more accurate assessments. Specific filter questions could be used for this purpose. Another approach would be to investigate the actual use of AR applications in real sales environments to gain deeper insights into the customer experience. It would also be useful to compare different AR technologies to identify which ones best promote the flow state and shopping experience in brick-and-mortar retail. Future studies could extend the research model to include variables such as brand perception and customer loyalty to analyze the effect of AR on these factors. Regarding the unconfirmed hypotheses, it would be interesting to employ alternative scales or measurement tools to see if this alters the results.

4.3 Practical Implications

Based on the results of the study, practical implications for the use of AR in stationary retail can be derived, which are of particular strategic relevance for management. Companies should make targeted investments in modern AR technologies to improve the shopping experience and simultaneously achieve sustainable competitive advantages. Developing high-quality content is particularly important, especially when shopping steps such as trying on clothes are replaced by AR. Precise coordination between physical and digital elements can enhance the authenticity of the presentation and strengthen customer confidence [13]. Investments in high-quality hardware, advanced software, and precise tracking systems are crucial to ensuring high quality [58]. Management should consider involving external experts to ensure professional implementation [59]. However, it should be noted that, despite technological advances in the field of AR, there are still challenges to be overcome [60]. For this reason, it is important that companies act within the realms of their possibility. For an AR application to be successfully integrated into the purchasing process, it must offer more than just playful elements. The application should primarily provide real added value for customers. A distinction must be made between functions that genuinely serve the customer's benefit and those that primarily benefit the company. In general, it is important to offer customizable AR applications tailored to the specific needs of the target group [6]. Another key consideration for management is the user-friendliness of the AR application. Intuitive usability minimizes inhibitions and promotes customer acceptance [13]. Employee training as on-site contact persons can further encourage acceptance and reduce any uncertainties. To underline the flow state, the focus should be on developing particularly immersive and appealing AR content [7]. Interactive functions, visually appealing representations and novel experiences [27] can achieve this by enabling users to fully immerse themselves in the application. To create a sustained state of flow, the AR application should align with the user's abilities while offering targeted challenges through varied features [57]. It is also advisable to minimize potential distractions [18], for example, by placing the AR application in a separate area to enable deeper immersion. Since the flow state does not significantly influence the shopping experience as a whole and does not act as a mediator, it is crucial for management to also consider additional factors such as store layout, product presentation, and a pleasant atmosphere. Regular customer feedback on the shopping experience can help to implement targeted improvements [6].

5 Conclusion

The aim of this research project was to investigate the influence of AR in brick-and-mortar retail. It analyzed how the use of AR enhances the customer's shopping experience and the significance of the flow state in this context. The results show that AR enriches the shopping experience with interactive, vivid and novel features by integrating additional digital elements that make the entire process more informative and engaging. Furthermore, these features increase customer engagement and enable a sensory-rich interaction with the products. This immersive environment makes it easier for consumers to concentrate fully on their activities and experience the shopping experience more intensively. However, the flow state appears to have less influence on the experience and consumer behavior than other factors. Alongside innovative AR applications, traditional elements also remain important. Moreover, enhancing the shopping experience through AR technologies is not necessarily amplified by an intense flow experience. It has been shown that the relationship between AR, flow and the shopping experience is complex and context-dependent. Overall, the study indicates that AR has the potential to transform brick-and-mortar retail and set new standards for shopping experiences. Future studies should explore further potential applications of AR to fully leverage this technology.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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Nomenclature

AR	Augmented Reality
CFA	Confirmatory Factor Analysis
EFA	Exploratory Factor-Analysis