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Examining the Determinants of User Stickiness in a Mobile Video Application: A Flow Theory Perspective

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ABSTRACT

This study investigates the determinants of user stickiness in short video applications through the lens of Flow Theory. A research model is developed to examine the influence of platform-specific factors, namely perceived personalization, design characteristics, and telepresence, on user stickiness, mediated by perceived control and flow experience. The study employs an online survey methodology, collecting data from 761 users of short video applications in China. Structural equation modeling is used to analyze the data and test the hypothesized relationships. The findings reveal that perceived personalization, design characteristics, and telepresence positively influence perceived control and flow experience, which in turn positively affect user stickiness. The study contributes to the literature by extending Flow Theory to the context of short video applications and providing empirical evidence for the role of platform-specific factors in driving user stickiness. Practical implications for short video platform operators are discussed, highlighting the importance of personalization, design, and telepresence in fostering user engagement and retention.

Keywords: Short Video Application, User Stickiness, Flow Theory, Mobile Video, Flow Experience

1 INTRODUCTION

In recent years, the rapid advancement of 4G and 5G networks, coupled with the ubiquity of smart mobile devices, has revolutionized people's lives, social interactions,

and entertainment choices. Short videos have emerged as a dominant medium for content distribution and consumption, offering unique user experiences through concise formats, mobile accessibility, and personalized recommendations [1]. According to the 50th "Statistical Report on China's Internet Development Status" by the China Internet Network Information Center (CNNIC), as of June 2022, short video users in China reached 962 million, representing an astounding 91.5% of the country's total internet users. This remarkable shift has triggered an information technology revolution, transforming online activities from text and image-based to video-centric.

Despite the growing body of literature on user stickiness in online platforms, research specifically focusing on short video applications remains limited. While some studies have investigated the motivations and gratifications associated with short video usage [2, 3], these studies have largely relied on descriptive analyses and have not provided an understanding of the psychological processes underlying user stickiness in this context.

Moreover, existing research on user stickiness in online platforms has primarily focused on factors such as content quality, social interaction, and platform features [4, 5, 6]. However, the potential influence of specific factors, such as perceived personalization, design characteristics, and telepresence, on user stickiness in short video applications has been largely overlooked. Given the unique characteristics of short video content, such as its brevity and immersive nature, it is crucial to examine how these factors may contribute to user retention in this specific context.

While flow theory has been applied to understand user engagement in various online contexts [4, 5, 6], its role in explaining user stickiness in short video applications has not been fully explored. There is a lack of research investigating how flow experience, in conjunction with other factors such as perceived control, may mediate the relationship between platform features and user stickiness in short video applications.

To address these research gaps, the current study draws upon flow theory to investigate the factors influencing user stickiness in short video applications. By examining the effects of perceived personalization, design characteristics, and telepresence on user stickiness, mediated by perceived control and flow experience, this study aims to provide a more comprehensive understanding of the psychological processes driving user retention in short video platforms.

To achieve these objectives, this study employs an online questionnaire survey (N=761) and structural equation modeling to analyze the data. By empirically testing the proposed model, this research addresses two key questions:

(1) How do perceptions of a short video application's features affect user stickiness?

(2) What are the mediating roles of perceived control and flow experience in this relationship?

2 LITERATURE REVIEW

2.1 User Stickiness in Short Video Applications

User stickiness, defined as users' willingness to continue using and engaging with a platform, has been recognized as a critical determinant of the success and longevity of online platforms [7, 8]. In the context of short video applications, the importance of user stickiness is even more pronounced, given the intense competition and the crucial need for platforms to retain users in order to maintain a competitive edge [5, 6]. Extensive research has addressed various determinants of user stickiness in online platforms, including content quality, user experience, social interaction, and platform features [4, 5, 6]. However, studies focusing specifically on user stickiness within short video applications remain scarce, calling for further investigation. Shown Table 1.

Table 1: Previous Studies on Continuance Intention of Short Video

Source	Theoretical /Perspectives	Antecedents→Mediators/Moderators →Consequences
[31]	Network externalities; Motivation theory	Network externalities→Perceived enjoyment; Perceived usefulness→Continued intention to use
[2]	Theory of planned behavior	Attitude; Subjective norm; Perceived value; Perceived control→Continuance participation intention→Continuance participation behavior
[9]	Media system dependency; Uses and gratification theory	Understanding; Play dependency relations; Orientation→Para-social interaction; Gratification / Habit→Continuance intention
[4]	Uses and gratification theory	Entertainment; Status seeking; Information seeking; Self-expression→Attitude; Satisfaction→Continuance intention to use

Source	Theoretical /Perspectives	Antecedents→Mediators/Moderators →Consequences
[6]	Self-regulation framework; Uses and gratification theory	Exhibitionism; Escapism; Voluntarism; Voyeurism; Information and social overload; Mobility gratifications→Satisfaction; Emotional exhaustion→Continuance intention
[51]	Uses and gratification theory	Information seeking; Entertainment; Socialization; Self-presentation→Education level; Cultural difference; Income level→Continuance intention
[52]	Expectation confirmation model	Confirmation→Satisfaction; Perceived usefulness; Habit; Subjective norms; Enjoyment→Continuance intention
[53]	Social cognitive perspective	Habit; Perceived user base→Resistance to change→Continuance intention
[54]	TAM; Diffusion of innovation	Ease of use; Compatibility; Relative advantage; Information quality; Risk; Satisfaction→Usefulness of social media→Continuance usage
[38]	Network externalities; Perceived value	Social interaction ties; Direct and indirect network externalities→Social value; Emotional value; Hedonic value; Information value→Continuance intention
[55]	Uses and gratification theory; SOR framework	Social activity; Information seeking; Network externality; Collective intelligence; Content consumption→Sense of belonging; Flow experience→Continuance intention
[56]	Means-end chain theory	Face consciousness; Innovativeness; Ambiguity intolerance; Need for uniqueness→Utilitarian value; Hedonic value→Continuance intention
[57]	Self-regulation framework	Peer influence; Self-image→Sense of belonging; Satisfaction→Continuance intention
[58]	Expectation confirmation model	Social identity→Perceived usefulness; Confirmation→Continuance intention
[10]	Utilitarian hedonic approach	Ease of use; Perceived usefulness; Enjoyment→Satisfaction→Continuance intention

2.2 Flow Theory and Its Application to the Research Model

Flow theory, proposed by [9], describes the optimal experience of complete involvement and enjoyment in an activity. The theory posits that individuals experience flow when they are fully immersed in an activity, with a high level of concentration, a sense of control, and a balance between the perceived challenges and their own skills [9]. Flow Theory has been widely applied to understand user engagement and

experience in various online contexts, such as online gaming [10], e-commerce [11], and social media [12].

In the context of short video applications, Flow Theory provides a valuable framework for understanding user stickiness. The current study adopts Flow Theory by incorporating two key variables from the theory into the research model: perceived control and flow experience. Perceived control, defined as users' sense of mastery over their interactions with a platform [11, 13], is considered an important antecedent of flow experience in online environments [11, 13]. Flow experience, characterized by complete absorption, enjoyment, and temporal dissociation [9], is hypothesized to be a crucial mediator between perceived control and user stickiness in short video applications. The inclusion of perceived control and flow experience in the research model is supported by previous studies that have demonstrated their relevance in explaining user engagement and continuance intention in various online platforms [10, 12]. However, the role of flow experience in fostering user stickiness in short video applications remains underexplored.

Furthermore, the research model extends Flow Theory by investigating the influence of platform-specific factors, such as perceived personalization, design characteristics, and telepresence, on perceived control and flow experience. These factors are hypothesized to be important antecedents of perceived control and flow experience in short video applications, given the personalized, immersive, and visually engaging nature of short video content [14, 15, 16]. By integrating these platform-specific factors with the core variables of Flow Theory, the research model provides a specific framework for understanding user stickiness in short video applications.

2.3 Perceived Personalization and Perceived Control

Perceived personalization refers to users' perception of the extent to which a platform provides tailored content and services based on their preferences and behaviors [14]. In the context of short video applications, perceived personalization can be influenced by factors such as recommended content, push frequency, and personalized settings [6, 17]. Previous studies have shown that perceived personalization can positively affect users' perceived control, as it reduces information overload and facilitates decision-making [18] .

2.4 Design Characteristics and Perceived Control

Design characteristics refer to the aesthetic and functional aspects of a platform's user interface, such as visual appeal, ease of use, and navigation [18, 19]. Well-designed user interfaces can enhance users' perceived control by providing clear navigation paths, descriptive labels, and intuitive layouts [20, 21]. In the context of short video applications, design characteristics can influence users' perception of control over their interactions with the platform and their ability to find desired content [19].

2.5 Telepresence and Flow Experience

Telepresence refers to users' sense of being present in a mediated environment, such as a virtual world created by a short video application [16, 22]. Previous studies have shown that telepresence can positively influence flow experience by immersing users in the virtual environment and enhancing their enjoyment and concentration [8, 23]. In the context of short video applications, telepresence can be enhanced by factors such as video quality, camera perspective, and interactive features [24].

2.6 Perceived Control, Flow Experience, and User Stickiness

Perceived control, defined as users' sense of mastery over their interactions with a platform and their ability to achieve desired outcomes [10, 13], is an essential precursor to flow experience [13, 25]. A high level of perceived control in the context of short video applications enhances users' likelihood of experiencing flow by allowing them to concentrate on their goals and enjoy the activities [20]. Research has demonstrated that perceived control directly contributes to user stickiness by boosting users' autonomy and motivation to continue using the platform [26]. Flow experience is also acknowledged as a critical determinant of user stickiness across online platforms [10, 26]. Users who attain flow states while engaging with a short video application tend to develop positive attitudes toward the platform, feel satisfied with their experiences, and are more inclined to persist in using the platform [27]. Consequently, flow experience serves as a mediator between various antecedents—including perceived personalization, design characteristics, telepresence, and perceived control—and user stickiness in short video applications.

3 RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

By integrating flow theory and the literature on user stickiness in short video applications, this study proposes a research model that aims to explain the influence mechanism of user stickiness in short video mobile application (see Fig. 1). The model examines the effects of perceived personalization, design characteristics, and telepresence on perceived control and flow experience, as well as the impact of perceived control and flow experience on user stickiness. Moreover, the model investigates the mediating roles of perceived control and flow experience in the relationships between the antecedents and user stickiness.

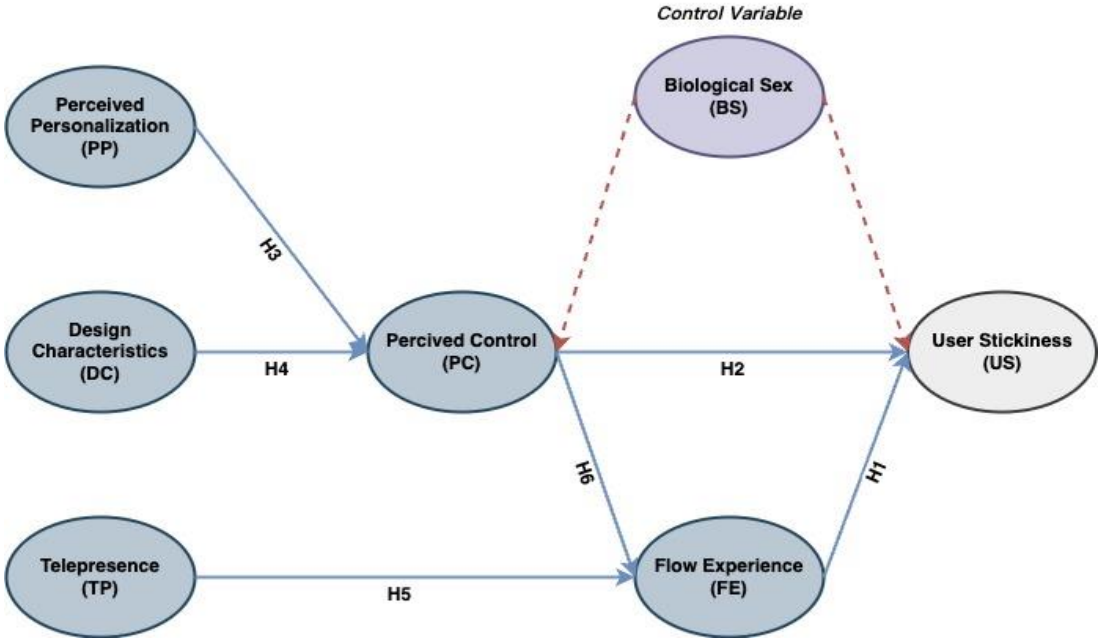

Fig. 1 Research model

3.1 Flow experience and user stickiness

Flow experience is characterized by complete concentration, intrinsic enjoyment, and a sense of potential control over the environment [10, 20]. In the context of short video applications, flow experience can be described as users' feelings of full engagement and enjoyment while browsing and watching short videos [27]. Previous studies have demonstrated that flow experience is a key predictor of user satisfaction and continued intention to use in various online contexts, such as social network games [28], mobile games [29], and social media [23]. When users experience flow while using a short video application, they are more likely to develop a positive attitude towards the platform, feel satisfied with their experience, and continue using the platform in the

future [27]. Therefore, we propose the following hypothesis:

H1: Flow experience positively affects user stickiness in the short video mobile application.

3.2 Perceived control and user stickiness

Perceived control refers to users' sense of control over their interactions with a platform and their ability to achieve desired outcomes [10, 13]. In the context of short video applications, perceived control can be influenced by factors such as the ability to customize content, navigate easily, and interact with the platform [26]. Previous studies have shown that perceived control can directly influence user stickiness by enhancing users' sense of autonomy and motivation to continue using the platform [26]. Thus, we hypothesize that:

H2: Perceived control positively affects user stickiness in the short video mobile application.

3.3 Perceived personalization and perceived control

Perceived personalization refers to users' perception of the extent to which a platform provides tailored content and services based on their preferences and behaviors [30]. In the context of short video applications, perceived personalization can be influenced by factors such as recommended content, push frequency, and personalized settings [6, 17]. Previous studies have shown that perceived personalization can positively affect users' perceived control, as it reduces information overload and facilitates decision-making [18]. Therefore, we propose the following hypothesis:

H3: Perceived personalization positively affects perceived control in the short video mobile application.

3.4 Design characteristics and perceived control

Design characteristics refer to the aesthetic and functional aspects of a platform's user interface, such as visual appeal, ease of use, and navigation [18, 19, 31]. Well-designed user interfaces can enhance users' perceived control by providing clear navigation paths, descriptive labels, and intuitive layouts [20, 21]. In the context of short video applications, design characteristics can influence users' perception of control over their interactions with the platform and their ability to find desired content [19]. Thus, we

hypothesize that:

H4: Design characteristics positively affect perceived control in the short video application.

3.5 Telepresence and flow experience

Telepresence refers to users' sense of being present in a mediated environment, such as a virtual world created by a short video application [16, 22]. Previous studies have shown that telepresence can positively influence flow experience by immersing users in the virtual environment and enhancing their enjoyment and concentration [8, 23]. In the context of short video applications, telepresence can be enhanced by factors such as video quality, camera perspective, and interactive features [24]. Therefore, we propose the following hypothesis:

H5: Telepresence positively affects flow experience in the short video mobile application.

3.6 Perceived control and flow experience

Perceived control has been identified as an important antecedent of flow experience [13, 25]. When users perceive a high level of control over their interactions with a platform, they are more likely to experience flow, as they can focus on their goals and enjoy the activity [9]. In the context of short video applications, users' perceived control over their interactions and ability to achieve desired outcomes can enhance their flow experience [26]. Thus, we hypothesize that:

H6: Perceived control positively affects flow experience in the short video mobile application.

All research hypotheses and variable relationships are shown in Figure 2.

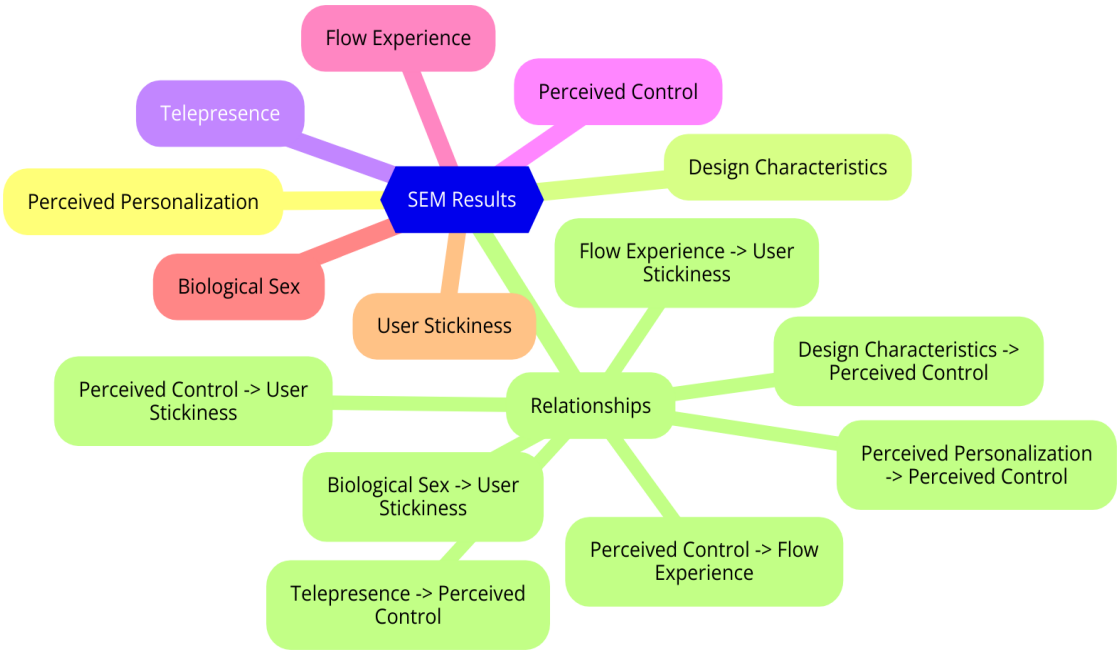

Fig. 2 Research Hypotheses and Variable Relationships

4 RESEARCH METHODOLOGY

4.1 Questionnaire design and item selection

The questionnaire for this study was designed using validated scales from prior research, with modifications tailored to the context of short video mobile applications. It comprised six principal constructs: perceived personalization, design characteristics, telepresence, perceived control, flow experience, and user stickiness. Each construct was assessed using multiple items that were adapted from existing studies to ensure content validity.

Perceived personalization was evaluated through four items derived from [6, 17]. Design characteristics were measured using three items based on [19]. Telepresence was gauged using four items sourced from [8, 16, 32]. Perceived control was appraised with three items adapted from [4, 33]. Flow experience was quantified through three items taken from [8, 12, 34]. User stickiness was evaluated using five items based on [4, 35, 36].

Responses were collected using a 5-point Likert scale, which ranged from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was initially crafted in English and subsequently translated into Chinese through the back-translation technique to verify the accuracy and equivalency of the items. A preliminary test with 50 short video users

was conducted to assess the questionnaire's clarity and comprehensibility. Feedback led to minor adjustments in the wording and clarity of the items. The final version of the questionnaire is presented in Table 2.

Table 2. Constructs and items.

Constructs	Items	Measurement	α/CR/AVE
Perceived Personalization	PP1	The content recommended by the short video app generally meets my personalized needs.	0.866/0.02/0.699
	PP2	The frequency of recommendations by the short video app generally meets my personalized needs.	
	PP3	The personalized settings of the short video app generally meet my personalized needs.	
	PP4	The push notifications and activities sent to me by the short video app generally meet my personal needs.	
Design Characteristics	DC1	The short video app 's interface design is visually appealing.	0.831/0.888/0.726
	DC2	Interface design makes it easy for me to find the features and content I need.	
	DC3	The short video app's interface design makes it easy for me to browse and navigate.	
Telepresence	T1	When using the short video app, I often forget about the passage of time.	0.858/0.904/0.701
	T2	The short video app creates an immersive experience for me.	
	T3	When using the short video app, I feel completely absorbed in the app’s world.	
	T4	The content provided by the short video app makes me feel close to the creators and other users.	
Perceived Control	PC1	I feel I control my interactions experience on the short video app.	0.802/0.884/0.718
	PC2	I have some choice and control over the content I want to watch.	
	PC3	I feel I can control the amount of time I spend on the short video app.	
Flow Experience	FE1	When using the short video app, my attention is completely focused on the app.	0.813/0.880/0.728
	FE2	I find using the short video app very enjoyable.	
	FE3	When using the short video app, time seems to pass quickly.	

Constructs	Items	Measurement	α/CR/AVE
User Stickiness	US1	I often spend a lot of time on the short video app.	0.888/0.918/0.692
	US2	Compared to other apps, I am more willing to invest time in the short video app.	
	US3	I frequently use the short video app.	
	US4	I plan to continue using the short video app in the future.	
	US5	I prefer using the short video app over other similar software.	

4.2 Nonresponse bias

Nonresponse bias refers to a situation in which people who do not respond to a questionnaire may bias the research results [37]. In this study that late respondents are more likely to resemble non-respondents than to resemble early respondents. This study addressed this issue by comparing the gender and age variables of the early respondents to those of the later respondents. A total of 259 respondents who completed the survey during the early stage were considered the earlier respondents, leaving 502 respondents who completed the survey during the later stage to be considered the later respondents. Achi-square test of the early and late respondents shows that they did not differ significantly ($p > 0.05$) in either gender or age. We, therefore, excluded the possibility of nonresponse bias.

4.3 Data collection and sample

Data for this study were collected through an online survey distributed via popular Chinese social media platforms, including WeChat groups, Weibo groups, and Xiaohongshu (Chinese version of Reddit) groups.

WeChat, Weibo, and Xiaohongshu are among the most widely used social media platforms in China, with a combined user base of over 1 billion people (CNNIC, 2021). By distributing the survey through these channels, we were able to reach a diverse and representative sample of Chinese internet users.

These platforms attract users from various age groups, geographical locations, and socioeconomic backgrounds (CNNIC, 2021), ensuring that our sample would reflect the heterogeneity of short video application users in China. According to the CNNIC (2021) report, the gender distribution of short video users in China is 57.1% female and

42.9% male, and the age distribution is 70.4% under 29 years old and 25.9% between 30-49 years old. The gender and age distribution of our sample are highly consistent with these data, supporting the representativeness of the sample. Furthermore, previous studies (e.g., [38, 39, 40]) have reported similar demographic characteristics of short video users, further validating the representativeness of our sample.

WeChat, Weibo, and Xiaohongshu are known for their high levels of user engagement and interactivity [9, 41], making them ideal platforms for recruiting participants who are active and experienced in using short video applications.

The social nature of these platforms allows for the implementation of snowball sampling techniques [9], where initial respondents can easily share the survey with their contacts, thus increasing the reach and diversity of the sample. To ensure the randomness and diversity of the sample, we employed a stratified sampling method on each platform. First, we divided potential participants into different subgroups based on their demographic characteristics such as geographical location, age, and gender. Then, we used a random number generator to select participants from each subgroup and invited them to participate in the survey via private messages. This sampling method ensured a balanced distribution of the sample across various demographic subgroups, enhancing the representativeness of the sample [42].

The survey was presented in the form of a questionnaire, as the aim of this study was to capture users' perceptions of their overall experience with short video applications, rather than their reactions to specific video content. This approach allowed us to collect data from a large and diverse sample of Chinese short video application users, enhancing the external validity and generalizability of our findings.

A total of 1013 responses were collected, out of which 761 were valid after excluding incomplete and invalid responses, 75.12% effective recovery rate exceeding the 25% recommendation [43]. According to Cohen's (1992) power analysis, for a medium effect size ($f^2 = 0.15$) and a target statistical power of 0.8, the minimum sample size required for a multiple regression analysis with 5 predictors is 91 at a significance level of 0.05. Our effective sample size of 761 far exceeds this requirement, ensuring adequate statistical power. Moreover, this sample size is comparable to those commonly used in studies on short video users [44, 45], indicating that our sample size is sufficient and reasonable. Demographics are shown in Table 3 and Fig 3:

Table 3. Demographic information of the respondents.

Demographics	Category	Frequency	Percentage (%)
Gender	Male	350	46.0
	Female	**411**	**54.0**
Age	Under 18	70	9.20
	19-25	**434**	**57.03**
	26-30	163	21.40
	30-40	71	9.33
	Over 40	23	3.02
Educational Level	Junior/High School or below	76	10.00
	Associate degree	61	8.01
	Bachelor's degree	**443**	**58.21**
	Graduate or above	181	23.80
Occupation	**Student**	**452**	**59.40**
	Employed	303	39.82
	Retired	6	0.80
Income (CNY)	**Below 2000**	**344**	**45.20**
	2001-4000	114	15.00
	4001-7000	137	18.00
	7001-10000	79	10.40
	Above 10000	87	11.43
Total		761	100.0

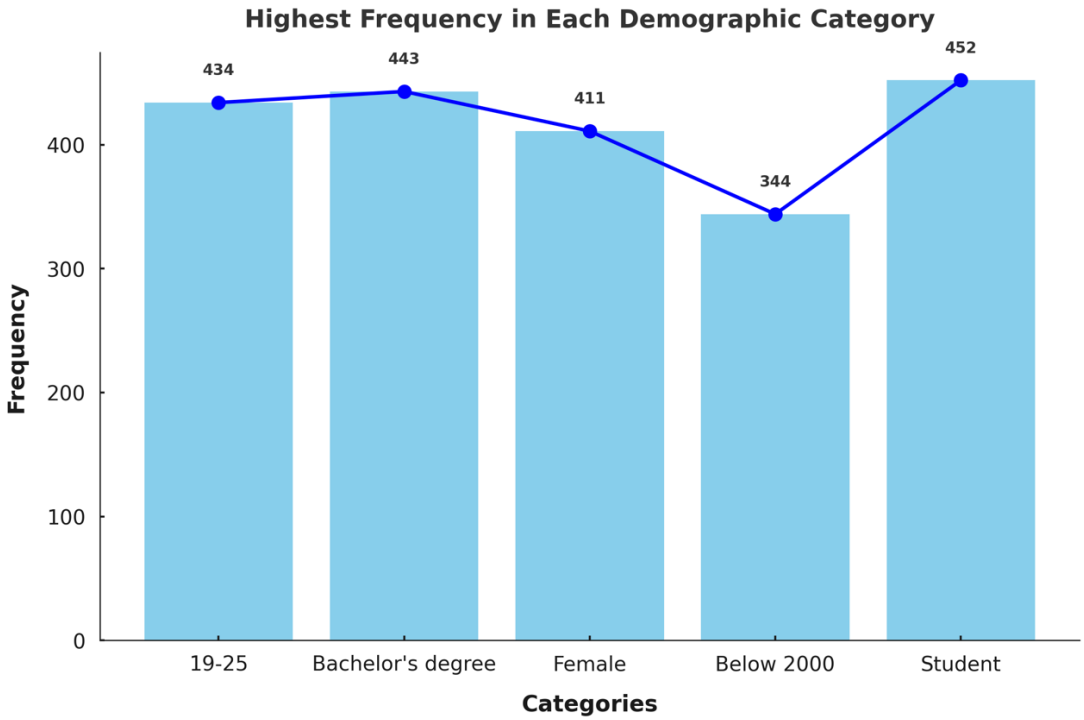

Fig. 3 Highest Frequency in Each Demographic Category

4.4 Data analysis methods

The collected data were analyzed using SPSS 26.0 and AMOS 29.0. First, descriptive statistics were computed to summarize the demographic characteristics of the sample and the usage patterns of the short video mobile application. Second, the reliability and validity of the measurement model were assessed using Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). Confirmatory factor analysis (CFA) was conducted to evaluate the fit of the measurement model.

Third, structural equation modeling (SEM) was employed to test the hypothesized relationships in the research model. The model fit was assessed using various fit indices, such as the root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker-Lewis index (TLI). The significance of the path coefficients was examined to determine the support for the hypotheses.

Finally, mediation analysis was conducted to investigate the mediating effects of perceived control and flow experience in the relationships between the antecedents and user stickiness. The bootstrap method with 5,000 resamples was used to estimate the significance of the indirect effects.

4.5 Ethics Statement

Our study did not require further ethics committee approval as it did not involve animal or human clinical trials and was not unethical. In accordance with the ethical principles outlined in the Declaration of Helsinki, all participants provided informed consent before participating in the study. The anonymity and confidentiality of the participants were guaranteed, and participation was completely voluntary.

5 RESULTS

5.1 Measurement model

The measurement model in this study was tested using SPSS 26.0 and AMOS 29.0. The results of the tests for internal reliability and convergent validity are presented in Table 4. Regarding internal reliability, the tested values of Cronbach's α were between 0.667 and 0.888, which exceeded the reference value of 0.6 [46]. The combined reliability (CR) of all latent variables exceeded 0.7, indicating good agreement and reliability of the measures across constructs [42]. For convergent validity, the standard factor loadings (SFL) for each construct were greater than 0.7, and the average variance extracted (AVE) values were greater than 0.5, indicating good convergent validity of the measurement model [42]. All data see Table 2 and Table 8. Furthermore, the data in Table 4 show that the discriminant validity of this study was met.

Table 4: Discriminant Validity

Variables	PP	DC	T	PC	FE	US
PP	**0.815**	0.582	0.457	0.405	0.515	0.354
DC	0.582	**0.831**	0.530	0.442	0.528	0.483
T	0.457	0.530	**0.825**	0.398	0.582	0.510
PC	0.405	0.442	0.398	**0.912**	0.464	0.369
FE	0.515	0.528	0.582	0.464	**0.771**	0.628
US	0.354	0.483	0.510	0.369	0.628	**0.771**

The results of the correlation analysis (see Table 5) indicate that all constructs are significantly correlated at the 0.01 level, with correlation coefficients ranging from 0.354 to 0.628. To test for multicollinearity, variance inflation factors (VIFs) and R^2 were calculated (see Table 6). All VIF values were below the recommended threshold of 5, indicating that multicollinearity is not a serious issue in this study [47]. According

to the results of Perceived Control and Flow Experience has corresponding explanation, which represents the prediction capabilities: 67.7% and 71.2%.

Table 5: Correlation Analysis

Variables	Mean	SD	PP	DC	T	PC	FE	US
Perceived Personalization	4.034	0.679	1					
Design Characteristics	3.939	0.718	0.582**	1				
Telepresence	3.148	1.048	0.457**	0.530**	1			
Perceived Control	3.876	0.674	0.405**	0.442**	0.398**	1		
Flow Experience	4.022	0.672	0.515**	0.528**	0.582**	0.464**	1	
User Stickiness	3.870	0.750	0.354**	0.483**	0.510**	0.369**	0.628**	1

Table 6: Results of VIF Test and R^2

Variables	VIF	R^2
Perceived Personalization	1.948	\
Design Characteristics	2.263	\
Telepresence	2.730	\
Perceived Control	2.000	0.677
Flow Experience	2.223	0.712

The overall validity of the measurement model was further assessed using exploratory factor analysis (EFA). The Kaiser-Meyer-Olkin (KMO) value was 0.919, and Bartlett's test of sphericity was significant ($p < 0.001$), indicating that the data were suitable for factor analysis (see Table 7). The EFA results (see Table 8) showed that six factors were extracted, explaining 70.702% of the total variance. The factor loadings of all items were above 0.5, and each item loaded significantly on its respective construct, demonstrating good convergent and discriminant validity [47].

Table 7: Overall Validity Test - Total Variance Explained

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.796	39.984	39.984	8.796	39.984	39.984
2	2.062	9.374	49.357	2.062	9.374	49.357
3	1.625	7.387	56.744	1.625	7.387	56.744
4	1.253	5.694	62.438	1.253	5.694	62.438
5	0.962	4.373	66.811	0.962	4.373	66.811
6	0.856	3.891	70.702	0.856	3.891	**70.702**
7	0.713	3.243	73.945			
8	0.591	2.686	76.631			
9	0.566	2.572	79.203			
10	0.550	2.500	81.703			
11	0.489	2.222	83.925			
12	0.470	2.134	86.060			
13	0.421	1.914	87.974			
14	0.377	1.714	89.688			
15	0.368	1.671	91.359			
16	0.338	1.538	92.897			
17	0.329	1.494	94.391			
18	0.290	1.316	95.707			
19	0.286	1.301	97.009			
20	0.243	1.107	98.115			
21	0.222	1.008	99.124			
22	0.193	0.876	100.000			

Table 8: Overall Validity Test - Factor Analysis Rotated Component Matrix Results

Factor	US	T	PP	PE	DC	PC
US5	0.807					
US2	0.782					
US3	0.781					
US4	0.667					
US1	0.644					
T3		0.850				
T2		0.796				
T4		0.786				
T1		0.660	~~0.430~~			
PP2			0.872			
PP3			0.778			
PP1			0.703			
PP4			0.672			
FE3				0.677		
FE1				0.575		
FE2	~~0.449~~			0.454		
DC2					~~0.810~~	
DC3		~~0.427~~		~~0.683~~		
DC1		~~0.436~~			~~0.615~~	
PC3						0.795
PC1						0.739
PC2						0.585

5.2 Structural model

In Table 9, the structural model analysis was performed using AMOS 29.0, and the structural model performed well for all fit indicators (RMSEA = 0.078, CMIN/DF = 2.330, TLI = 0.916, IFI = 0.926, and CFI = 0.926), which met and outperformed the reference standard and was suitable for further analysis and testing. The test results (see Fig. 4 and Table 10) showed that perceived personalization ($\beta = 0.220$, $p < 0.005$) and design characteristics ($\beta = 0.324$, $p < 0.001$) positively influenced perceived control; perceived control ($\beta = 0.284$, $p < 0.001$) and telepresence ($\beta = 0.461$, $p < 0.001$) positively influenced flow experience, while flow experience ($\beta = 0.591$, $p < 0.001$) positively influenced user stickiness. However, perceived control ($\beta = 0.093$, $p > 0.05$) did not have a significant effect on user stickiness. Thus, all hypotheses (H1 – H4, H6) were supported in this study, except for H5, which was not supported. In addition, the

explained variance in the study model was 9.0% for perceived control, 61.0% for flow experience, and 53.5% for user stickiness.

Table 9: Model Fit

Fit Indices	Obtained Value	Recommended Threshold	Evaluation
RMSEA	0.078	< 0.08	Good
CMIN/DF	2.330	< 3	Good
TLI	0.916	> 0.90	Good
IFI	0.926	> 0.90	Good
CFI	0.926	> 0.90	Good

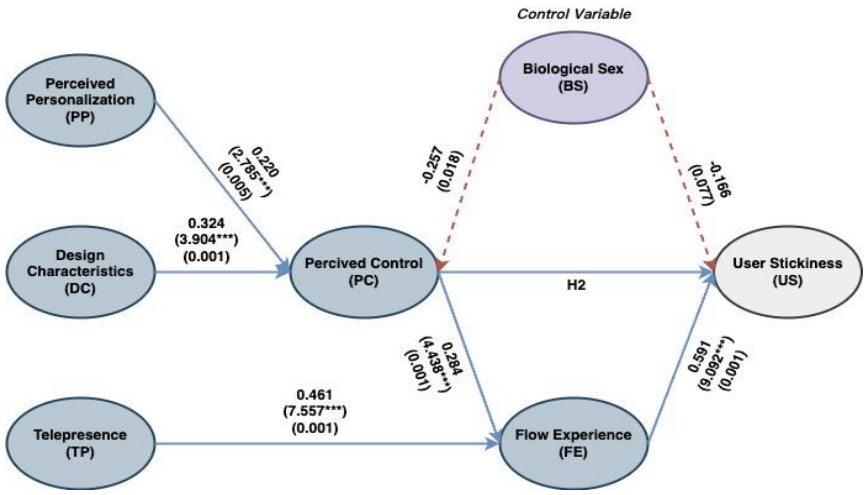

Fig.4. Structural model testing. Notes: '*' = p < 0.05, '**' = p < 0.01, and '***' = p < 0.001. Dashed lines indicate that this hypothesis is not supported.

Table 10: CB-SEM Hypothesis Testing

Hypothesis	Paths	β	Significance	Results
H1	FE → US	0.591	<0.001	Supported
H2	FE → CL	0.138	<0.01	Supported
H3	CL → US	0.632	<0.001	Supported
H4	PP → PC	0.220	<0.005	Supported
H5	DC → PC	0.324	<0.001	Supported
H6	TP → FE	0.461	<0.001	Supported
		Items		
Control Variables	Biological sex → PC	-0.257	<0.018	Supported
	Biological sex → US	-0.166	<0.077	Supported
	Age → PC	0.066	>0.05	Reject
	Age → FE	-0.120	>0.05	Reject
	Paths	β	Significance	Results
	Age → US	0.013	>0.05	Reject
	Education → PC	-0.029	>0.05	Reject
	Education → FE	0.010	>0.05	Reject
	Education → US	-0.091	>0.05	Reject
	Occupation → PC	0.156	>0.05	Reject
	Occupation → FE	0.046	>0.05	Reject
	Occupation → US	-0.250	>0.05	Reject
	Work income → PC	-0.045	>0.05	Reject
	Work income → FE	0.083	>0.05	Reject
	Work income → US	0.042	>0.05	Reject
	Occupation → PC	0.156	>0.05	Reject
	Occupation → FE	0.046	>0.05	Reject

5.3 Mediating model

To further validate the proposed paths showing how perceived control and flow experience affect the sustained intention to use short video, multiple sets of mediation tests were conducted using Hayes' PROCESS plug-in based on a bootstrap sample of 5000 [48]. The results (see Tables 10, 11 and 12) show that the indirect effects of perceived personalization and design characteristics on flow experience and user stickiness through perceived control were significant and played a partial mediating role. Additionally, the indirect effect of telepresence on user stickiness through flow experience was significant and played a partial mediating role, while the indirect effect

of perceived control on user stickiness through flow experience was significant and played a full mediating role.

Table 11: Results of Mediation Analysis (Direct Effects)

Path	β	SE	t	p	BLLCI	ULCI	Decision	Type
PP → PC → FE(US)								
PP → PC	0.220	0.079***	2.785	0.005	0.065	0.375	Supported	
PC → FE(US)	0.284	0.064**	4.438	0.000	0.158	0.410	Supported	**Partial mediation**
PP → FE(US)	0.515	0.060***	8.583	0.000	0.397	0.633	Supported	
Total effect of PP → FE(US)	0.577	0.062***	9.306	0.000	0.455	0.699	Supported	
DC → PC → FE(US)								
DC → PC	0.324	0.083***	3.904	0.000	0.161	0.487	Supported	
DC → FE(US)	0.528	0.060***	8.800	0.000	0.410	0.646	Supported	**Partial mediation**
Total effect of DC → FE(US)	0.620	0.062***	9.677	0.000	0.498	0.742	Supported	
TP → FE → US								
TP → FE	0.461	0.061***	7.557	0.000	0.341	0.581	Supported	
FE → US	0.591	0.065***	9.092	0.000	0.463	0.719	Supported	**Partial mediation**
TP → US	0.510	0.064***	7.969	0.000	0.384	0.636	Supported	
Total effect of T → US	0.782	0.057***	13.719	0.000	0.670	0.894	Supported	

Path	β	SE	t	p	BLLCI	ULCI	Decision	Type
PC → FE → US								
PC → FE	0.284	0.064***	4.438	0.000	0.158	0.410	Supported	**Full mediation**
FE → US	0.591	0.065***	9.092	0.000	0.463	0.719	Supported	
PC → US	0.093	0.067	1.388	0.167	-0.038	0.224	ns	
Total effect of PC → US	0.261	0.071***	3.676	0.000	0.122	0.400	Supported	

Note: * p < 0.05, ** p < 0.01, *** p < 0.001, ns = not significant

Table 12: Indirect Effects

Paths	Effect	SE	LLCI	ULCI	p	Decision
PP → PC → FE(US)	0.062	0.030	0.003	0.121	0.001	Supported
DC → PC → FE(US)	0.092	0.038	0.018	0.166	0.000	Supported
TP → FE → US	0.272	0.052	0.170	0.374	0.000	Supported
PC → FE → US	0.168	0.048	0.074	0.262	0.000	Supported

5.4 Difference tests

Difference tests were conducted to compare the effects of demographic variables and short video usage on the research variables. The results (see Tables 13 and 14) showed that gender had a significant effect on design characteristics ($t = -2.019$, $p < 0.05$), with females scoring higher than males. Whether users had purchased short video products or services had a significant effect on user stickiness ($t = 3.365$, $p < 0.001$), with purchasers scoring higher. Occupation had a significant effect on telepresence ($F = 4.435$, $p < 0.05$), with employed users scoring the highest. Income had a significant effect on flow experience ($F = 2.688$, $p < 0.05$), with users earning over 10,000 CNY scoring the highest.

Regarding short video usage, the duration of use had a significant effect on design characteristics ($F = 3.115$, $p < 0.05$), with users of less than half a year scoring the highest. The frequency of weekly use had significant effects on telepresence ($F = 3.258$,

$p < 0.05$) and user stickiness ($F = 9.670$, $p < 0.001$), with moderate users (3-5 times/week) scoring the highest on telepresence and the most frequent users (≥9 times/week) scoring the highest on stickiness. The average daily time spent on short video had a significant effect on user stickiness ($F = 10.884$, $p < 0.001$), with users spending more time scoring higher on stickiness (See Tables 15 and 16).

Table 13: Gender

Variable	Male (N=100)	Female (N=161)	t	p
Design Characteristics	3.82±0.803	4.012±0.651	-2.019*	0.045
Flow Experience	3.993±0.714	4.039±0.646	-0.537	0.592
Perceived Control	3.95±0.64	3.83±0.692	1.398	0.163
Perceived Personalization	4.033±0.689	4.035±0.675	-0.022	0.983
Telepresence	3.11±1.161	3.172±0.974	-0.467	0.641
User Stickiness	3.934±0.74	3.83±0.755	1.092	0.276

Note: * $p < 0.05$.

Table 14: Purchased Short Video Products or Services

Variable	Male (N=100)	Female (N=161)	t	p
Design Characteristics	3.943±0.737	3.933±0.693	0.103	0.918
Flow Experience	4.031±0.676	4.009±0.669	0.259	0.796
Perceived Control	3.907±0.61	3.833±0.754	0.847	0.398
Perceived Personalization	4.007±0.699	4.073±0.652	-0.776	0.438
Telepresence	3.149±1.093	3.148±0.989	0.010	0.992
User Stickiness	4.005±0.653	3.684±0.833	3.365***	0.001

Note: *** $p < 0.001$.

Table 15: ANOVA Test for Weekly Usage Frequency

Variable	< 1/wk	1-2/wk	3-5/wk	6-8/wk	≥ 9/wk	F	LSD Post-hoc
Perceived Personalization	4.088±0.727	4.089±0.617	4.038±0.678	4.139±0.624	3.966±0.716	0.585	
Design Characteristics	3.684±0.782	3.919±0.599	4.031±0.699	4.102±0.632	3.892±0.779	1.416	
Telepresence	2.895±0.929	3.211±0.953	3.491±0.959	3.34±1.052	2.935±1.101	3.258*	1<5<2<4<3
Perceived Control	3.737±0.927	3.83±0.673	3.925±0.659	4.074±0.597	3.83±0.652	1.231	
Flow Experience	3.877±0.869	4.037±0.644	3.987±0.592	4.231±0.651	3.988±0.685	1.211	
User Stickiness	3.105±0.795	3.587±0.804	3.917±0.688	3.994±0.702	4.057±0.651	9.670***	1<2<3<4<5

Note: * p < 0.05, *** p < 0.001.

Table 16: ANOVA Test for Daily Usage Time

Variable	< 0.5 hr	0.5-1 hr	1-2 hrs	2-3 hrs	> 3 hrs	F	LSD Post-hoc
Perceived Personalization	4.139±0.637	3.949±0.602	4.067±0.695	4.063±0.699	3.931±0.879	0.768	
Design Characteristics	3.778±0.843	3.94±0.58	3.991±0.651	3.929±0.805	4.111±0.849	1.053	
Telepresence	3.302±1.054	2.976±0.96	3.26±0.971	3.042±1.163	3.198±1.285	1.083	
Perceived Control	3.903±0.756	3.94±0.648	3.844±0.623	3.762±0.696	3.931±0.715	0.558	
Flow Experience	3.917±0.855	3.986±0.622	4.084±0.613	3.96±0.59	4.25±0.697	1.294	
User Stickiness	3.421±0.872	3.719±0.72	4.024±0.607	4.067±0.612	4.392±0.653	10.884***	1<2<3<4<5

Note: *** p < 0.001.

5.5 Control variables

The effects of control variables (biological sex, age, education, occupation, and income) on perceived control, flow experience, and user stickiness were tested in the structural equation model (see Table 10). The results showed that only biological sex had

significant effects on perceived control ($\beta = -0.257$, $p < 0.018$) and user stickiness ($\beta = -0.166$, $p < 0.077$), while the other control variables had no significant effects ($p > 0.05$). Therefore, age, education, occupation, and income were removed from the final model.

5.6 Hypothesis testing

The hypothesis testing results are summarized in Table 10. The results support H1, indicating that perceived personalization positively influences perceived control ($\beta = 0.220$, $p < 0.005$). H2 is also supported, showing that design characteristics positively affect perceived control ($\beta = 0.324$, $p < 0.001$). The results also support H3, confirming that telepresence positively influences flow experience ($\beta = 0.461$, $p < 0.001$). H4 is supported, indicating that perceived control positively affects flow experience ($\beta = 0.284$, $p < 0.001$). However, H5 is not supported, as perceived control does not have a significant direct effect on user stickiness ($\beta = 0.093$, $p > 0.05$). Finally, H6 is supported, showing that flow experience positively influences user stickiness ($\beta = 0.591$, $p < 0.001$).

The mediation analysis results (see Tables 10 and 11) provide further insights into the relationships among the variables. The indirect effects of perceived personalization and design characteristics on flow experience and user stickiness through perceived control are significant, indicating partial mediation. Similarly, the indirect effect of telepresence on user stickiness through flow experience is significant, suggesting partial mediation. Interestingly, while perceived control does not have a significant direct effect on user stickiness, it has a significant indirect effect through flow experience, indicating full mediation.

6 DISCUSSION

This study aimed to investigate the factors influencing user stickiness in the context of short video application, focusing on the roles of perceived personalization, design characteristics, telepresence, perceived control, and flow experience. The study provides a more nuanced understanding of the antecedents of flow experience and user stickiness, highlighting the importance of perceived personalization, design characteristics, telepresence, and perceived control in fostering flow experience and user retention. The findings also shed light on the psychological mechanisms underlying users' continued engagement with short video applications, emphasizing the

central role of flow experience in mediating the relationship between perceived control and user stickiness.

First, the results indicate that perceived personalization and design characteristics have positive effects on perceived control, which in turn positively influences flow experience. These findings are consistent with previous research suggesting that personalized content and user-friendly interface design can enhance users' sense of control and facilitate flow experience [6, 19]. The study highlights the importance of providing tailored content recommendations and designing intuitive and visually appealing interfaces to enhance users' sense of control and foster flow experience in short video applications.

Second, the study reveals that telepresence has a significant positive effect on flow experience, which is in line with prior research indicating that a sense of presence in a virtual environment can contribute to the optimal experience of flow [8, 16]. This finding suggests that creating a vivid and immersive virtual environment can help users become fully absorbed in the short video application, leading to a more engaging and enjoyable experience.

Third, the results show that flow experience has a significant positive effect on user stickiness, which is consistent with the findings of previous studies [4, 12]. This highlights the crucial role of flow experience in fostering users' continued engagement and loyalty towards short video applications. When users experience a state of flow, characterized by intense concentration, enjoyment, and temporal dissociation, they are more likely to develop a strong attachment to the application and continue using it in the future.

Fourth, the study finds that perceived control has a significant indirect effect on user stickiness through the mediation of flow experience, although its direct effect is not significant. This finding extends previous research by highlighting the central role of flow experience in linking perceived control to user stickiness [10]. It suggests that perceived control alone may not be sufficient to retain users, but rather it is the experience of flow, facilitated by a sense of control, that ultimately drives users' continued engagement with short video applications.

7 CONCLUSION

7.1 Theoretical Implications

This study makes several contributions to the literature on user stickiness in mobile applications, particularly in the context of short video platforms. By integrating flow theory [9] with the unique functional characteristics of short video applications, such as perceived personalization, design characteristics, and telepresence, this research provides an exploratory framework for understanding the factors that drive user stickiness in this rapidly growing domain.

One of the key theoretical implications of this study is the extension of flow theory to the context of short video applications. While previous research has explored the role of flow in various online contexts, such as e-commerce [10], gaming [9], and social media [23], this study is to demonstrate the applicability of flow theory in explaining user stickiness in short video platforms. By showing that flow experience is a critical mediator between perceived control and user stickiness, this study highlights the importance of creating conditions that facilitate the optimal state of flow, characterized by intense concentration, enjoyment, and temporal dissociation [9].

For the study, by identifying perceived personalization, design characteristics, and telepresence as key antecedents of flow experience and user stickiness in short video applications. While previous studies have examined the role of personalization [6], design aesthetics [19], and immersion [16] in various online contexts, this research is the first to integrate these factors into a comprehensive model of user stickiness in short video platforms.

Another important theoretical implication of this study is the revelation of the mediating role of flow experience in the relationship between perceived control and user stickiness. While previous research has suggested that perceived control is an important factor in driving user engagement [10, 16], this study demonstrates that the effects of perceived control on user stickiness are fully mediated by flow experience in the context of short video applications.

7.2 Practical Implications

First, the results highlight the critical importance of perceived personalization in fostering flow experience and user stickiness. As users increasingly expect tailored

content and recommendations that cater to their unique preferences and interests, designers and managers of short video applications must prioritize the development of advanced algorithms and data analytics capabilities that can deliver highly personalized user experiences [6]. This may involve leveraging machine learning techniques to analyze user behavior, social networks, and content consumption patterns, and using this data to generate individualized content feeds and recommendations [49, 50]. By investing in personalization technologies and strategies, short video platforms can create a more engaging and immersive user experience that keeps users coming back for more.

In addition to personalization, the findings of this study underscore the importance of design characteristics in driving flow experience and user stickiness. To create a more engaging and immersive user experience, designers of short video applications should focus on creating visually appealing, intuitive, and user-friendly interfaces that promote a sense of control and mastery [19]. This may involve using eye-catching graphics, animations, and visual effects to capture users' attention, as well as designing clear and consistent navigation structures that allow users to easily browse and discover new content [24]. By prioritizing design aesthetics and usability, short video platforms can create a more satisfying and enjoyable user experience that encourages prolonged engagement and loyalty.

Furthermore, the results of this study highlight the importance of telepresence in facilitating flow experience and user stickiness. To create a more immersive and engaging user experience, managers of short video applications should invest in technologies and features that promote a sense of presence and connection with the virtual environment [16]. This may involve using virtual reality or augmented reality technologies to create more realistic and interactive video experiences [10] or incorporating social features that allow users to connect and interact with other users in real-time [2]. By fostering a sense of telepresence and social connectedness, short video platforms can create a more engaging and sticky user experience that keeps users invested in the application.

Finally, the findings of this study suggest that managers of short video applications should focus on creating opportunities for users to experience flow by providing clear goals, immediate feedback, and a balance between challenge and skill [9]. This may

involve designing interactive features and challenges that encourage users to fully immerse themselves in the application, such as quizzes, games, or creative tasks that require focus and skill development [38]. By providing users with a sense of accomplishment and mastery, short video platforms can foster a more engaging and rewarding user experience that drives long-term stickiness and loyalty.

7.3 Limitations and Future Scope

This study, while contributive, has limitations that offer avenues for future research. To address the sample's restriction to Chinese users, future studies should employ multi-country surveys and cross-cultural experiments, utilizing tools like Hofstede's cultural dimensions to examine how cultural factors moderate user stickiness. The cross-sectional design's potential common method bias could be mitigated through longitudinal panel studies, collecting data at multiple time points (e.g., every three months over a year) to track behavioral changes. Researchers could combine in-depth interviews and focus groups with quantitative methods in a mixed-method approach, providing richer insights into user motivations. To overcome self-report biases, future studies should incorporate objective data from app usage logs, such as daily active time, interaction frequency, and content creation metrics, obtained through collaborations with platform providers or by developing tracking apps [51, 52, 53]. The limited factor set can be expanded by conducting exploratory factor analysis on a comprehensive list of potential variables, followed by confirmatory factor analysis to validate new constructs. To investigate emerging technologies' impact, A/B testing of AR/VR features in short video apps could be performed. Experimental designs manipulating key variables (e.g., personalization levels, interface designs) in controlled settings would help establish causality. Advanced statistical techniques like cross-lagged panel analysis could better elucidate the dynamic relationships between variables. To explore potential negative impacts, researchers could use standardized psychological scales (e.g., addiction inventories, well-being measures) in conjunction with usage data. Business model influences could be studied through comparative analyses of different monetization strategies (e.g., ad-supported vs. subscription-based) and their effects on user engagement [54, 55, 56]t. Cross-platform comparisons could employ social network analysis to map user migration patterns between apps.

Interdisciplinary approaches, such as combining psychological theories with machine learning algorithms for content analysis, could provide novel insights. Researchers

could employ machine learning algorithms for content analysis, utilizing computer vision and natural language processing (NLP) to analyze visual elements, captions, and user comments, integrating these findings with motivational theories. Emotion recognition software could capture real-time user responses, correlating with engagement metrics and psychological constructs [57, 58]. Social network analysis and graph neural networks could map content spread and predict user behavior. Time series analysis, using ARIMA models or LSTM neural networks, could forecast engagement patterns and be integrated with habit formation theories. Multimodal analysis combining audio, visual, and textual data through deep learning techniques could identify influential elements driving user stickiness. Reinforcement learning algorithms could optimize content recommendations based on user behavior and psychological profiles. Big data analytics, leveraging frameworks like Apache Spark, could process large-scale user data, while advanced NLP techniques such as BERT or GPT models could analyze user-generated content. Topic modeling and word embedding techniques could uncover latent themes and semantic relationships in user text, correlating these with engagement metrics. Causal inference methods, including propensity score matching or instrumental variable analysis, could establish causal relationships between app features and user stickiness.

8 DECLARATIONS

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Competing Interests: The author declares no conflict of interest.

Consent for Publication: Writing consent was obtained from the individual involved in this study.

Author Statement: Due to the limited variables obtained in the study and constraints in the experimental design, although the sample size provided a somewhat representative research base, the lack of EEG and skin conductance tests prevented the acquisition of specific subjective research data. Additionally, given the severe time constraints, the value of this study is considerably limited. Consequently, in the limitations and future research section, I have highlighted these issues and, drawing inspiration from Professor Lisa Feldman Barrett of Northeastern University in the

United States, I have outlined potential operational methods for future research. This approach aims to inspire researchers to continue related studies in the field of digital marketing using these suggested methodologies.

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