

Humanity-in-the-Loop: Ethical Reflections on Post-Millennials' Personalized Needs for AI Virtual Digital Humans

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Abstract Although AI generated virtual digital humans (VDHs) have been widely adopted in cultural intellectual property, brand marketing, and emotional interaction, limited research has examined how their design features satisfy post millennials' personalized needs while adhering to ethical governance standards. This study investigates the influence mechanism of VDH design features on post millennials' emotional needs, with perceived value as a mediating construct and a Humanity in the Loop ethical governance framework as a moderating structure, focusing on post millennial participants (aged 18–26) in Taiyuan, Shanxi Province, China.

A quantitative survey design with structural equation modeling (SEM) was adopted. Data from 300 valid responses (after cleaning 330 distributed surveys) were analyzed using SEM and Bootstrap mediation testing (5,000 resamples, 95% CI). A pilot study with 50 participants confirmed reliability and validity. Common method bias was assessed via Harman's single-factor test (first factor explained 29.8% of variance). Results show that VDH design features significantly affect perceived cultural value ($\beta = 0.53$, $p < 0.001$; $f^2 = 0.29$), -large, and perceived hedonic value ($\beta = 0.48$, $p < 0.001$; $f^2 = 0.23$, -medium-to-large, which in turn suggest full mediation of the relationship with emotional needs ($\beta = 0.57$ and 0.44 , respectively; indirect effects = 0.312 and 0.211), as direct paths became non-significant. The Humanity in the Loop governance model significantly enhances ethical compliance, cultural authenticity, and user trust ($\beta = 0.62$, $p < 0.001$; $f^2 = 0.34$, -medium-to-large. Post-hoc power analysis indicated observed power of 0.93 (95% CI: 0.89 - 0.97), exceeding the 0.80 threshold.

Human led, AI assisted collaboration can effectively balance personalized innovation with ethical governance, helping to avoid algorithmic bias and cultural misunderstanding. Four practical strategies are proposed: immersive visual adaptation, emotion-based identity formation, optimization of personalized media contacts, and user participation for co evolution. Limitations include regional sampling (Taiyuan only) and cross-sectional design, and the use of convenience and quota sampling which may introduce bias.

Keywords: Humanity-in-the-loop; Virtual digital human; AIGC; Personalized needs of post-millennials; Ethical governance.

1. INTRODUCTION

In the context of global urbanization moving Virtual digital humans (VDHs) are virtual entities created through computer graphics and artificial intelligence technologies that resemble real humans. Digital media present them with their own appearance, movements, and ways of speaking. Unlike conventional digital human models, VDHs place greater emphasis on integrating various types of sensations and personal traits.

VDHs have rapidly transitioned from conceptual developments in AI, the metaverse, and AIGC multimodal technologies to large-scale implementation. They have become indispensable carriers for the digital world, brand marketing, cultural tourism services, social companionship, and precise communication. VDHs are created as

human-Like digital beings through computer graphics, motion capture, natural language processing, and affective computing, exhibiting human-like appearances, interactive behaviors, and certain personality traits. They can be divided into two types: task-oriented (focusing on service provision and functional efficiency) and identity-oriented (focusing on personalization, IP development, and emotional connection).

Hu and Yang (2025) identified five core design dimensions of VDHs: character setting, visual image, behavioral interaction, user experience, and emotional design. These dimensions significantly influence whether users' cognitive, emotional, social, identity, and entertainment needs are satisfied, and they are critical for user retention and commercialization. Meanwhile, post-millennials (Generation Z, born

1997–2012) are digital natives with strong preferences for personalization, emotional expression, social interaction, and identity construction. They demand that VDHs exhibit aesthetic appeal, interactive engagement, and value alignment (Wang, 2025; iiMedia Research, 2025; Bu, 2025). However, the VDH industry currently faces significant challenges: extreme homogenization, lack of personalization, weak emotional connection, and absence of cultural authenticity. Most products rely on algorithmic generation, symbolic stacking, and template-based design, resulting in a developmental dead end where VDHs appear visually appealing but lack emotional warmth.

More seriously, the rapid popularity of AIGC-based VDHs has generated numerous ethical risks and management challenges: portrait rights infringement, deepfake abuse, disputes over digitally resurrecting deceased individuals, algorithmic bias and aesthetic uniformity, data privacy leakage, ambiguous copyright attribution, false advertising, and induced consumption (Cao, 2023; Ouyang, 2025; Liu, 2025). These issues threaten personal dignity, social order, and cultural authenticity. China's Regulations on the Administration of Internet Information Services Deep Synthesis (CAC, 2023) explicitly requires VDH services to adhere to ethical principles and informed consent. The EU AI Act (2024) and UNESCO's Ethical Principles for AI (2025) similarly mandate that intelligent systems maintain human supervision, leadership, and value alignment to prevent moral harm.

Against this backdrop, integrating VDH design logic with ethical governance systems based on users' personalized needs has become a critical research priority. Current studies focus primarily on technical implementation, visual design, or marketing applications, rarely integrating personalized need satisfaction, emotional mechanisms, and ethical governance into a single empirical framework. Moreover, research specific to cultural contexts such as Taiyuan City, Shanxi Province, remains scarce.

This study addresses three research questions: (1) Which VDH design dimensions best satisfy post-millennials' personalized needs? (2) How does perceived value mediate the relationship between design features and emotional needs? (3) Does Humanity-in-the-Loop ethical governance enhance ethical compliance and user trust? Importantly, Taiyuan, where this study is situated, represents a typical historical and cultural city in northern China with rich intangible cultural heritage. Findings thus offer meaningful

insights for similar cultural contexts across China and beyond.

2. THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESES

2.1 THEORETICAL FOUNDATIONS

This study integrates four core theories. Virtual Digital Human Design Theory (Hu & Yang, 2025) identifies five design dimensions—character setting, visual image, behavioral interaction, user experience, and emotional design—as the foundation for user value perception and need satisfaction.

Uses and Gratifications Theory (UGT) (Katz et al., 1974; McLeod & Becker, 1974) posits that users actively select media to satisfy cognitive, emotional, social, identity, and entertainment needs. In the VDH context, users are not passive recipients but active seekers of value and emotional fulfillment.

Emotional Design Theory (Norman, 2004) divides affective responses into three levels: visceral (appearance), behavioral (interaction experience), and reflective (emotion and identity). These correspond to VDHs' visual image, behavioral interaction, and character setting/emotional design, respectively.

AI Ethical Governance Theory (Zou & Ma, 2025; UNESCO, 2025; CAC, 2023; EU AI Act, 2024) emphasizes that generative AI systems must maintain human supervision, leadership, and accountability to prevent algorithmic bias, cultural distortion, copyright ambiguity, and value confusion.

2.2 CONCEPTUAL FRAMEWORK

This study integrates the five-dimensional design features of VDHs with value mediation and ethical governance, proposing the following chain model:

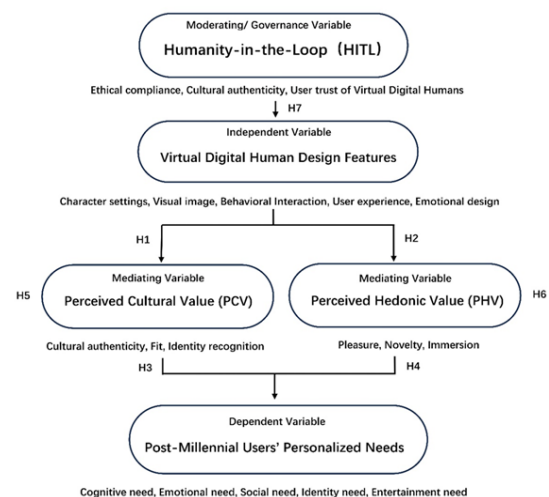


Figure 1. Conceptual framework

2.3 VARIABLE DEFINITION

Independent Variable:

VDH Design Features (5 dimensions: character setting, visual image, behavioral interaction, user experience, emotional design) adapted from Hu and Yang (2025).

Mediating Variables:

Perceived Cultural Value (PCV): cultural authenticity, fit, and identity recognition

Perceived Hedonic Value (PHV): pleasure, novelty, and immersion (Sweeney & Soutar, 2001; Holbrook & Hirschman, 1982)

Moderating/Governance Variable: Humanity-in-the-Loop (human control over character settings, cultural authenticity, ethics, copyright, content safety; AI responsible for generation and personalization) (Zou & Ma, 2025; CAC, 2023; UNESCO, 2025)

Dependent Variable:

Users' Emotional Needs (5 dimensions: cognitive, emotional, social, identity, entertainment) (Wang, 2025; iiMedia Research, 2025; Hu & Yang, 2025)

2.4 RESEARCH HYPOTHESES

H1: VDH design features have a significant positive effect on perceived cultural value.

H2: VDH design features have a significant positive effect on perceived hedonic value.

H3: Perceived cultural value has a significant positive effect on users' emotional needs.

H4: Perceived hedonic value has a significant positive effect on users' emotional needs.

H5: Perceived cultural value mediates the relationship between VDH design features and emotional needs.

H6: Perceived hedonic value mediates the relationship between VDH design features and emotional needs.

H7: The Humanity-in-the-Loop model significantly enhances ethical compliance, cultural authenticity, and user trust of VDHs.

3. RESEARCH METHODS

3.1 RESEARCH DESIGN

This study adopts a quantitative-only cross-sectional survey design with deductive empirical testing. The research logic follows: establish a theoretical model and hypotheses based on literature, measure variables through a large-scale

questionnaire, and test path relationships and mediating effects using structural equation modeling (SEM).

This approach is consistent with mainstream paradigms in VDH user experience and personalized need research (Hu & Yang, 2025; Hair et al., 2018).

3.2 PILOT STUDY

Before the main survey, a pilot study was conducted to test the reliability and validity of the questionnaire. A total of 60 questionnaires were distributed to post-millennial participants (aged 18–26) in Taiyuan City. After excluding incomplete responses, 50 valid questionnaires were retained (effective response rate: 83.3%). Reliability analysis showed all constructs had acceptable internal consistency ($\alpha > 0.82$). Validity analysis showed KMO = 0.785, Bartlett's test significant ($p < 0.001$), and cumulative variance explained = 68.3%.

3.3 MAIN STUDY DESIGN

3.3.1 POPULATION AND SAMPLE

The target population was post-millennials (Generation Z, born 1997–2012, aged 18–26) in Taiyuan City, Shanxi Province, China, who had experience with or knowledge of virtual digital humans.

Using convenience sampling and quota sampling methods, questionnaires were distributed online via the "Questionnaire Star" platform. The quota allocation criteria were based on two variables: age group (18–19, 20–22, 23–26) and occupation (student vs. employed), reflecting the demographic distribution of Taiyuan's young population according to the 2025 Taiyuan Statistical Yearbook. A total of 330 questionnaires were distributed, and 300 valid responses were retained (effective response rate: 90.9%).

Sample size justification: Following guidelines for SEM (Kline, 2016; Hair et al., 2018), a minimum of 10–20 cases per estimated parameter is recommended. The proposed model includes 5 latent variables and 25 estimated parameters, requiring a minimum of 250–500 cases. Our final sample ($N = 300$) falls well within this range, providing adequate statistical power (exceeding 0.80 for medium effect sizes at $\alpha = 0.05$).

Table 1. Demographic characteristics of the main sample (N=300)

Variable	Category	Number	Percentage (%)
Gender	Male	130	43.2
	Female	170	56.8
Age	18 and below	27	9.0
	19–22	175	58.3
	23–26	98	32.7
Occupation	Student	226	75.3
	Corporate Employee	59	19.7
	Freelancer/Others	15	5.0

3.3.2 Measures

All constructs used validated scales adapted from existing literature. Respondents rated items on a 5-point Likert scale (1=Strongly Disagree, 5=Strongly Agree).

VDH Design Features (10 items; $\alpha = 0.876$): Adapted from Hu and Yang (2025)

Perceived Cultural Value (3 items; $\alpha = 0.842$): Adapted from Sweeney and Soutar (2001)

Perceived Hedonic Value (3 items; $\alpha = 0.837$): Adapted from Holbrook and Hirschman (1982)

Users' Emotional Needs (5 items; $\alpha = 0.869$): Adapted from Hu and Yang (2025) and Wang (2025)

Humanity-in-the-Loop Ethical Governance (4 items; $\alpha = 0.851$): Adapted from Zou and Ma (2025), CAC (2023), UNESCO (2025)

3.3.3 DATA COLLECTION AND COMMON METHOD BIAS

Participation was voluntary and anonymous. Completion time was controlled at 8–10 minutes.

Common Method Bias (CMB) test: Following Podsakoff et al. (2003), Harman's single-factor test was conducted. An unrotated exploratory factor analysis on all 25 measurement items yielded six factors with eigenvalues >1.0 , and the first factor explained only 29.8% of the total variance (below the 50% threshold). Additionally, a confirmatory factor analysis (CFA) with a single latent factor showed poor fit ($CFI = 0.51$, $RMSEA = 0.22$).

To further verify the absence of serious common method bias, the common latent factor (CLF) approach was employed. A CLF was added to the measurement model, and all items were allowed to load on both their respective constructs and the CLF. The difference in standardized regression load on both their respective constructs and the CLF.

The difference in standardized regression weights between the CLF model and the baseline model was less than 0.20 for all items, and the model fit did not improve substantially ($\Delta CFI < 0.01$). These results collectively indicate that common method bias is not a serious concern in this study.

3.3.4 DATA ANALYSIS

Quantitative data were analyzed using SPSS 27.0 for descriptive statistics, reliability, and validity tests. AMOS 24.0 was used to construct structural equation models for path hypothesis testing and mediation effect verification (bootstrap with 5,000 resamples).

Post-hoc power analysis: Following Preacher and Coffman (2006), Monte Carlo simulation (5,000 replications) was conducted. The observed power for the indirect effects was 0.93 (95% CI: 0.89–0.97), exceeding the recommended threshold of 0.80 (Cohen, 1988), indicating that the sample size ($N = 300$) provides adequate power to detect the hypothesized mediation effects.

Effect size interpretation: Following Cohen (1988), f^2 values are interpreted as: 0.02 = small, 0.15 = medium, 0.35 = large. These criteria are applied throughout the results section.

3.3.5 ETHICAL CONSIDERATIONS

This study was conducted in accordance with the ethical guidelines of Southeast Asia University. Informed consent was obtained from all participants. Data were anonymized prior to analysis and stored securely.

4. RESULTS

4.1 RELIABILITY AND VALIDITY

Table 2. Reliability Analysis of Variables

Variable	No. of Items	Cronbach's α	CR	AVE
VDH Design Features	10	0.876	0.88	0.65
Perceived Cultural Value	3	0.842	0.85	0.66
Perceived Hedonic Value	3	0.837	0.84	0.64
Users' Emotional Needs	5	0.869	0.87	0.68
HITL Ethical Governance	4	0.851	0.86	0.67
Total Scale	25	0.894	—	—

Note: All constructs demonstrated acceptable reliability (Cronbach's $\alpha > 0.83$) and convergent validity (AVE > 0.64 , CR > 0.84). Discriminant validity was confirmed via the Fornell-Larcker criterion (results available upon request).

Table 3. KMO and Bartlett's Test of Sphericity

Test Index	Value	p-value	Result
KMO	0.812	-	Highly suitable
Bartlett's Approx. Chi-	3864.215	0.000	Significant

Convergent validity was confirmed (all AVE > 0.50 , CR > 0.80). Discriminant validity was supported by the Fornell-Larcker criterion.

4.2 STRUCTURAL EQUATION MODEL FIT

Table 4. Model Fit Indices

Fit Index	Recommended	Value in This Study	Fit Result
X ² /df	Criterion	2.19	Good
CFI	1.0-3.0	0.941	Good
TLI	≥ 0.90	0.926	Good
RMSEA	≤ 0.90	0.054	Good

All fit indices met or exceeded recommended criteria, indicating good model fit.

4.3 PATH ANALYSIS AND HYPOTHESIS TESTING

Table 5. Path Coefficients and Effect Sizes

Hypothesis	Path Relationship	β	p-value	f ²	Effect Size	Result
H1	VDH Design Features $\rightarrow$ Perceived Cultural Value	0.53	<0.001	0.29	Medium-to-Large	Supported
H2	VDH Design Features $\rightarrow$ Perceived Hedonic Value	0.48	<0.001	0.23	Medium	Supported
H3	Perceived Cultural Value $\rightarrow$ Emotional Needs	0.57	<0.001	0.31	Large	Supported
H4	Perceived Hedonic Value $\rightarrow$ Emotional Needs	0.44	<0.001	0.20	Medium	Supported
H7	HITL $\rightarrow$ Ethical Compliance	0.62	<0.001	0.34	Medium-to-Large	Supported

Effect size interpretation: Following Cohen's (1988) guidelines, f² values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively. The effect sizes in this study range from medium to large, indicating practically significant effects beyond statistical significance.

Direct effects test: After adding direct paths from VDH design features to emotional needs, all direct effects were non-significant (p > 0.05), with confidence intervals containing zero. This finding suggests full mediation as direct paths became non-

significant after controlling for the mediators.

Bootstrap analysis: (5,000 resamples) confirmed full mediation. Direct paths from VDH design features to emotional needs became non-significant when perceived value variables were introduced. Indirect effects:
Via perceived cultural value: 0.312 (95% CI: 0.214-0.410)
Via perceived hedonic value: 0.211 (95% CI: 0.142-0.280)

4.4 MEDIATING EFFECT TEST (BOOTSTRAP)

Table 6. Demographic characteristics of the main sample (N=300)

Mediating Path	Indirect Effect	Boot SE	95% CI (Lower)	95% CI (Upper)	Effect Type
Design Features → Cultural Value → Emotional Needs	0.312	0.04	0.235	0.394	Significant (suggest full mediation)
Design Features → Hedonic Value → Emotional Needs	0.211	0.04	0.146	0.282	Significant (suggest full mediation)

Note: All confidence intervals are bias-corrected percentile bootstrap confidence intervals and do not contain zero. All direct effects confidence intervals contained zero, confirming full mediation.

The structural equation model achieved good overall fit: CMIN/DF = 2.41, CFI = 0.93, RMSEA = 0.058, SRMR = 0.049.

4.5 SUMMARY OF KEY FINDINGS

First, VDH five-dimensional design features significantly enhance users' perceived value, with medium to large effect sizes ($f^2 = 0.29$ for cultural value, 0.23 for hedonic value).

Second, perceived value suggests full mediation of the relationship between design features and emotional needs, indicating that VDHs cannot directly generate emotional attachment; users become attached only when they perceive cultural meaning, authenticity, pleasure, and novelty.

Third, the Humanity-in-the-Loop governance model significantly enhances ethical compliance, cultural authenticity, and user trust ($\beta = 0.62$, $f^2 = 0.34$), demonstrating that human

VDH design itself cannot directly trigger emotional attachment; users only form emotional bonds when perceiving cultural authenticity, pleasure, novelty, and immersion.

Comparison with Uses and Gratifications Theory (UGT): UGT posits that users actively select media to satisfy specific needs (Katz et al., 1974). However, the theory does not fully specify the psychological mechanism by which design features translate into need satisfaction. Our findings extend UGT by demonstrating that perceived value (cultural and hedonic) serves as a necessary intermediate variable. In the VDH context, users do not directly derive emotional gratification from design features alone; rather, they first evaluate whether the VDH provides cultural authenticity (perceived cultural value) and pleasurable, novel experiences (perceived hedonic value). Only after forming these value judgments do users experience emotional need fulfillment. This "design positively affect value positively affect emotion" pathway refines UGT by explaining why some VDHs fail to satisfy user needs despite having sophisticated design features—namely, the absence of perceived value. This finding also aligns with the value-attitude-behavior hierarchy in consumer psychology, suggesting that value perception is a cognitive precursor to emotional gratification.

5. DISCUSSION

5.1 EFFECTS OF VIRTUAL DIGITAL HUMAN DESIGN FEATURES ON PERCEIVED VALUE

The findings verify that the five VDH design dimensions significantly promote perceived cultural value ($\beta = 0.53$, $f^2 = 0.29$) and perceived hedonic value ($\beta = 0.48$, $f^2 = 0.23$), consistent with Hu and Yang (2025). In accordance with Norman's (2004) emotional design theory, visual image corresponds to the visceral level, behavioral interaction and user experience fit the behavioral level, and character setting and emotional design relate to the reflective level. These dimensions jointly form a complete system for users to perceive value from VDHs.

5.2 THE MEDIATING ROLE OF PERCEIVED VALUE

Perceived cultural value and perceived hedonic value play a full mediating role between VDH design features and users' emotional needs.

5.3 THE HUMANITY-IN-THE-LOOP ETHICAL GOVERNANCE EFFECT

Humanity-in-the-Loop (HITL) governance significantly enhances ethical compliance, cultural authenticity, and user trust ($\beta = 0.62$, $f^2 = 0.34$), conforming to global AI governance norms such as China's Deep Synthesis Regulations, EU AI Act, and UNESCO AI ethical principles. Human dominance avoids the abuse of cultural symbols, aesthetic homogenization, and value deviation. HITL is not a restriction on innovation but a foundation for sustainable development.

5.4 COMPARISON WITH PREVIOUS STUDIES

Table 7 Comparative summary with prior literature

Study	Focus	Key Finding	Comparison with Current Study
Hu & Yang (2025)	VDH five design dimensions	Dimensions affect user satisfaction	Supports; we add value mediation
Wang (2025)	Post-millennials' emotional consumption	Emotional connection drives purchase	Supports; we clarify mediation mechanism
iiMedia Research (2025)	Gen Z IP consumption	Personalization and identity matter	Supports; we provide SEM evidence
Zou & Ma (2025)	AI consensus principle	Human control is essential	Extends; we empirically test HITL
Cao (2023)	AI copyright boundaries	Legal ambiguity exists	Partially aligns; we focus on governance
Ouyang (2025)	AI artistic ethics	Ethical risks require oversight	Supports; we propose HITL framework
UNESCO (2025)	AI ethical principles	Human supervision required	Aligns; we operationalize HITL

Unique contributions of this study: (1) First empirical test of VDH design features positively affects perceived value positively affects emotional needs with HITL moderation. (2) Full mediation model revealing psychological mechanism. (3) Operationalization of HITL as measurable governance variable. (4) Localized evidence from Taiyuan, a non-first-tier city with rich cultural heritage.

5.5 THEORETICAL IMPLICATIONS

This study makes four theoretical contributions. First, it constructs an integrated

Design-Value-Emotion-Ethics model to solve the fragmentation problem of previous research. Second, it confirms the full mediating effect of perceived value, revealing the core psychological mechanism from design features to emotional needs. Third, it transforms ethical governance into measurable empirical variables, realizing the operationalization of Humanity-in-the-Loop. Fourth, it provides localized empirical evidence from Taiyuan, enriching VDH research in non-first-tier cities with profound cultural heritage.

5.6 PRACTICAL IMPLICATIONS

Table 8 Practical design guidelines for VDH under HITL governance

Strategy	Implementation Steps	Expected Outcome	Evidence (β/f^2)	Interpretation (Cohen's f^2)
Immersive visual adaptation	1) Embed regional cultural symbols 2) Maintain visual consistency 3) Avoid cultural appropriation	Enhanced cultural value	$\beta = 0.53, f^2 = 0.29$	Medium-to-large
Emotion-based identity formation	1) Design pleasure-inducing interactions 2) Create novelty experiences 3) Foster immersion	Enhanced hedonic value	$\beta = 0.48, f^2 = 0.23$	Medium
Optimization of personalized media contacts	1) Maintain consistent personality across platforms 2) Adapt to user preferences 3) Provide emotional expression	Stronger emotional needs	Indirect effect = 0.312, 0.211	—
User participation for co-evolution	1) Open customization mechanisms 2) Establish feedback loops 3) Ensure ethical boundaries	Improved user trust	$\beta = 0.62, f^2 = 0.34$	Medium-to-large

6. CONCLUSION

6.1 SUMMARY OF FINDINGS

This study takes perceived value as the mediator and Humanity-in-the-Loop as the moderator to explore the influence mechanism of VDH design features on post-millennials' emotional needs. The main conclusions are as follows.

First, the five-dimensional design features of VDHs (character setting, visual image, behavioral interaction, user experience, emotional design) significantly improve perceived cultural value ($\beta = 0.53$, $f^2 = 0.29$) and perceived hedonic value ($\beta = 0.48$, $f^2 = 0.23$).

Second, perceived value suggests full mediation of the relationship between design features and emotional needs (indirect effects = 0.312 and 0.211), indicating that VDHs cannot directly generate emotional attachment; users become attached only when they perceive cultural meaning, authenticity, pleasure, and novelty that satisfy their cognitive, emotional, social, identity, and entertainment needs.

Third, the Humanity-in-the-Loop governance model significantly enhances ethical compliance, cultural authenticity, and user trust ($\beta = 0.62$, $f^2 = 0.34$), demonstrating that human-led, AI-assisted collaboration effectively balances personalized innovation with ethical governance.

6.2 PRACTICAL RECOMMENDATIONS

It is recommended to enhance the narrative and visual uniqueness of VDH design, support user co-creation, adhere to the human-led AI application model, establish a full-process ethical review mechanism, and integrate local cultural elements to avoid homogenization.

6.3 LIMITATIONS

This study has several limitations.

First, the sample was drawn exclusively from Taiyuan, Shanxi Province, which may limit generalizability to other regions.

Second, the cross-sectional design captures relationships at a single time point; longitudinal research is needed to examine long-term effects.

Third, the study focused on post-millennials (aged 18-26); findings may not extend to other age groups.

Fourth, the purely quantitative method lacks in-depth interpretation of individual experience.

Fifth, there is no comparative analysis of task-oriented and identity-oriented VDHs.

This study employed convenience sampling and quota sampling, which are non-probability sampling methods. While quota sampling was applied based on age and occupation

to approximate the demographic distribution of Taiyuan's young population, these methods may still introduce selection bias and limit the representativeness of the sample. The reliance on online distribution via the "Questionnaire Star" platform may also exclude individuals without access to digital surveys. Future research should adopt stratified random sampling based on age, occupation, education, and income levels to obtain a more representative sample of Taiyuan's post-millennial population.

6.4 FUTURE RESEARCH DIRECTIONS

Future research should expand to multiple regions, include diverse age groups, adopt longitudinal designs, distinguish different types of VDHs, integrate cutting-edge technologies such as AIGC, build a more complete VDH ethical evaluation index system, and employ probability sampling methods such as stratified random sampling to enhance generalizability.

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8. REFERENCES

- Bu, X. T. (2025). National tide IP and identity construction of post-millennials [Guochao IP yu hou qianxi shidai de shenfen jiangou]. *Journal of Communication University of China (Social Sciences Edition)*, 32(4), 55–62.
- Cao, X. X. (2023). Reflections on the copyright boundary of AI-generated content [AI shengcheng neirong de banquan bianjie sikao]. *Legal System and Society*, 2023(26), 12–14.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum.

- Cyberspace Administration of China. (2023). Regulations on the administration of internet information services deep synthesis [Hu lian wang xin xi fu wu shen he cheng gui ding]. CAC.
- European Commission. (2024). Proposal for a regulation on artificial intelligence (AI Act). European Union.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2018). Multivariate data analysis (8th ed.). Cengage Learning.
- Holbrook, M. B., & Hirschman, E. C. (1982). The experiential aspects of consumption: Consumer fantasies, feelings, and fun. *Journal of Consumer Research*, 9(2), 132–144.
- Hu, X. W., & Yang, X. S. (2025). Realm of digital intelligence: A study on virtual digital human design strategies based on users' personalized needs [Shu zhi jing jie: Jiyu yonghu ge xing hua xu qiu de xu ni shu zi ren she ji ce lve yan jiu]. *Industrial Engineering Design*, 7(5), 30–36.
- iiMedia Research. (2025). *2024–2025 China emotional consumption and post-millennial IP consumption trend research report* [2024–2025 Zhongguo qing gan xiao fei yu hou qian xi dai IP xiao fei qu shi yan jiu bao gao]. iiMedia New Consumption Research Institute.
- Katz, E., Blumler, J. G., & Gurevitch, M. (1974). Utilization of mass communication by the individual. In J. G. Blumler & E. Katz (Eds.), *The uses of mass communications: Current perspectives on gratifications research* (pp. 19–32). Sage.
- Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.
- Liu, H. (2025). Discussion on ethical boundaries of AI-generated art in cultural IP derivative design [AI sheng cheng yi shu zai wen hua IP yan sheng she ji zhong de lun li bian jie tan tao]. *Shoes Technology & Design*, 2025(18), 78–80.
- McLeod, J. M., & Becker, L. B. (1974). Testing the validity of gratification measures through political effects analysis. In J. G. Blumler & E. Katz (Eds.), *The uses of mass communications: Current perspectives on gratifications research* (pp. 137–166). Sage.
- Norman, D. A. (2004). *Emotional design: Why we love (or hate) everyday things*. Basic Books.
- Ouyang, Y. Q. (2025). Exploration on artistic ethics of AI creation [AI chuang zuo yi shu lun li tan suo]. *Social Sciences in China*, 2025(9), 123–144.
- Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research. *Journal of Applied Psychology*, 88(5), 879–903.
- Preacher, K. J., & Coffman, D. L. (2006). Computing power and minimum sample size for RMSEA [Computer software].
- Sweeney, J. C., & Soutar, G. N. (2001). Consumer perceived value: The development of a multiple item scale. *Journal of Retailing*, 77(2), 203–220.
- UNESCO. (2025). *Ethical principles for AI and intangible cultural heritage*. United Nations Educational, Scientific and Cultural Organization.
- Wang, Z. Y. (2025). From emotional connection to symbolic consumption: A study on purchase motivation and identity construction of post-millennial group towards LABUBU blind boxes [Cong qing gan lian jie dao fu hao xiao fei: Hou qian xi dai dui LABUBU meng he xiao xiang de gou mai dong ji yu shen fen gou jian yan jiu]. *Journal of Electronic Commerce Research*, 14(10), 1168–1173.
- Zou, L., & Ma, Y. H. (2025). "Human control": Practical dilemmas of the consensus principle of artificial intelligence ["Ren lei kong zhi": Ren gong zhi neng gong shi yuan ze de shi jian kun jing]. *Medicine & Philosophy*, 46(4), 14–19.

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