AR/VR Application in Online Retailing: A Meta-Analysis of the Influence of AR/VR Attributes on Consumer Purchase Stages

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Abstract:

Given their prevalence and capacity in creating transcended shopping experiences for consumers, researchers have investigated how the AR/VR technologies influence individuals' purchase decision-making process. Following this stream of research, we offer a timely meta-analysis of the influence of AR/VR attributes (i.e., vividness, presence, immersion, and interactivity) on a number of key outcomes within the three stages of consumer purchase stages (i.e., pre-purchase, purchase, and post-purchase). Analyzing 439 effect sizes from 58 samples across 52 papers, involving 116,266 participants, it finds these attributes to be key determinants of consumer responses at each purchase stage. The study identifies hedonic and utilitarian value perceptions, along with technostress, as mediating mechanisms. It also explores technology-related (like mobile device use, customization) and product-related (such as product size, brand fame) moderators, offering insights for designing effective AR/VR technologies in online retail and guiding product strategy. This research is pertinent for both Information Systems researchers and practitioners.

Keywords: Augmented/virtual reality, consumer journey, meta-analysis

Tracks: Digital Marketing & Social Media

1. Introduction

The digital landscape is undergoing a revolutionary shift, heralded by the rise of the Metaverse. Recently, the Metaverse, an emerging concept, represents the next generation of the Internet (Web3) (Belk et al., 2022). The Metaverse aims to create a highly immersive and persistent digital environment using advanced technologies, such as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), among users (Davis et al., 2009; Lee & Chen, 2011). The advent of AR and VR technologies has ushered in a new era of digital transformation, particularly in the realm of retailing, healthcare, automotive, and manufacturing (Fan et al., 2022; Parekh et al., 2020). In online retailing, these technologies have the potential to create immersive and interactive experiences that significantly reshape the consumer journey, which comprises three distinctive stages that a consumer goes through when making a purchase decision. Our meta-analysis addresses these gaps by examining specific AR/VR attributes, assessing their effects across the consumer journey, introducing technostress as a mediator, and exploring new moderators. This study informs AR/VR strategies in Metaverse retailing, underscoring its importance for future research and practice.

2. Literature review

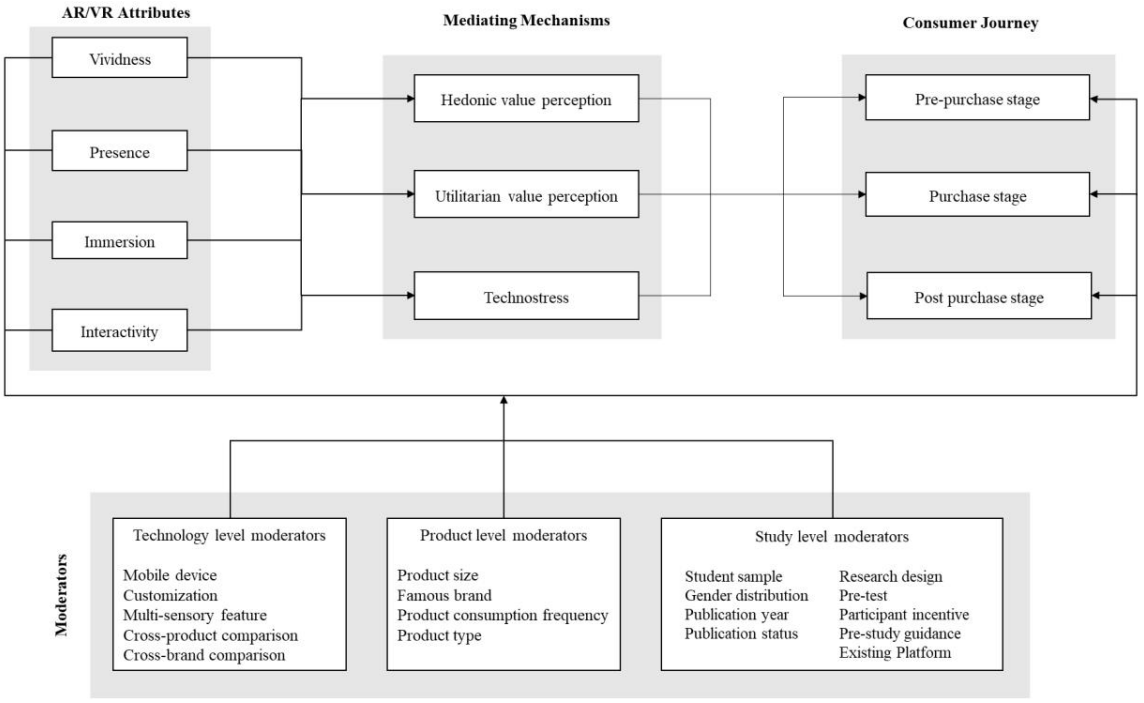

Figure 1. Conceptual model

Our study constructs a conceptual model to dissect the effects of AR/VR attributes, specifically presence, immersion, vividness, and interactivity, on the consumer journey's stages (As shown in Figure 1). These attributes, grounded in the pioneering work of Sutherland (1968) are pivotal in crafting a sensory-rich virtual environment that significantly

impacts user engagement and satisfaction across the consumer journey (Wedel et al., 2020).

At the pre-purchase stage, AR/VR technologies serve as potent marketing tools, improving brand visibility and product awareness, and are influential in shaping consumers' brand and product attitudes through interactive demonstrations (Javornik, 2016; Varnali & Toker, 2010). During the purchase stage, AR/VR facilitate immersive shopping experiences that transcend conventional digital interfaces, enhancing purchase intentions and decision comfort (Flavián et al., 2019; Huang & Liao, 2015). Post-purchase, these technologies can bolster customer satisfaction by offering interactive support and personalized engagement, potentially fostering loyalty and positive word-of-mouth (Boyd & Koles, 2019; Hilken et al., 2020).

Mediation occurs through hedonic and utilitarian value perceptions, where hedonic value is associated with the enjoyment and entertainment provided by AR/VR (Babin et al., 1994; Hsu et al., 2021), and utilitarian value encompasses the functional benefits, like efficiency and effectiveness in shopping experiences (Alzayat & Lee, 2021; Hilken et al., 2020). Technostress emerges as a negative mediator, representing the stress or negative psychological impact caused by the use or complexity of technology (Brod, 1984; Tarafdar et al., 2010).

Moderating factors at the technology level include device type and customization, which can significantly influence user experiences (Fu'Adi et al., 2021; Okazaki et al., 2020). Product level moderators such as size and brand notoriety also play a critical role, affecting levels of engagement and setting user expectations (Alzayat & Lee, 2021; Meißner et al., 2020). At the study level, variables like sample demographics, publication status, and research design introduce variability in the effects observed in AR/VR studies (Iyer et al., 2020; Venkatesh & Morris, 2000).

3. Method

3.1 Data Collection and Coding:

Our meta-analysis began with a systematic data collection process using a detailed search string across three key databases: Scopus, Web of Science, and ProQuest, ensuring extensive literature coverage. Studies not aligning with our research were excluded via specific criteria. From 2269 initial papers, 52 met our inclusion criteria. Variables related to AR/VR attributes, mediators, and consumer journey stages were extracted and coded. Dummy codes were applied for technology and product-related moderators, as well as study characteristics. Two researchers independently coded the data to ensure reliability, with over 90% agreement achieved.

3.2 Effect Size Integration:

Correlation coefficients were the primary effect size metric. Other forms were converted accordingly using the formula by Peterson and Brown (2005). Independent studies within the same paper were coded separately, and multiple estimates within a study were averaged. The dataset included 439 effect sizes from 58 studies with over 116,000 participants. Random-effects models were utilized for integrating effect sizes, and heterogeneity was assessed using a Q-test. Publication bias was examined using Rosenthal's fail-safe N and Kendall's τ.

3.3 Structural Equation Modeling (SEM):

A comprehensive correlation matrix was compiled and analyzed using AMOS 28.0 to perform SEM. This approach allowed for the simultaneous examination of the interrelationships among AR/VR attributes, value perceptions, technostress, and the consumer journey stages.

3.4 Moderating Effects:

Moderators were hypothesized to affect the relationship between AR/VR attributes and the consumer journey. Hierarchical Linear Modeling (HLM) was used to test these effects, considering both within-study and between-study variances. Level 1 included dummy-coded AR/VR attributes and consumer journey stages, while Level 2 included technology, product, and study-level variables such as mobile device usage, product size, and publication status.

4. Result

4.1 Effect Size Integration:

Vividness was strongly correlated with utilitarian ($r_{wc} = 0.512$, $p < .001$) and hedonic value perceptions ($r_{wc} = 0.504$, $p < .001$), while it negatively correlated with technostress (rwc = -0.562, $p < .001$). Presence influenced utilitarian ($r_{wc} = 0.543$, $p < .001$) and hedonic values ($r_{wc} = 0.523$, $p < .001$) positively but had no significant effect on technostress ($r_{wc} = 0.310$, $p = 0.372$). Immersion and interactivity positively impacted both utilitarian and hedonic values, with immersion showing a particularly strong effect on hedonic value perception ($r_{wc} = 0.683$, $p < .001$).

In the consumer journey, vividness exerted the strongest influence during the purchase stage ($r_{wc} = 0.487$, $p < 0.001$), presence was most impactful post-purchase ($r_{wc} = 0.627$, $p < 0.001$), and immersion showed the highest effect also post-purchase ($r_{wc} = 0.524$, $p = 0.001$). Interactivity significantly affected all stages, with a pronounced effect post-purchase ($r_{wc} = 0.572$, $p < 0.001$).

Hedonic value perception had substantial effects across all consumer journey stages,

most significantly post-purchase (r_{wc} =0.568, p < 0.001). Utilitarian value showed the strongest effect during the purchase stage (r_{wc} = 0.565, p < 0.001). Technostress was negatively correlated with pre-purchase (r_{wc} =-0.201, p=0.209) and purchase stages (rwc =-0.207, p=0.240), and had a non-significant positive post-purchase effect (r_{wc} =0.298, p=0.181).

4.2 SEM Results:

Table 1. Results of the structural equation model

Note:"***"”p < 0.01, "**" p < 0.05

Relationship	**Estimate**	**S.E.**	**C.R.**	**P**
Presence→utilitarian_value	0.464	0.035	13.123	***
Presence→hedonic_value	0.127	0.03	4.245	***
Presence→technostress	0.176	0.041	4.258	***
Presence→pre_purchase	0.046	0.04	1.135	0.256
Presence→purchase	0.418	0.034	13.705	***
Presence→post_purchase	-0.5	0.109	-4.689	***
Interactivity→utilitarian_value	0.35	0.029	11.942	***
Interactivity→hedonic_value	0.227	0.025	9.065	***
Interactivity→Technostress	0.277	0.035	8.003	***
Interactivity→pre_purchase	0.296	0.034	8.621	***
Interactivity→purchase	0.508	0.031	17.867	***
Interactivity→post_purchase	-0.907	0.136	-6.773	***
Immersion→utilitarian_value	-0.02	0.034	-0.573	0.566
Immersion→hedonic_value	0.583	0.029	19.952	***
Immersion→Technostress	-0.036	0.04	-0.913	0.361
Immersion→pre_purchase	0.349	0.044	7.825	***
Immersion→purchase	0.414	0.041	11.132	***
Immersion→post_purchase	-0.962	0.131	-7.473	***
Utilitarian_value→pre_purchase	0.389	0.034	11.228	***
Utilitarian_value→purchase	0.056	0.029	2.111	**
Utilitarian_value→post_purchase	-0.094	0.048	-1.997	**
Hedonic_value→pre_purchase	-0.181	0.043	-4.138	***
Hedonic_value→purchase	-0.539	0.04	-14.948	***
Hedonic_value→post_purchase	1.41	0.156	9.229	***
Technostress→pre_purchase	-0.437	0.024	-17.947	***
Technostress→purchase	-0.59	0.025	-26.464	***
Technostress→post_purchase	1.483	0.148	10.196	***
Pre_purchase→purchase	0.171	0.027	7.094	***
Purchase→post_purchase	1.925	0.188	9.447	***

As shown in Table 1, presence increased utilitarian value (β = 0.46, p < .001) and positively impacted the purchase stage (β = 0.418, p < .001), but negatively influenced post-purchase (β = -0.5, p < .001). Immersion significantly elevated hedonic value perception (β = 0.583, p < .001) and had positive effects on the purchase (β = 0.414, p < .001) and pre-

purchase stages (β = 0.349, p < .001), yet a strong negative effect on post-purchase (β = -0.962, p < .001). Interactivity positively affected both value perceptions and the purchase stages, with notable influence on the purchase stage (β = 0.508, p < .001).

Utilitarian value had a positive effect on the purchase (β = 0.056, p = 0.035) and pre-purchase stages (β = 0.389, p < .001), but a negative impact on post-purchase (β = -0.094, p = 0.046). Hedonic value negatively affected the purchase (β = -0.539, p < .001) and pre-purchase stages (β = -0.181, p < .001), but positively influenced post-purchase (β = 1.41, p < .001). Technostress negatively impacted the purchase (β = -0.59, p < .001) and pre-purchase stages (β = -0.437, p < .001), and positively affected post-purchase (β = 1.483, p < .001).

4.3 Moderating Effects:

Table 2. Estimation results—HLM model

	Moderators	β	t value	Std. Error
Level1	(Intercept)	-19.727*	-2.550	7.735
	Immersion	-0.015	-0.470	0.031
	Vividness	0.0119	0.398	0.030
	Interactivity	-0.0104	-0.332	0.032
	Prepurchase	-0.053	-1.643	0.032
	Purchase	-0.067*	-2.506	0.027
Level2	Student sample	0.306**	2.652	0.004
	Gender distribution	-0.077	-1.320	0.090
	Publication year	0.01***	-5.564	0.061
	Publication status	-0.119***	4.225	0.073
	Research design	-0.338*	-2.020	0.038
	Pre-test	-0.015	-0.382	0.039
	Participant incentive	-0.106*	-2.224	0.048
	Pre-study guidance	-0.157***	-3.384	0.047
	Existing Platform	0.266***	3.915	0.068
	Mobile device	0.293***	3.899	0.075
	Customization	0.246***	3.507	0.070
	Multi-sensory feature	-0.32***	-5.332	0.060
	Cross-product comparison	-0.325***	-6.115	0.053
	Cross-brand comparison	-0.096	-1.542	0.062
	Product size	0.221*	2.361	0.093
	Famous brand	-0.137**	-2.818	0.048
	Product consumption frequency	0.163**	3.114	0.052
	Product type	-0.269***	-5.287	0.051

As shown in the Table 2, technology factors like mobile devices (β = 0.293, p < 0.001) and customization features (β = 0.246, p < 0.001) significantly boosted AR/VR's impact, whereas multi-sensory features (β = -0.320, p < 0.001) and cross-product comparison (β = -0.325, p < 0.001) lessened it. For product-level factors, larger product size (β = 0.221, p < 0.05) and higher consumption frequency (β = 0.163, p < 0.01) were positive moderators.

Study-level factors revealed that student samples (β = 0.306, p < 0.001) and recent publication years (β = 0.010, p < 0.01) were associated with stronger effects, while gender distribution (β = -0.077, p < 0.05) and research design (β = -0.338, p < 0.001) affected the

impact of AR/VR attributes negatively.

5. Discussion

The SEM findings revealed that presence, immersion, and interactivity significantly influence the consumer journey, but with varying effects. Presence and interactivity were found to positively impact the purchase stage, suggesting their importance in the decision-making process. Immersion influences both the pre-purchase and purchase stages, but all three attributes had negative impacts on the post-purchase stage. This could imply that while AR/VR enhances the shopping experience, it might lead to post-purchase dissonance due to possibly unmet heightened expectations or sensory overload.

The study also highlighted the mediating roles of utilitarian and hedonic value perceptions. Utilitarian value perception positively affected the pre-purchase and purchase stages but had a negative impact post-purchase. This suggests a shift in consumer focus from practical benefits to overall satisfaction after purchase. Conversely, hedonic value perception negatively influenced early purchase stages but had a significant positive effect post-purchase, indicating that the enjoyment from AR/VR becomes more appreciated after the purchase. Technostress was found to negatively affect the early stages of the consumer journey but had a positive impact post-purchase. This could be because consumers, after overcoming the initial barrier of technostress, might learn and adapt, enhancing their post-purchase experience.

HLM results revealed that recent studies report stronger effects of AR/VR, likely reflecting technological advancements. Methodological aspects such as research design and participant incentives significantly influenced outcomes, emphasizing the need for rigor in AR/VR research. Certain product-related factors like device used and customizations were positive moderators, suggesting that a well-designed AR/VR application can enhance the consumer journey. In contrast, multi-sensory features and cross-product comparisons were negative moderators, possibly due to their potential to distract from the immersive AR/VR experience.

6. Contributions and limitations

This study significantly advances the theoretical understanding of AR/VR technologies in the context of the Metaverse by offering a holistic view of their impact on the consumer journey.

Theoretically, it also enhances the knowledge of how utilitarian and hedonic values, along with technostress, mediate the relationship between AR/VR attributes and consumer experience. The inclusion of technostress as a mediator provides insights into potential negative outcomes of AR/VR usage. The research contributes to a nuanced understanding of

the conditional effects of AR/VR, proposing a set of technology and product-level factors that moderate their impact on consumer behavior. This includes recognizing customization as a significant enhancer of AR/VR's effectiveness and identifying information overload as a potential detriment.

Practically, the study informs the design of AR/VR applications by emphasizing the importance of presence, immersion, and interactivity, advocating for their careful implementation to enhance the consumer experience during the purchase process. It also highlights the need for applications to balance utilitarian and hedonic aspects to cater to the consumers' comprehensive value perceptions. Furthermore, the findings suggest strategies for mitigating technostress, encouraging the development of user-friendly AR/VR interfaces to foster positive pre-purchase and purchase experiences. Lastly, the study's implications suggest that AR/VR applications should avoid overwhelming consumers with too many options, advocating for a curated approach to product presentation in virtual environments.

This study, while shedding light on AR/VR's role in online retailing, acknowledges certain limitations. The rapidly evolving nature of AR/VR means that newer studies could offer insights into more specific constructs, potentially refining our understanding of AR/VR's effects. Existing research variability and differences in measuring key variables like AR/VR attributes and consumer journey stages may also limit result comparability. Moreover, as AR/VR technologies expand to include novel applications such as virtual fitting rooms or personalized recommendations, their impact on different consumer journey stages might shift, which this study has not captured. Future research should, therefore, adapt to these technological advancements to fully grasp AR/VR's implications in retail.

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