



Mechanisms Underlying the Spillover Effect of Digital Green Behavior Among Civil Aviation Passengers

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Abstract. Driven by China's "dual carbon" strategy, leveraging digital technology to foster sustainable behaviors is vital for civil aviation's high-quality development. Grounded in self-perception, self-identity, and green behavior spillover theories, this study develops a dual-mediation framework to elucidate how digital green behavior drives spillover effect of green behavior of civil aviation passengers. Empirical analysis of 474 passengers demonstrates that digital green behavior exerts a significant positive impact on green behavior spillover, with green self-efficacy and green psychological climate acting as parallel mediators. Furthermore, perceived green culture in civil aviation is found to positively moderate both mediating pathways. This research is the first to systematically reveal the underlying mechanism of the transition from context-specific participation to continuous behavioral expansion through a digital empowerment lens. It provides a robust theoretical foundation and practical guidance for airlines to optimize digital intervention mechanisms, cultivate a green travel culture, and accelerate the industry's low-carbon transition.

Keywords: Digital green behavior, Green behavior spillover effect, Green psychological climate, Green self-efficacy, Perceived green culture in civil aviation.

1 Introduction

Achieving "dual carbon" strategy is vital for China's sustainable development^[1]. As a high-emission sector, the civil aviation industry is shifting toward high-quality growth under the 14th Five-Year Special Plan. With passenger volume exceeding 770 million in 2025, individual actions aggregate into significant environmental impacts, making green behavior spillover a critical transition driver^[2]. However, traditional unidirectional intervention paradigms fail to meet the demands of the digital era. While digital empowerment offers a key pathway for behavior quantification, visualization, and monetization, whether initial green attempts in digital contexts can generate "positive spillover effects" across scenarios remains an urgent theoretical puzzle to be solved.

Literature identifies green behavior spillover as a vital pathway for civil aviation's low-carbon transition. Xiao found that green activities activate environmental goals,

enhancing subsequent sustainable preferences and purchase intentions^[3]. Tao revealed how digital platforms, such as "Ant Forest," transform fragmented actions into socio-ecological benefits through real-time feedback and ritualized participation^[4]. Kitchen argued that fostering spillover effects facilitates a strategic shift from "unidirectional control" to "user value co-creation," thereby increasing governance efficiency^[5]. Furthermore, Yang confirmed that environmental attempts in digital contexts effectively induce subsequent physical pro-environmental behaviors^[6]. However, international research predominantly focuses on daily consumption, leaving highly regulated sectors like civil aviation under-explored. Similarly, domestic research on green behavior spillover remains in its infancy, and the "underlying mechanism" by which green behaviors translate into long-term governance efficiency through deep-seated psychological processes has yet to be systematically elucidated.

Therefore, this study investigates the spillover effects of digital green behavior among civil aviation passengers through a combination of theoretical and empirical approaches. By exploring the key influencing factors and formation mechanisms, this research not only extends the application boundaries of green behavior spillover theory within digital and aviation contexts but also provides theoretical support and managerial implications for airlines to build intelligent green governance mechanisms and foster long-term environmental habits among passengers.

2 Theoretical Analysis and Research Hypothesis

2.1 Digital Green Behavior and Green Behavior Spillover Effect

Green behavior spillover is essential for the systematic migration of environmental goals across contexts. Grounded in self-perception theory, digital tools transform implicit efforts into explicit digital assets, reinforcing passengers' self-attribution as "environmentalists"^[7]. This process reduces implementation costs and generates behavioral momentum. Furthermore, digital community interactions stimulate intrinsic motivation, while streamlined behavioral paths mitigate concerns over practice complexity, facilitating the extension of low-carbon habits to daily life. Accordingly, we propose:

H1: Digital green behavior among civil aviation passengers significantly and positively affects their green behavior spillover effect.

2.2 The Mediating Role of Green Self-Efficacy

Green self-efficacy, an individual's confidence in executing environmental actions, strongly predicts behavioral consistency^[8]. High-efficacy passengers perceive greater control, facilitating the positive transfer of green habits. Conversely, low efficacy diminishes the motivation for broader responsibilities. Digital platforms enhance this efficacy through real-time feedback, reinforcing individual contributions. As efficacy strengthens, passengers increasingly sustain pro-environmental practices across scenarios, manifesting a cross-contextual spillover tendency. Accordingly, we propose:

H2: Green self-efficacy positively mediates the relationship between digital green behavior among civil aviation passengers and green behavior spillover.

2.3 The Mediating Role of Green Psychological Climate

Green psychological climate refers to an individual's subjective perception of environmental values and advocacy within their surroundings^[9]. In digitized aviation, community interactions and honorary identifiers (e.g., eco-badges) reinforce organizational green orientation, fostering a positive climate. This climate significantly drives cross-contextual behavioral migration. Digitized interaction environments reshape passengers' attribution mechanisms and behavioral persistence. When passengers perceive consistent environmental advocacy, they develop psychological belonging and self-expectations, leading to sustained green choices across scenarios. Accordingly, we propose:

H3: Green psychological climate positively mediates the relationship between digital green behavior among civil aviation passengers and green behavior spillover.

2.4 The Moderating Role of Perceived Green Culture in Civil Aviation

Perceived green culture in civil aviation moderates the activation of internal psychological mechanisms by influencing identification with green initiatives. In high-perception contexts, digitized green services are viewed as value affirmations, stimulating green self-efficacy and a positive green psychological climate^[10]. Conversely, weak cultural perception leads passengers to dismiss such services as mere corporate strategies, weakening the mediating effects. Thus, perceived green culture serves as a critical moderator, forming a moderated mediation model. Accordingly, we propose:

H4a: Perceived green culture in civil aviation positively moderates the relationship between digital green behavior among civil aviation passengers and green self-efficacy.

H4b: Perceived green culture in civil aviation positively moderates the relationship between digital green behavior among civil aviation passengers and green psychological climate.

Based on the preceding analysis, this study posits that high levels of perceived civil aviation green culture strengthen the positive impact of digitized green behavior on the mediating variables, thereby enhancing the overall effectiveness of the mediation pathways^[11]. Accordingly, we propose:

H5a: Perceived green culture in civil aviation positively moderates the mediating effect of green self-efficacy between digital green behavior among civil aviation passengers and green behavior spillover.

H5b: Perceived green culture in civil aviation positively moderates the mediating effect of green psychological climate between digital green behavior among civil aviation passengers and green behavior spillover.

The theoretical model of this study is illustrated in Figure 1.

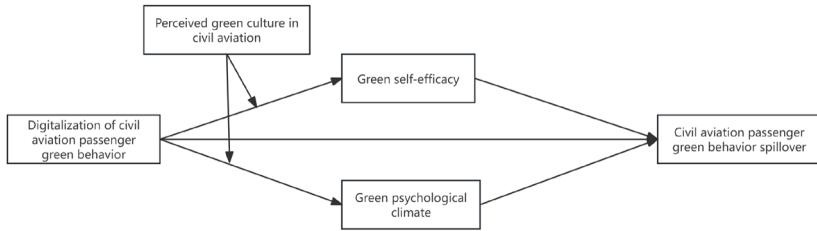


Fig. 1. The theoretical model.

3 Research design

3.1 Sample Selection and Data Collection

This study employed an online questionnaire to investigate digital green behavior spillover among civil aviation passengers. Of 480 responses, 474 were valid (98.75% effective rate). The sample comprised 52.74% males ($n=250$) and 47.26% females ($n=224$). Predominant age groups were 26–35 (35.65%) and 36–45 (24.89%), while those over 55 represented the smallest portion (8.23%). Regarding travel frequency, passengers flying 4–6 times annually constituted the largest segment (32.91%), followed by frequent travelers (11+ times, 28.69%), whereas infrequent travelers represented only 3.80%.

3.2 Variable Measurement

All variables were assessed using established scales adapted to the digital aviation context, employing a 5-point Likert scale (1 = "strongly disagree" to 5 = "strongly agree"). Digital green behavior was measured with a 5-item scale adapted from Melville^[12] and Li^[11] (Cronbach's $\alpha = 0.842$). Green behavior spillover (Cronbach's $\alpha = 0.865$) utilized a 6-item scale adapted from She^[11] and Maki^[7], covering within- and cross-domain dimensions. Green self-efficacy (5 items, Cronbach's $\alpha = 0.832$), green psychological climate (5 items, Cronbach's $\alpha = 0.820$), and perceived green culture (4 items, Cronbach's $\alpha = 0.800$) were measured using scales from Chen^[13], Chou^[14], and Zhang^[15], respectively. Gender, age, and flight frequency served as controls to account for exogenous influence.

4 Research Results

4.1 Common Method Bias and Discriminant Validity Tests

To address potential common method bias, Harman's single-factor test was performed. Six factors were extracted; the variance explained by the largest factor was 29.600% (below the 40% threshold), and the cumulative variance explained was 68.000% (above

60%). These results meet the testing criteria, suggesting that common method variance is not a significant concern in this study. Confirmatory factor analysis (CFA) results (Table 1) further confirmed that the five-factor model provided a superior fit ($\chi^2 = 268.385, df = 265, RMSEA = 0.005, CFI = 0.991, TLI = 0.990$), demonstrating robust discriminant validity among variables.

Table 1. Results of CFA analysis (N=474).

Model	χ^2	df	χ^2/df	RMSEA	IFI	CFI	TLI
Five-factor model	268.385	265	1.013	0.005	0.992	0.990	0.991
Four-factor model	2106.156	476	4.425	0.106	0.796	0.872	0.896
Three-factor model	2175.406	402	5.411	0.115	0.765	0.793	0.762
Two-factor model	2635.532	395	6.672	0.120	0.749	0.726	0.748
Unifactor model	2925.118	394	7.424	0.138	0.715	0.702	0.710

4.2 Descriptive Statistics and Correlation Analysis

Correlation results (Table 2) revealed that digital green behavior was significantly and positively correlated with green self-efficacy ($r = 0.257$), green psychological climate ($r = 0.216$), perceived green culture in civil aviation ($r = 0.278$), and green behavior spillover effect ($r = 0.378$; all $p < 0.01$). Additionally, green self-efficacy ($r = 0.321$) and green psychological climate ($r = 0.297$) showed significant positive correlations with spillover. These findings align with theoretical expectations, providing preliminary support for subsequent hypothesis testing.

Table 2. Results of the correlation analysis.

Variable name	M	SD	1	2	3	4	5
1.Digital green behavior	3.373	0.797	1				
2.Green behavior spillover effect	3.385	0.720	0.378**	1			
3.Green self-efficacy	3.265	0.828	0.257**	0.321**	1		
4.Green psychological climate	3.319	0.782	0.216**	0.297**	0.211**	1	
5.Perceived green culture in civil aviation	3.407	0.831	0.278**	0.282**	0.319**	0.237**	1

Note: N=474. ** Represents $p < 0.01$.

4.3 Hypothesis Testing.

Hypotheses were tested using stepwise regression and bootstrapping. Main effect results (Table 3) show that introducing digital green behavior (Model 2) increased R^2 from 3.0% to 17.3%, significantly impacting spillover ($\beta = 0.342, p < 0.001$), supporting H1. Regarding mediation, digital green behavior significantly affects green self-efficacy (Model 8: $\beta = 0.269, p < 0.001$). In Model 4, green self-efficacy impacts spillover ($\beta = 0.196, p < 0.001$) while the digital green behavior coefficient dropped to

0.290, supporting H2. Similarly, Models 11 and 6 confirm the mediating role of green psychological climate ($\beta = 0.215 \rightarrow 0.206, p < 0.001$), supporting H3. Further validation using the PROCESS macro shows that the 95% confidence intervals (CI) for both pathways—[0.030, 0.086] and [0.020, 0.073]—do not contain zero. These effects account for 16.37% and 13.16% of the total effect, respectively, providing further support for H2 and H3.

Models 9 and 12 reveal that the interaction terms between digital green behavior and perceived green culture in civil aviation significantly and positively predict both green self-efficacy ($\beta = 0.139, p < 0.01$) and green psychological climate ($\beta = 0.225, p < 0.001$). The interaction terms contributed a 1.1% increase in explained variance ($\Delta R^2 = 0.011$) for both mediators, confirming the positive moderating role of perceived green culture. Simple slope plots (Figures 2) further illustrate these effects. Thus, H4a and H4b are supported.

The moderated mediation results are summarized in Table 4. Bootstrapping analysis revealed that the indirect effect of green self-efficacy strengthened as perceived green culture in civil aviation increased (from M-1SD: effect = 0.064, 95% CI [0.040, 0.169] to M+1SD: effect = 0.414, 95% CI [0.320, 0.508]), with an index of moderated mediation of 0.041 (SE = 0.012, 95% CI [0.019, 0.067]), supporting H5a. Similarly, the mediating role of green psychological climate also significantly increased with higher perceived culture in civil aviation (from M-1SD: effect = 0.082, 95% CI [0.023, 0.187] to M+1SD: effect = 0.412, 95% CI [0.317, 0.508]). The corresponding index was 0.030 (SE = 0.011, 95% CI [0.011, 0.052]), supporting H5b.

Table 3. Results of regression analysis.

Model	Green behavior spillover effects among civil aviation passengers						Green self-efficacy			Green psychological climate		
	1	2	3	4	5	6	7	8	9	10	11	12
Control variable												
Sex	-0.13	-0.154	-0.107	-0.129	-0.143	-0.156*	-0.114	-0.12	-0.108	0.020	0.010	0.030
	g*	*		*	*	*		7				
Age	0.067	0.054	0.057*	0.049	0.073	0.061*	0.037	0.027	0.029	-0.022	-0.029	-0.021
	*	*			**							
Annual flight frequency	-0.04	-0.051	-0.043	-0.047	-0.040	-0.044*	-0.023	-0.02	-0.003	-0.033	-0.034	-0.006
	9*	**	*	**	*			5				
Argument												
Digital green behavior		0.342		0.290*		0.298**		0.269	0.174*		0.215	0.134*
		***		**		*		***	**		***	*
Metavariable												
Green self-efficacy			0.268*	0.196*								
			**	**								
Green psychological climate					0.273	0.206**						
					***	*						
Metavariable												
Perceived green culture in civil aviation									0.244*		0.149*	
									**		*	

Interaction												
Digital green behavior*									0.139*		0.225*	
Perceived green culture in civil aviation									*		**	
R^2	0.030	0.173	0.124	0.220	0.117	0.220	0.009	0.075	0.153	0.007	0.055	0.128
ΔR^2	0.006	0.007	0.007	0.009	0.007	0.008	0.007	0.008	0.011	0.007	0.009	0.011
F	4.857	24.46	16.661	26.340	15.59	26.413*	1.372	9.544	14.033	1.026	6.761	11.446
	**	7***	***	***	3***	**		***	***		***	***

Note: N = 474. *p < 0.05, **p < 0.01, ***p < 0.001.

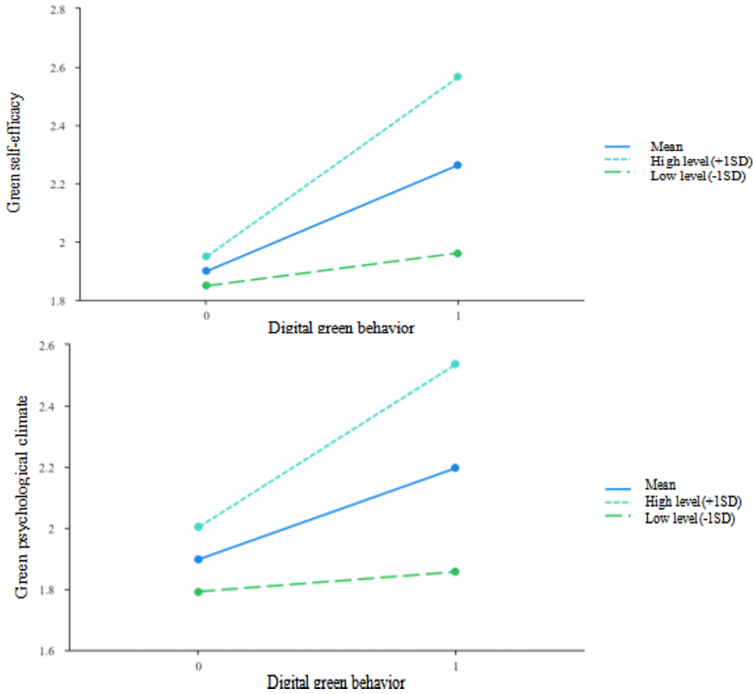


Fig. 2. The moderating effect of perceived green culture in civil aviation on the relationship between digital green behavior and green self-efficacy/green psychological climate.

Table 4. The regulated mediation effect test of perceived green culture in civil aviation.

Perceived green culture in civil aviation	Index	Boot	95%Boot	95%Boot
		SE	LLCI	ULCI
Green self-efficacy	0.041	0.012	0.019	0.067
Green psychological climate	0.030	0.011	0.011	0.052

5 Conclusion and Discussion

5.1 Research Conclusions

This study investigates the formation mechanism of digital green behavior spillover among civil aviation passengers. It identifies green self-efficacy and green psychological climate as mediators, while establishing the moderating role of perceived green culture. The key conclusions are as follows:

1. Digital green behavior significantly drives green behavior spillover. Digital platforms lower participation barriers through visual feedback, facilitating the positive migration of low-carbon practices from aviation to daily life.

2. Green self-efficacy and psychological climate mediate the relationship between digital green behavior and green behavior spillover. Digital empowerment facilitates the internalization of green motivation by enhancing environmental confidence and climate alignment.

3. Perceived green culture in civil aviation exerts a robust moderating effect. A strong industry green culture strengthens the impact of digital green behavior on psychological mechanisms and amplifies the overall governance efficiency of digital tools.

4. Green behavior spillover among civil aviation passengers results from multi-level synergy. Digital green behavior serves as the initial trigger, psychological mechanisms drive behavioral internalization, and perceived green culture reinforces this causal chain, forming a systemic mechanism.

5.2 Management Implications and Recommendations

This research provides significant theoretical and practical insights for the civil aviation industry to facilitate passenger green behavior spillover and low-carbon transformation through digital means. Based on empirical findings, this paper proposes recommendations across four dimensions—digital empowerment, efficacy cultivation, climate construction, and cultural perception:

First, construct digital empowerment mechanisms by leveraging platforms to lower participation barriers and transforming abstract actions into perceivable digital assets (e.g., carbon points) linked to membership benefits. Second, cultivate green self-efficacy by decomposing macro emission goals into micro-units—such as carbon savings per electronic boarding pass—to enhance "behavioral effectiveness." Third, create a green psychological climate via "eco-pioneer" stories and social interaction functions to strengthen group identity and reduce the psychological costs of pro-environmental actions. Finally, enhance perceived green culture by releasing verifiable sustainability data and embedding green symbols into service processes to build a "co-creation community," ensuring green habits stably integrate into daily life.

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References

1. International Air Transport Association (IATA). (2026). <https://www.iata.org/>.
2. Civil Aviation Administration of China (CAAC). (2026). <https://www.caac.gov.cn/index.html>.
3. Xiao, R. Y. Research on digital empowerment for green development of civil aviation enterprises [D]. Civil Aviation University of China. DOI:10.27627/d.cnki.gzmhy.2023.000087 (2023).
4. Tao, M. M. Mechanism research on the spillover effect of pro-environmental behavior [D]. Guizhou University of Finance and Economics. DOI:10.27731/d.cnki.ggzcj.2023.000116 (2023).
5. J. P K. Encyclopedia of tourism management and marketing[J].Journal of Marketing Communications, 30(4): 529-529. DOI:10.1080/13527266.2022.2151770 (2024).
6. Yang, B. From "Virtual" to "Real": The spillover mechanism of digital green behavior on actual pro-environmental behavior[D], Guangxi Normal University. DOI:10.27036/d.cnki.ggxsu.2025.001453 (2025).
7. Maki A, Carrico R A, Raimi T K, et al. Meta-analysis of pro-environmental behaviour spillover[J]. Nature Sustainability, 2(4): 307-315.DOI:10.1038/s41893-019-0263-9 (2019)
8. Ones S D, Dilchert S. Environmental Sustainability at Work: A Call to Action[J]. Industrial and Organizational Psychology, 5(4): 444-466. DOI:10.1111/j.1754-9434.2012.01478.x (2012).
9. Ruepert M A, Keizer K, Steg L. The relationship between Corporate Environmental Responsibility, employees' biospheric values and pro-environmental behaviour at work[J]. Journal of Environmental Psychology, 54:65-78. DOI:10.1016/j.jenvp.2017.10.006 (2017).
10. S M K, Sid T. Encouraging pro-environmental behavior in university employees: An approach toward environmental sustainability as moderated by green organizational culture. [J]. Journal of community psychology, 50(3): 1454-1469.DOI:10.1002/JCOP.22726 (2021).
11. She, S. X., Li, S. C., Hou, Z. P., et al. Nudging Strategy and Mechanism of Digital Green Behavior Spillover: A Study Based on Ant Forest Context. Foreign Economics & Management,46(07), 38-52. DOI:10.16538/j.cnki.fem.20230525.401 (2024).
12. Melville P N. Information Systems Innovation for Environmental Sustainability[J].MIS Quarterly, 34 (1):1-21. <https://doi.org/10.2307/20721412> (2010).
13. Chen M, Tung P. Developing an extended Theory of Planned Behavior model to predict consumersâ intention to visit green hotels[J]. International Journal of Hospitality Management, 36:221-230. DOI:10.1016/j.ijhm.2013.09.006 (2014).
14. Chou C. Hotels' environmental policies and employee personal environmental beliefs: Interactions and outcomes[J]. Tourism Management, 40:436-446. DOI:10.1016/j.tourman.2013.08.001 (2014).
15. Zhang, D. D. Research on the impact of environmental regulation on the green development behavior and performance of new agricultural management entities: The moderating role of green culture[D]. Jiangsu University. DOI:10.27170/d.cnki.gjsuu.2023.001217 (2023).

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