Bridging the Digital Divide: Assessing the Impact of Augmented Reality on Consumer Engagement, Purchase Intention, and Immersive E-Commerce Experiences

[1]**Dr. U. Praveen**, Assistant Professor, Department of Commerce with Information Technology,

Sri Ramakrishna College of Arts & Science, Coimbatore
[2]**Dr. H. Punithavathy**, Assistant Professor, Department of Commerce with Information Technology,
Sri Ramakrishna College of Arts & Science, Coimbatore
[3]**Dr. Priyanka Jayaraj**, Associate Professor, Department of Commerce with Information Technology,
Sri Ramakrishna College of Arts & Science, Coimbatore

Abstract
Traditional e-commerce platforms often struggle with the "touch-and-try" barrier, creating a digital divide between physical retail confidence and online convenience. Augmented Reality (AR) addresses this gap by superimposing interactive 3D digital content onto the user's physical environment. This study evaluates the impact of AR technology on consumer engagement, perceived product diagnosticity, purchase intention, and overall e-commerce experience. Utilizing a structured survey sample of 50 respondents (N=50), parametric and non-parametric statistical evaluations—specifically Chi-Square tests of independence, Multiple Linear Regression, and One-Way Analysis of Variance (ANOVA)—were conducted.
The empirical results demonstrate that AR features significantly reduce pre-purchase ambiguity and elevate consumer purchase intentions ($R2=0.612, p<0.001$). Furthermore, significant demographic variations in engagement were observed across age cohorts. The research concludes with practical strategic implications for digital retail platform developers and e-commerce managers.

Introduction

The rapid evolution of modern retail has shifted consumer preferences toward digital channels. However, standard online shopping interfaces relying on 2D images and text descriptions struggle to convey detailed spatial, tactile, and aesthetic information. This limitation, often called the sensory "digital divide," leads to high cart abandonment rates and product returns.
Augmented Reality (AR) bridges this gap by blending virtual elements into real-time physical environments via mobile devices or head-mounted hardware. Technologies such as virtual try-ons (VTO) for apparel, cosmetics, and optical wear, alongside 3D spatial previews for home furniture, transform static browsing into active sensory exploration. Grounded in the Stimulus-Organism-Response (SOR) framework and the Technology Acceptance Model (TAM), this study investigates how AR attributes (visual vividness, spatial presence, and real-time interactivity) influence internal consumer states and shape downstream behavioural outcomes.

Objectives of the Study

1. To measure the effect of AR feature adoption on consumer engagement metrics within e-commerce platforms.
2. To evaluate the direct impact of AR-driven immersive experiences on consumer purchase intention.
3. To test for demographic differences (specifically across age groups) in the adoption and perceived utility of AR shopping tools.
4. To identify key predictor variables (interactivity, perceived usefulness, and spatial presence) that drive overall consumer purchase decisions.

Scope of the Study

- **Target Domain:** E-commerce retail sectors integrating AR features (e.g., fashion/apparel, cosmetics, home furnishings, and consumer electronics).
- **Target Audience:** Consumer shoppers with varying experience levels using mobile AR applications or web-based AR tools.

- **Core Variables:**
  - Independent Variables: Interactivity, Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Visual Vividness, Spatial Presence.
  - Dependent Variables: Consumer Engagement, Purchase Intention.
  - Demographic Factors: Age, Gender, Shopping Frequency.

Limitations of the Study

1. **Sample Size:** The sample size (N=50) limits the broad generalizability of the findings across global retail populations.
2. **Self-Reporting Bias:** Data gathered through self-administered questionnaires may introduce subjective rating tendencies or social desirability biases.
3. **Cross-Sectional Nature:** The study captures user responses at a single point in time, omitting long-term longitudinal tracking of post-purchase satisfaction or return rates.
4. **Device Heterogeneity:** Differences in smartphone hardware processing, screen sizes, and camera quality across respondents may vary individual AR rendering quality and perceived realism.

Research Methodology

Sampling and Data Collection

A primary quantitative survey design was employed. Data was gathered from 50 respondents (N=50) using a structured 5-point Likert Scale questionnaire ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree"). Respondents were selected using convenient sampling techniques, filtering for individuals with experience in online shopping platforms.

Analytical Tools

The dataset was processed using statistical software. Three primary quantitative tools were deployed:

1. **Chi-Square ($\chi 2$) Test of Independence:** Used to determine whether a statistically significant relationship exists between respondent age groups and their frequency of AR feature utilization.
2. **Multiple Linear Regression Analysis:** Employed to test the predictive power of AR attributes (Interactivity, Perceived Usefulness, and Spatial Presence) on Consumer Purchase Intention.
3. **One-Way Analysis of Variance (ANOVA):** Conducted to examine differences in total Consumer Engagement scores across three age cohorts (18–24, 25–34, 35+).

Related Subtopics

Theoretical Framework Alignment

- **Technology Acceptance Model (TAM):** PEOU and PU act as foundational drivers determining whether consumers adopt AR shopping interfaces over 2D web formats.
- **Stimulus-Organism-Response (SOR) Model:** Environmental AR stimuli (vividness, interactivity) trigger cognitive and affective organismic states (enjoyment, immersion), leading to behavioral responses (purchase completion).

Cognitive Load and Perceived Risk Mitigation

AR functions as a risk-reduction mechanism. By allowing consumers to project true-to-scale 3D models of items (e.g., placing a sofa in a living room), AR reduces uncertainty regarding fit, sizing, and color coordination, thereby easing cognitive strain during pre-purchase evaluation.

Data Analysis & Quantitative Hypotheses Testing (N=50)

1. Chi-Square ($\chi 2$) Test of Independence

- **Objective:** Test association between **Age Group** and **AR Usage Frequency** (High vs. Low).
- **Null Hypothesis (H01):** There is no association between age group and AR usage frequency.
- **Alternative Hypothesis (Ha1):** There is a significant association between age group and AR usage frequency.

Observed Contingency Table (N=50)

Age Group	Low AR Usage	High AR Usage	Total
18–24	5	17	**22**
25–34	7	11	**18**
35+	8	2	**10**
Total	**20**	**30**	**50**

Expected Frequencies Calculations

- E11=(22×20)/50=8.80, E12=(22×30)/50=13.20
- E21=(18×20)/50=7.20, E22=(18×30)/50=10.80
- E31=(10×20)/50=4.00, E32=(10×30)/50=6.00

Chi-Square Calculation Formula

$\chi 2=\sum E(O-E)2$

$\chi 2=8.8(5-8.8)2+13.2(17-13.2)2+7.2(7-7.2)2+10.8(11-10.8)2+4(8-4)2+6(2-6)2$

$\chi 2=1.641+1.094+0.006+0.004+4.000+2.667=9.412$

- **Degrees of Freedom (df):** $(3-1)\times(2-1)=2$
- **Critical Value ($\alpha=0.05$,df=2):** 5.991
- **Result:** Since χcalculated2(9.412)>χcritical2(5.991), we **reject H01** ($p<0.01$). Younger demographics display a significantly higher frequency of AR interaction.

2. Multiple Linear Regression Analysis

- **Dependent Variable (Y):** Purchase Intention (Scale 1–5).
- **Independent Variables:**
  - X1: AR Interactivity
  - X2: Perceived Usefulness (PU)
  - X3: Spatial Presence / Realism

Regression Model Summary

Model	R	R2	Adjusted R2	Std. Error of Estimate
1	0.782	0.612	0.587	0.384

Regression ANOVA Output

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-Statistic	Sig. (p-value)
Regression	10.697	3	3.566	24.19	<0.001
Residual	6.783	46	0.147		
Total	**17.480**	**49**			

Coefficients Table

Variable	Unstandardized β	Std. Error	Standardized β	t-value	Sig. (p-value)
(Constant)	0.512	0.245	—	2.090	0.042
Interactivity (X1)	0.341	0.088	0.385	3.875	<0.001
Perceived Usefulness (X2)	0.389	0.092	0.412	4.228	<0.001

Spatial Presence (X3)	0.184	0.076	0.221	2.421	0.019

- **RegressionEquation:**

Purchase Intention=0.512+0.341(X1)+0.389(X2)+0.184(X3)

- **Interpretation:** Approximately 61.2% (R2=0.612) of the variance in Purchase Intention is explained by the three AR attributes. Perceived Usefulness (β=0.412,p<0.001) exerts the strongest positive influence, followed by AR Interactivity (β=0.385,p<0.001) and Spatial Presence (β=0.221,p=0.019).

3. One-Way Analysis of Variance (ANOVA)

- **Objective:** Test for differences in **Consumer Engagement Scores** (Scale 1–5) across three age cohorts: Group 1 (18–24), Group 2 (25–34), and Group 3 (35+).
- **Null Hypothesis (H02):** Mean consumer engagement is equal across all age groups (μ1=μ2=μ3).
- **Alternative Hypothesis (Ha2):** At least one age group mean differs significantly.

Sample Group Summary Stats (N=50)

Age Group	ni	Mean (X^-)	Std. Deviation (S)
18–24	22	4.32	0.41
25–34	18	3.95	0.48
35+	10	3.41	0.55
Total	**50**	**4.00**	**0.57**

One-Way ANOVA Table

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	Calculated F	p-value
Between Groups	5.774	2	2.887	13.24	<0.001
Within Groups (Error)	10.246	47	0.218		
Total	**16.020**	**49**			

- **Decision Rule:** Critical value F0.05(2,47)≈3.20.
- **Result:** Since Fcalculated(13.24)>Fcritical(3.20), we **reject H02** (p<0.001). Post-hoc analyses confirm that younger consumers (18–24) report significantly higher immersive engagement scores than older users (35+).

Results and Discussion

Summary of Key Findings

1. **Bridge Over Pre-Purchase Uncertainty:** The strong explanatory power (R2=0.612) confirms that AR features reduce visual ambiguity, giving shoppers confidence to complete purchase transactions.
2. **Utilitarian Utility Over Novelty:** Perceived Usefulness (β=0.412) serves as the primary driver of purchase intention, showing that consumers value functional utility—such as accurate sizing, spatial previewing, and realistic product rendering—over gimmickry.
3. **Generational Readiness Divide:** Chi-Square (χ2=9.412) and ANOVA (F=13.24) evaluations confirm that Gen Z and younger Millennials exhibit higher AR engagement and usage frequency. Older consumer segments show lower engagement, highlighting the need for simpler user interfaces (PEOU optimization).

Strategic Implications for E-Commerce Retailers

- **Prioritize High-Utility AR Tools:** E-commerce platforms should invest in true-to-scale AR rendering, accurate color representation, and spatial fitting tools rather than simple decorative visual overlays.
- **Reduce Onboarding Friction:** To drive adoption among older demographics, developers must simplify AR interactions, providing clear visual instructions and instant web-based AR options (WebAR) that remove the need for

app downloads.

Conclusion

Augmented Reality serves as an effective bridge across the traditional digital divide in e-commerce, transforming static 2D product displays into dynamic, interactive try-on experiences. By delivering immediate product feedback and spatial understanding, AR strengthens consumer engagement and drives purchase intent. As mobile computing power increases, integrating high-fidelity AR solutions will transition from a competitive edge to a baseline standard for digital retail platforms seeking to reduce product returns and build long-term consumer trust.

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