Transformational Leadership and Green Transportation Participation Behavior: Parallel Mediation Through Digital Transformation and Sustainability Awareness and the Contingent Role of Government Support

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ABSTRACT

Transport decarbonization depends not only on infrastructure and technology but also on individuals' sustained adoption of lower-carbon mobility. Drawing on transformational leadership theory (Bass & Avolio, 1994), the resource-based view (Barney, 1991), dynamic capability theory (Teece, 2007), and the theory of planned behavior (Ajzen, 1991), this study examines how transformational leadership influences green transportation participation behavior through digital transformation and sustainability awareness. Survey data from 512 employees and managers in Vietnam were analyzed using partial least squares structural equation modeling with 5,000 bootstrap resamples (Hair et al., 2022). Transformational leadership positively affected digital transformation (β = 0.709), sustainability awareness (β = 0.613), and green transportation participation behavior (β = 0.290). Digital transformation (β = 0.205) and sustainability awareness (β = 0.307) also significantly increased participation behavior. Both indirect effects were significant through digital transformation (β = 0.145) and sustainability awareness (β = 0.188). The model explained 48.6% of the variance in green transportation participation behavior. Government support had a small positive direct effect (β = 0.106), whereas its moderating effects were nonsignificant. These findings demonstrate that transformational leadership promotes sustainable mobility through complementary capability-building and cognitive pathways, while government support appears to operate as an independent institutional condition rather than strengthening these relationships.

Keywords: transformational leadership; digital transformation; sustainability awareness; green transportation participation behavior; government support; sustainable mobility.

INTRODUCTION

The decarbonization of transportation is central to the global sustainability transition. Energy-related carbon dioxide emissions reached nearly 38.4 billion tonnes in 2025, while road transport generated slightly more than 6 billion tonnes in 2024, with passenger cars and vans accounting for over 60% of road-sector emissions (IEA, 2025, 2026). These figures indicate that technological advances in vehicles and fuels must be accompanied by sustained changes in mobility behavior. Public transportation, walking, cycling, shared mobility, electric mobility, and reduced dependence on fossil-fuel vehicles can lower emissions, congestion, energy consumption, and local air pollution. However, these alternatives generate environmental benefits only when individuals consider them feasible, legitimate, and suitable for repeated use. Green transportation participation behavior is therefore a critical outcome linking climate policy, organizational sustainability, and everyday mobility decisions.

Sustainable mobility research has traditionally emphasized infrastructure, travel costs, service quality, urban form, and public policy. Although these factors remain important, they do not fully explain why individuals facing similar transportation options make different choices. Environmental awareness, perceived benefits, social expectations, and policy incentives influence low-carbon travel intentions and behavior (He et al., 2024; Waqas et al., 2018). Digital technologies further shape mobility decisions by making routes, schedules, prices, emissions, and shared services more visible and accessible. Digital maps, integrated ticketing, mobility

platforms, and carbon-feedback systems can reduce information barriers and facilitate greener choices (Gong & Ribiere, 2021; Zhang et al., 2024). Nevertheless, digital access, environmental cognition, and institutional conditions are often examined separately, leaving their organizational origins insufficiently understood.

Organizations constitute an important but underexplored setting for sustainable mobility. Employers influence commuting norms, parking policies, travel reimbursement, remote-working arrangements, information access, and participation in sustainability programs. Transformational leaders can articulate a shared environmental vision, allocate resources to digital systems, encourage experimentation with alternative mobility, and legitimize behavioral change. Through idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration, transformational leadership supports organizational transformation and employee engagement (Bass, 1985; Bass & Avolio, 1994; Burns, 1978). Prior studies indicate that environmentally oriented leadership strengthens environmental awareness and employee pro-environmental behavior (Le et al., 2024; Ren et al., 2024; Robertson & Barling, 2013). However, whether general transformational leadership shapes employees' green transportation participation remains unclear.

This study proposes two complementary mechanisms. First, digital transformation enables organizations to redesign communication, decision-making, and value creation through digital technologies (Gong & Ribiere, 2021; Verhoef et al., 2021; Vial, 2019), thereby reducing practical barriers to sustainable mobility. Second, sustainability awareness increases understanding of environmental consequences, carbon reduction, and sustainable transportation benefits, strengthening the attitudes and moral relevance underlying pro-environmental action (Ajzen, 1991; Kollmuss & Agyeman, 2002). Government support may additionally provide infrastructure, incentives, legitimacy, and policy continuity (DiMaggio & Powell, 1983; Scott, 2014). Vietnam offers a relevant context because Decision No. 876/QD-TTg established a national program for green energy transition and transport-sector emission reduction toward net zero by 2050 (Vietnam, 2022).

Using survey data from 512 Vietnamese employees and managers and PLS-SEM, this study tests whether transformational leadership directly predicts green transportation participation, whether digital transformation and sustainability awareness operate as parallel mediators, and whether government support moderates their behavioral effects. The study extends leadership theory into sustainable mobility, integrates capability-based and cognitive explanations, compares two simultaneous indirect pathways, and distinguishes the direct enabling role of government support from its potential moderating role in an emerging-economy context.

Theoretical Background and Hypothesis Development

An integrated theoretical framework

The model combines five theoretical lenses because no single theory fully explains the movement from leadership to green transportation behavior. Transformational leadership theory explains how leaders change followers' meaning systems, aspirations, and willingness to depart from established routines. The resource-based view treats leadership and organizational knowledge as valuable intangible resources that can support strategic change (Barney, 1991). Dynamic capability theory explains how leaders help organizations sense opportunities, seize digital possibilities, and reconfigure resources under technological and environmental change (Teece, 2007; Teece et al., 1997). The theory of planned behavior provides a behavioral logic through which awareness and evaluative beliefs contribute to intention and action (Ajzen, 1991). Institutional theory locates these organizational and behavioral processes within public rules, incentives, infrastructure, and legitimacy systems (DiMaggio & Powell, 1983; Scott, 2014).

The integration follows a resource-capability-cognition-behavior sequence, while allowing more than one route from leadership to behavior. Transformational leadership is the initiating strategic and social resource. Digital transformation represents a capability that can reduce practical frictions and expand access to mobility information and services. Sustainability awareness is a cognitive resource that clarifies why low-carbon travel is desirable. Green transportation participation behavior is the focal outcome, encompassing the use or support of public transport, walking, cycling, shared mobility, and reduced reliance on fossil-fuel vehicles. Government support is an institutional condition expected to make digital and cognitive resources more consequential. This

structure avoids treating digitalization as automatically sustainable or awareness as automatically behavioral; instead, it tests whether both mechanisms have distinct empirical effects.

Transformational leadership and green transportation participation behavior

Transformational leaders influence behavior by articulating a meaningful future, modeling valued conduct, stimulating new ways of thinking, and responding to followers' individual needs (Bass, 1985; Bass & Avolio, 1994). These mechanisms can apply to transportation choices when leaders connect commuting and business travel to organizational sustainability goals. A leader who publicly uses lower-carbon modes, endorses flexible work or collective transport, recognizes employee initiatives, and frames mobility as part of corporate responsibility can alter descriptive and injunctive norms. Idealized influence gives green travel symbolic legitimacy; inspirational motivation links personal choices to a shared environmental purpose; intellectual stimulation invites employees to reconsider habitual car or motorcycle use; and individualized consideration helps address practical constraints faced by different employees.

Evidence from environmental leadership research supports this extension. Environmentally specific transformational leadership predicts employee environmental awareness and pro-environmental performance, while leadership role modeling and green vision can activate employees' environmental passion and voluntary behavior (Ren et al., 2024; Robertson & Barling, 2013). Vietnamese research further shows that green transformational leadership contributes to environmental and firm performance through green organizational mechanisms (Le et al., 2024). Although transportation participation occurs partly outside formal job duties, it is still shaped by organizational values, commuting programs, and leader communication. A positive direct relationship is therefore expected even after accounting for digital transformation and sustainability awareness.

H1. Transformational leadership positively influences green transportation participation behavior.

Transformational leadership and digital transformation

Digital transformation involves more than purchasing technology. It is a strategic change in how an organization configures processes, data, communication, relationships, and value creation through digital technologies (Gong & Ribiere, 2021; Verhoef et al., 2021; Vial, 2019). Such transformation requires direction, resource mobilization, learning, experimentation, and the management of resistance. Transformational leadership is suited to these requirements because it creates a credible vision of change and gives employees psychological permission to challenge established routines. Leaders can prioritize digital investments, coordinate functions, support skill development, and protect experimentation from premature failure.

From a dynamic capability perspective, leaders help organizations sense relevant technologies, seize opportunities, and reconfigure assets and routines (Teece, 2007). Warner and Wäger (2019) describe digital transformation as an ongoing process of strategic renewal supported by digital sensing, seizing, and transforming capabilities. Recent work on green digital transformational leadership similarly finds that leadership can foster a green digital mindset and green digital transformation (Alabdali et al., 2024). In the transportation domain, leadership support can enable integrated communication tools, digital commuting surveys, route-planning resources, shared-mobility partnerships, remote-work systems, or carbon-monitoring dashboards. Transformational leadership should therefore be associated with a higher level of perceived digital transformation.

H2. Transformational leadership positively influences digital transformation.

Transformational leadership and sustainability awareness

Sustainability awareness refers to an individual's understanding of environmental challenges, the consequences of carbon-intensive activities, and the contribution of sustainable choices to ecological and social well-being. Awareness is not simply exposure to information. It involves the salience, interpretation, and personal relevance of environmental consequences. Leaders influence this cognition by selecting issues for attention, framing them within organizational purpose, and reinforcing them through decisions and symbols. Transformational leaders

can explain why emissions reduction matters, connect abstract climate goals to employees' daily travel, and present sustainable mobility as both feasible and morally meaningful.

Leadership research provides evidence for this cognitive route. Ren et al. (2024) found that environmentally specific transformational leadership strengthened employee environmental awareness, which in turn improved pro-environmental performance. Robertson and Barling (2013) likewise showed that leaders influence employee environmental behavior through psychological mechanisms. These findings fit the idea that leaders shape interpretive frames before behavior changes. In transportation, leaders can raise awareness of the environmental effects of commuting, business travel, idling, and vehicle choice, while also drawing attention to public transport, walking, cycling, and electric or shared mobility. Transformational leadership is thus expected to enhance sustainability awareness even when the leadership scale is broader than an explicitly green leadership measure.

H3. Transformational leadership positively influences sustainability awareness.

Digital transformation and green transportation participation behavior

Digital transformation can affect mobility behavior by changing the cost and quality of decision making. Before a trip, digital tools can provide route alternatives, service schedules, waiting times, fares, weather conditions, walking connections, bicycle availability, ride-sharing options, and charging locations. During a trip, real-time updates reduce uncertainty and improve perceived control. After a trip, digital records or carbon feedback can reinforce learning. These functions matter because individuals often continue using high-carbon modes not only because of preference but also because alternatives seem complex, unreliable, or difficult to coordinate.

The relationship is consistent with dynamic capability theory at both organizational and user levels. Organizations that integrate data, digital platforms, and communication systems can create an environment in which sustainable travel options are easier to discover and use. Zhang et al. (2024) showed that low-carbon functions in digital maps can support awareness and behavioral change toward green transportation. Digital transformation may also enable remote or hybrid work, digital meetings, flexible scheduling, and mobility-as-a-service partnerships, thereby reducing unnecessary trips or private-vehicle dependence. Nevertheless, digitalization is not inherently green; it should have a positive behavioral effect when the adopted tools increase the accessibility, convenience, and transparency of sustainable options.

H4. Digital transformation positively influences green transportation participation behavior.

Sustainability awareness and green transportation participation behavior

The theory of planned behavior proposes that behavior is proximally related to intention, which is shaped by attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991). Sustainability awareness can strengthen the attitudinal component by making the consequences of travel choices more visible and by increasing the perceived benefits of low-carbon modes. Awareness of emissions, air pollution, resource use, and urban congestion can change the evaluation of private fossil-fuel travel, while awareness of health and collective benefits can improve evaluations of walking, cycling, public transport, and shared mobility.

Awareness alone is not a guarantee of action, as the environmental behavior literature has long recognized an attitude-behavior gap (Kollmuss & Agyeman, 2002). Yet awareness remains a necessary cognitive foundation when alternatives are available and barriers are manageable. Sustainable transportation studies find that perceived benefits, environmental concern, attitudes, incentives, and social norms are associated with the acceptance or intention to use low-carbon modes (He et al., 2024; Waqas et al., 2018). In an organizational setting, sustainability awareness may also interact with identity and shared values: employees who understand the environmental significance of travel are more willing to support corporate mobility initiatives and adjust personal routines. A positive direct relationship is therefore expected.

H5. Sustainability awareness positively influences green transportation participation behavior.

Parallel mediating roles of digital transformation and sustainability awareness

A mediation perspective specifies how transformational leadership reaches behavioral outcomes. Leadership may influence green transportation directly, but part of its effect should operate through resources that make behavior easier and more meaningful. Digital transformation is an enabling-capability mediator. Transformational leaders mobilize attention and resources for digital change; digital systems then reduce informational and coordination barriers to sustainable mobility. This route is grounded in the resource-based view and dynamic capability theory because leadership helps build a capability that subsequently supports behavioral adaptation. The indirect effect does not require employees to become deeply environmentally committed; it can arise because green options become more convenient, visible, and controllable.

Sustainability awareness is a cognitive mediator. Transformational leaders shape values, issue salience, and collective purpose; employees then apply this understanding to transportation choices. This route is grounded in transformational leadership theory and the theory of planned behavior because leadership changes beliefs and evaluations that influence action. It also reflects evidence that environmental awareness transmits the effect of environmentally specific transformational leadership to pro-environmental performance (Ren et al., 2024). Unlike a serial model, the present framework does not require digital transformation to precede awareness. Organizations can build awareness through communication, role modeling, training, and sustainability narratives independently of digital capability.

Testing the mediators in parallel has theoretical and practical advantages. It separates a capability pathway from a cognition pathway and permits their magnitudes to be compared while controlling for each other. A significant digital indirect effect would indicate that leadership generates behavior partly by improving the enabling environment. A significant awareness indirect effect would indicate that leadership generates behavior partly by changing how employees understand sustainability. Because both routes can coexist with a remaining direct effect, the expected pattern is complementary partial mediation rather than complete mediation.

H6a. Digital transformation mediates the positive relationship between transformational leadership and green transportation participation behavior.

H6b. Sustainability awareness mediates the positive relationship between transformational leadership and green transportation participation behavior.

Moderating role of government support

Government support represents perceived public commitment to green transportation through infrastructure, policies, incentives, awareness campaigns, regulation, and investment. Institutional theory suggests that such support can provide resources, reduce uncertainty, and legitimize behavior (DiMaggio & Powell, 1983; Scott, 2014). In emerging transportation systems, digital tools may have limited behavioral value if services are fragmented, charging or cycling infrastructure is unavailable, or public transport is unreliable. Strong government support should make digital information more actionable because the underlying alternatives exist and are credible. It can also signal continuity, encouraging organizations and individuals to invest in new routines.

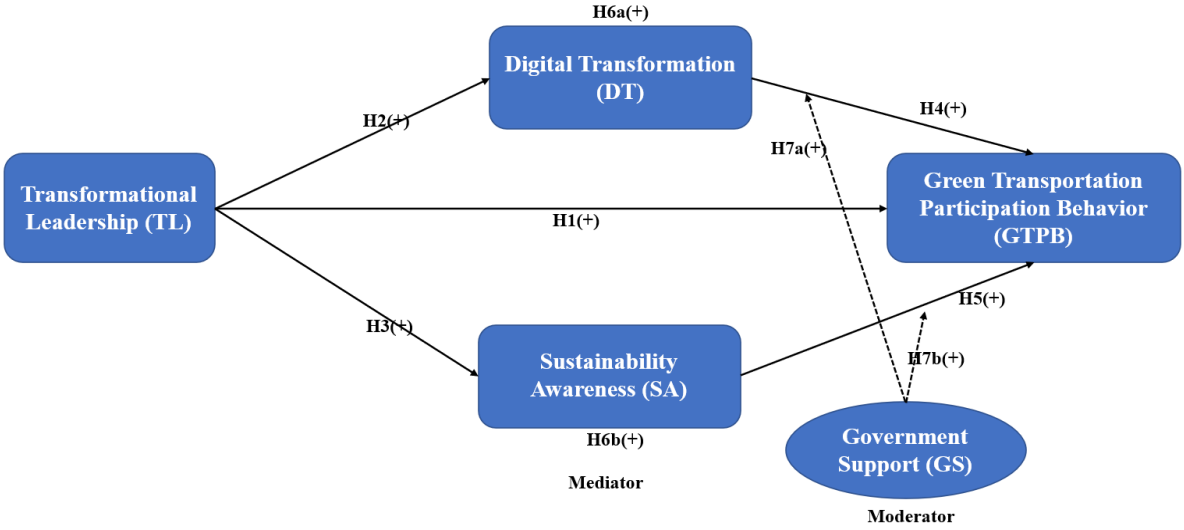
Government support may similarly strengthen the effect of sustainability awareness. An aware individual may still be unable or unwilling to act when routes are unsafe, services are inaccessible, prices are unfavorable, or regulations are inconsistent. Public investment and incentives can convert concern into feasible choice. Evidence from digital-environmental research shows that government support can condition the value of digital development for green innovation (Guo et al., 2023), and transportation research has linked government policy awareness and incentives to low-carbon or electric-mobility adoption (He et al., 2024; Waqas et al., 2018). Vietnam's green transport program further signals an institutional commitment to energy transition in the sector (Vietnam, 2022). Accordingly, perceived government support is expected to amplify both the digital and awareness pathways.

H7a. Government support positively moderates the relationship between digital transformation and green transportation participation behavior, such that the relationship is stronger when government support is higher.

H7b. Government support positively moderates the relationship between sustainability awareness and green transportation participation behavior, such that the relationship is stronger when government support is higher.

Figure 1. Leadership-Driven Digital Sustainability Model for Green Transportation Participation

Figure 1. Research Model: Leadership-Driven Digital Sustainability Model for Green Transportation Participation



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METHOD

Research design and context

The study used a quantitative, cross-sectional survey design to test the proposed relationships. The unit of analysis was the individual employee or manager because the outcome concerned personal participation in green transportation and the key explanatory variables were perceptual assessments of leadership, digital transformation, sustainability awareness, and government support. Vietnam was selected as the empirical context because rapid urbanization and motorization coexist with expanding digital infrastructure and a policy commitment to transport decarbonization. This combination creates substantial variation in employees' exposure to organizational digitalization, sustainability communication, and public support for green mobility.

The questionnaire introduced the academic purpose of the study, stated that responses were anonymous, and used a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Participation was voluntary. The instrument included demographic questions followed by five six-item construct scales. Data collection was conducted through organizational and professional networks using online and paper-based questionnaires during the first four months of 2026. A purposive-convenience strategy was used to reach respondents with experience of organizational leadership and digital technologies. The final analytic data set contained 512 complete responses and no missing item-level values.

Sample adequacy and respondent profile

Sample adequacy was assessed before structural estimation. An a priori power calculation for an omnibus multiple-regression test with seven predictors, a medium effect size ($f^2 = 0.15$), $\alpha = 0.05$, and statistical power of 0.95 indicated a minimum of approximately 153 observations. The obtained sample of 512 substantially exceeded this benchmark and was also adequate for the complexity of the PLS-SEM model. The sample was

balanced by gender and included substantial representation across age, education, position, experience, ownership type, and organization size. More than 44% of respondents held supervisory, managerial, or executive roles, supporting informed assessments of leadership and organizational digital transformation.

Table 1. Respondent Characteristics (N = 512)

Characteristic	**Category**	**N 512**	**%**
Gender	Male	253	49.4
	Female	259	50.6
Age	Under 25	43	8.4
	25-34	157	30.7
	35-44	153	29.9
	45-54	106	20.7
	55 and above	53	10.4
Education	High school	23	4.5
	Diploma	91	17.8
	Bachelor's degree	233	45.5
	Master's degree	144	28.1
	Doctoral degree	21	4.1
Position	Employee	176	34.4
	Supervisor	109	21.3
	Middle manager	118	23.0
	Senior manager	65	12.7
	Executive	44	8.6
Experience	Under 5 years	86	16.8
	5-10 years	167	32.6
	11-15 years	119	23.2
	16-20 years	88	17.2
	Over 20 years	52	10.2
Organization type	State-owned	97	18.9
	Private	107	20.9
	Foreign-invested	96	18.8
	Joint venture	108	21.1
	Other	104	20.3
Organization size	Under 50 employees	136	26.6
	50-99 employees	91	17.8
	100-199 employees	126	24.6
	200-299 employees	88	17.2
	300 employees and above	71	13.9

Note. Percentages may not total 100.0 because of rounding.

Source: Compiled by the author

Measures

Transformational leadership (TL) was measured with six items adapted from the transformational leadership tradition of Bass and Avolio (Bass & Avolio, 1994). The items captured a clear and inspiring vision, motivation toward challenging goals, encouragement of innovative thinking, attention to individual needs, ethical role modeling, and the promotion of sustainability and environmental responsibility. The inclusion of an explicit sustainability item made the scale contextually relevant while preserving the broader transformational leadership domain.

Digital transformation (DT) was measured with six items reflecting the broad adoption of digital technologies, digitally enabled communication and collaboration, decision support, continuous upgrading of digital capabilities, operational efficiency, and support for sustainability initiatives. The scale was informed by contemporary definitions that conceptualize digital transformation as strategic and organizational change rather than simple digitization (Gong & Ribiere, 2021; Verhoef et al., 2021; Vial, 2019).

Sustainability awareness (SA) was measured with six items assessing understanding of the environmental impacts of transportation, awareness of societal sustainability challenges, recognition of the importance of carbon reduction, belief in the environmental contribution of sustainable transportation, personal responsibility for sustainable mobility, and integration of sustainability into daily travel choices. The scale therefore captured both problem awareness and solution-oriented awareness.

Green transportation participation behavior (GTPB) was measured with six items covering frequent use of environmentally friendly modes, preference for public transportation, walking or cycling for short trips, efforts to reduce fossil-fuel vehicle use, support for community green transportation initiatives, and intention to increase future green transportation use. Because the scale includes current behavior, advocacy, and prospective participation, it represents a broad participation construct rather than a narrowly observed modal share. The items were adapted from sustainable transportation and green travel research (Waqas et al., 2018; Zhang et al., 2024).

Government support (GS) was measured with six items assessing infrastructure provision, policy encouragement, incentives, public awareness campaigns, regulation, and public investment that improves access to green transport. The scale operationalized government support as a perceived institutional environment rather than an objective policy index. Higher scores indicate that respondents perceive public institutions as providing stronger material and normative support for sustainable mobility.

Common method considerations and preliminary screening

The use of a single questionnaire creates potential common method variance. Procedural remedies were therefore embedded in the design: respondents were assured of anonymity, the questionnaire emphasized that there were no right or wrong answers, constructs were separated into labeled sections, and items used concise language. As a statistical diagnostic, an unrotated single-factor analysis of all 30 substantive indicators showed that the first factor accounted for 31.64% of total variance, below the conventional 50% warning level. This test cannot rule out all method bias, but it indicates that a single general factor did not dominate the covariance structure (Podsakoff et al., 2003).

The raw data were also examined for missing values, scale-range violations, and distributional anomalies. All 512 cases were complete, and all responses fell within the intended one-to-five range. Construct means ranged from 3.76 to 4.01, with standard deviations between 0.39 and 0.57. Absolute construct-level skewness was below .42 and excess kurtosis was close to zero. These patterns did not indicate severe distributional problems, although PLS-SEM was selected primarily for its prediction-oriented treatment of latent-variable relationships and mediation rather than as a response to nonnormality.

Data analysis

The model was estimated in SmartPLS 4 (Ringle et al., 2024) using the two-stage PLS-SEM assessment sequence recommended by (Hair et al., 2022). In the measurement model, indicator reliability was evaluated through outer loadings; internal consistency through Cronbach's alpha, rho_A, and composite reliability; convergent validity through average variance extracted (AVE); and discriminant validity through the heterotrait-monotrait ratio (HTMT) (Henseler et al., 2015). Loadings near 0.70 were interpreted in conjunction with construct reliability and AVE rather than removed mechanically. Collinearity was examined with variance inflation factors (VIFs).

The structural model was evaluated with standardized path coefficients, 5,000 bootstrap resamples, t statistics, p values, and percentile 95% confidence intervals. Explanatory power was assessed with R^2 and adjusted R^2, and substantive contribution with f^2 effect sizes using (Cohen, 1988) Cohen's (1988) benchmarks. The two interaction terms, GS × DT and GS × SA, were estimated as single-score interaction constructs using a two-stage moderation approach. Mediation was evaluated from bootstrapped specific indirect effects rather than relying on causal-steps logic; the persistence of a significant direct effect together with same-signed indirect effects was interpreted as complementary partial mediation (Nitzl et al., 2016). SRMR and NFI were reported as supplementary indicators, recognizing that global fit is secondary in variance-based SEM.

RESULTS

Descriptive statistics and correlations

Table 2 reports construct means, standard deviations, and correlations calculated from the mean scores of the six indicators for each construct. Respondents reported relatively high transformational leadership and digital transformation, while sustainability awareness and green transportation participation were also above the midpoint. Transformational leadership correlated strongly with digital transformation (r = 0.707) and moderately with sustainability awareness (r = 0.612) and green transportation participation behavior (r = 0.619). Digital transformation and sustainability awareness were both positively correlated with participation behavior. Government support showed only small zero-order correlations with the organizational constructs but a positive correlation with participation behavior, foreshadowing a possible additive rather than interactive role.

Table 2. Descriptive Statistics and Construct Correlations

Construct	Mean	SD	TL	DT	SA	GTPB	GS
TL	4.010	0.491	1.000				
DT	3.988	0.412	0.707	1.000			
SA	3.761	0.385	0.612	0.471	1.000		
GTPB	3.813	0.415	0.619	0.557	0.582	1.000	
GS	3.887	0.566	-0.031	0.018	0.016	0.102	1.000

Source: Compiled by the author

Measurement model

The reflective measurement model met accepted reliability and validity criteria. Outer loadings ranged from 0.690 to .860. Twenty-nine of the 30 loadings were at or above 0.70; GTPB3 loaded at .690 and was retained because it was close to the guideline, represented walking and cycling behavior that was substantively important, and its removal was unnecessary given satisfactory construct reliability and AVE. Cronbach's alpha ranged from 0.821 to 0.912, rho_A from 0.822 to 0.974, and composite reliability from 0.870 to 0.930. AVE values ranged from 0.527 to 0.688, exceeding 0.50 for every construct. These results support indicator reliability, internal consistency, and convergent validity.

Table 3. Indicator Loadings, Reliability, and Convergent Validity

Construct	Item	Loading	α	rho_A	CR	AVE
Transformational leadership	TL1	0.799	0.885	0.886	0.913	0.636
	TL2	0.826				
	TL3	0.790				
	TL4	0.778				
	TL5	0.816				
	TL6	0.774				
Digital transformation	DT1	0.733	0.836	0.837	0.880	0.550
	DT2	0.782				
	DT3	0.742				
	DT4	0.708				
	DT5	0.754				
	DT6	0.728				
Sustainability awareness	SA1	0.716	0.821	0.822	0.870	0.527
	SA2	0.733				
	SA3	0.738				
	SA4	0.727				
	SA5	0.702				
	SA6	0.740				
Green transportation participation behavior	GTPB1	0.748	0.833	0.836	0.878	0.546
	GTPB2	0.769				
	GTPB3	0.690				
	GTPB4	0.721				
	GTPB5	0.774				
	GTPB6	0.727				
Government support	GS1	0.823	0.912	0.974	0.930	0.688
	GS2	0.860				
	GS3	0.846				
	GS4	0.819				
	GS5	0.822				
	GS6	0.806				

Source: Compiled by the author

Note. α = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted. Reliability and AVE are shown on the first row of each construct.

Discriminant validity was assessed using HTMT. All point estimates were below the conservative threshold of 0.85, ranging from 0.046 to 0.821. The highest value was between transformational leadership and digital transformation, which is theoretically reasonable because leadership is expected to be closely associated with organizational change capability but remains below the threshold. The pattern supports empirical distinctiveness among the five focal constructs.

Table 4. Heterotrait-Monotrait Ratios

Construct	TL	DT	SA	GTPB	GS
TL	-				
DT	0.821	-			
SA	0.718	0.569	-		
GTPB	0.721	0.668	0.703	-	
GS	0.048	0.046	0.071	0.131	-

Source: Compiled by the author

Note. All HTMT values are below 0.85.

Structural model and direct effects

All inner VIF values were below 2.54, indicating that collinearity did not threaten the structural estimates. The bootstrapping results are presented in Table 5 and Figure 2. Transformational leadership had a positive direct effect on green transportation participation behavior ($\beta = 0.290$, $t = 6.060$, $p < 0.001$), supporting H1. It strongly predicted digital transformation ($\beta = 0.709$, $t = 32.990$, $p < 0.001$) and sustainability awareness ($\beta = 0.613$, $t = 23.064$, $p < 0.001$), supporting H2 and H3. Digital transformation positively predicted participation behavior ($\beta = 0.205$, $t = 4.531$, $p < 0.001$), supporting H4. Sustainability awareness also had a positive effect ($\beta = 0.307$, $t = 7.668$, $p < 0.001$), supporting H5. Among the two mediators, sustainability awareness had the larger direct association with participation behavior.

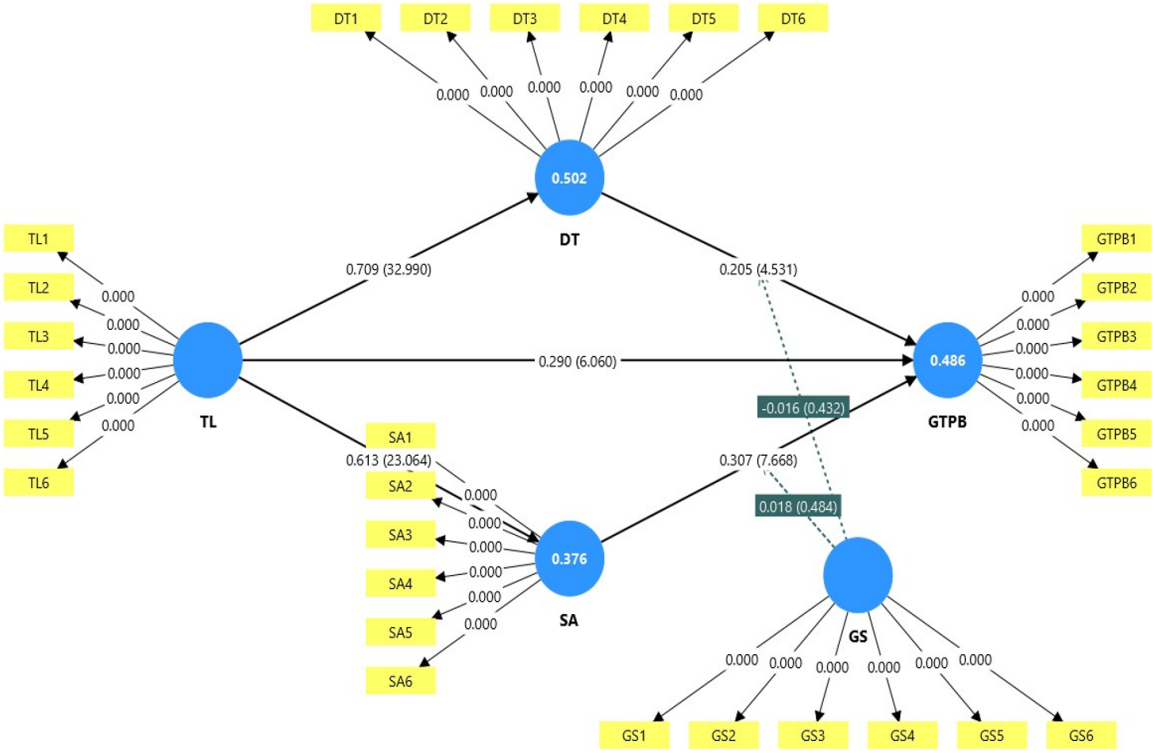
Table 5. Direct and Moderating Effects

Hyp.	Path	β	SE	t	p	95% CI	Decision
H1	TL → GTPB	0.290	.0479	6.060	< .001	[0.196, 0.381]	Supported
H2	TL → DT	0.709	.0215	32.990	< .001	[0.666, 0.750]	Supported
H3	TL → SA	0.613	.0266	23.064	< .001	[0.560, 0.663]	Supported
H4	DT → GTPB	0.205	0.0452	4.531	< 0.001	[0.120, 0.293]	Supported
H5	SA → GTPB	0.307	0.0400	7.668	< 0.001	[0.230, 0.388]	Supported
Aux.	GS → GTPB	0.106	0.0353	2.998	0.003	[0.044, 0.172]	Positive
H7a	GS × DT → GTPB	-0.016	0.0379	0.432	0.666	[-0.096, 0.053]	Not supported
H7b	GS × SA → GTPB	0.018	0.0365	0.484	0.628	[-0.052, 0.092]	Not supported

Source: Compiled by the author

Note. Bootstrap resamples = 5,000. CI = percentile bootstrap confidence interval. GS → GTPB was estimated as a lower-order main effect required for moderation analysis and is reported as an auxiliary effect.

Figure 2 PLS-SEM Results With 5,000 Bootstrap Resamples



Note. Values on structural paths are standardized coefficients with t statistics in parentheses. Values inside endogenous constructs are R^2. Interaction effects are shown with dashed paths.

Mediation analysis

Both specific indirect effects were positive and statistically significant. The indirect effect through digital transformation was β = 0.145 (t = 4.436, p < 0.001, 95% CI [0.083, 0.211]), supporting H6a. The indirect effect through sustainability awareness was β = 0.188 (t = 7.061, p < 0.001, 95% CI [0.139, 0.244]), supporting H6b. The total indirect effect was β = 0.333, and the total effect of transformational leadership on participation behavior was β = 0.624. Because the direct effect remained significant and all direct and indirect effects had the same sign, the results indicate complementary partial mediation. The total indirect effect represented approximately 53.4% of the total effect. The awareness pathway accounted for approximately 30.2% of the total effect, compared with 23.3% for the digital pathway, showing that cognition was the somewhat stronger transmission mechanism.

Table 6. Specific Indirect, Total Indirect, and Total Effects

Hyp.	Effect	β	SE	t	p	95% CI	Decision
H6a	TL → DT → GTPB	0.145	0.0327	4.436	< 0.001	[0.083, 0.211]	Supported
H6b	TL → SA → GTPB	0.188	0.0266	7.061	< 0.001	[0.139, 0.244]	Supported
-	Total indirect TL → GTPB	0.333	0.0383	8.710	< 0.001	[0.259, 0.409]	-
-	Total effect TL → GTPB	0.624	0.0249	25.090	< 0.001	[0.574, 0.671]	-

Source: Compiled by the author

Note. Bootstrap resamples = 5,000. The direct effect TL → GTPB remained significant, indicating complementary partial mediation.

Moderation, explanatory power, and effect sizes

The proposed moderation effects were not supported. The interaction between government support and digital transformation was negative but near zero (β = -0.016, p = 0.666), and the interaction between government support and sustainability awareness was positive but near zero (β = 0.018, p = 0.628). Both confidence intervals crossed zero. Conditional effects changed only minimally across lower and higher levels of government support. Consequently, H7a and H7b were rejected. Government support nevertheless had a small positive main effect on participation behavior (β = 0.106, p = 0.003), implying that it may independently enable green transportation rather than strengthen the marginal effects of organizational digital transformation or sustainability awareness.

The model explained 50.2% of the variance in digital transformation, 37.6% in sustainability awareness, and 48.6% in green transportation participation behavior. Transformational leadership had large f^2 effects on digital transformation (1.009) and sustainability awareness (0.602), demonstrating that leadership was a central antecedent of both mediators. Its direct f^2 effect on participation behavior was small (0.065), as were the effects of digital transformation (0.040) and government support (0.022). Sustainability awareness had the largest predictor-specific effect on participation behavior (0.113), between small and medium. Both interaction f^2 values were below 0.001. Supplementary model fit was satisfactory (SRMR = 0.046 for the estimated model; NFI = 0.904).

Table 7. Explanatory Power and Effect Sizes

Endogenous construct	Predictor	R^2	Adjusted R^2	f^2	Interpretation
Digital transformation	TL	0.502	0.501	1.009	Large
Sustainability awareness	TL	0.376	0.375	0.602	Large
Green transportation participation behavior	TL	0.486	0.480	0.065	Small
	DT			0.040	Small
	SA			0.113	Small-medium
	GS			0.022	Small
	GS × DT			< 0.001	Negligible
	GS × SA			< 0.001	Negligible

Note. Cohen's (1988) guidelines: f^2 values of 0.02, 0.15, and 0.35 indicate small, medium, and large effects, respectively. SRMR = 0.046; NFI = 0.904 for the estimated model.

DISCUSSION

Overview of the findings

This study examined whether transformational leadership contributes to green transportation participation behavior through direct, capability-based, and cognitive mechanisms, and whether government support strengthens the latter two mechanisms. Seven of the nine hypotheses were supported. Transformational leadership predicted participation behavior directly and strongly predicted both digital transformation and sustainability awareness. Each mediator, in turn, predicted participation behavior and carried a significant portion of the leadership effect. Government support had a positive direct association with participation but did not moderate either mediator-outcome relationship. Overall, the findings support a leadership-driven model of sustainable mobility while showing that the institutional environment operates differently from the proposed amplification logic.

The model explained nearly half of the variance in green transportation participation behavior, which is meaningful for a behavioral outcome influenced by many factors outside the organizational domain, including household constraints, urban form, service availability, distance, cost, weather, and habit. The results should not be read as evidence that leadership replaces transportation infrastructure or policy. Rather, they show that organizations and leaders form an important layer of the broader mobility system. Leadership can affect whether

employees notice green alternatives, understand their significance, and perceive digital resources that make participation more feasible.

Transformational leadership as a driver of sustainable mobility

The positive direct effect of transformational leadership on green transportation participation supports the extension of leadership theory beyond conventional job performance and workplace environmental behavior. Leaders appear able to influence mobility-related choices even after digital transformation and sustainability awareness are included. This remaining direct effect may reflect social modeling, collective identity, perceived expectations, and support for behavioral experimentation. When leaders consistently integrate sustainability into decisions and personal conduct, green mobility can become part of what employees believe a responsible organizational member does.

The result aligns with Robertson and Barling (2013) argument that leaders shape pro-environmental behavior through role modeling and motivational processes, and with recent evidence that green transformational leadership improves employee environmental outcomes (Le et al., 2024; Ren et al., 2024). The current finding broadens that evidence because the leadership measure was not restricted to environmentally specific behaviors and the outcome included transportation outside the immediate workplace. This suggests a spillover mechanism: a general leadership style that supports vision, innovation, ethics, and sustainability can influence daily conduct at the organizational-societal boundary.

The direct effect was smaller than the total indirect effect, indicating that leadership is most consequential when it creates intervening resources. This is theoretically important. It cautions against symbolic sustainability leadership that relies on speeches or personal example without changing systems and awareness. Inspirational messages may initiate change, but lasting mobility participation requires the practical and cognitive conditions represented by digital transformation and sustainability awareness.

Digital transformation as an enabling capability

Transformational leadership had a very strong effect on digital transformation, consistent with the view that digital change is a leadership and organizational capability challenge rather than a purely technical project. The large f^2 effect indicates that employees' perceptions of digital adoption, collaboration, decision support, capability upgrading, efficiency, and sustainability alignment were closely tied to transformational leadership. This supports dynamic capability theory: leaders provide the direction and social coordination required to sense digital opportunities, seize them through investment and experimentation, and reconfigure routines (Teece, 2007; Warner & Wäger, 2019). It also complements recent evidence that green digital transformational leadership can cultivate a digital mindset and green digital transformation (Alabdali et al., 2024).

Digital transformation positively influenced green transportation participation, although its predictor-specific effect was small. This size is plausible because the construct was organization-wide and not limited to mobility technologies. General digital maturity can facilitate participation through communication, data visibility, hybrid work, digital meeting systems, route information, service integration, and carbon feedback, but it cannot by itself alter service coverage, distance, physical safety, or personal constraints. The result nevertheless confirms that technology-enabled convenience and information are behaviorally relevant. It also supports Zhang et al. (2024) finding that low-carbon features in digital maps can help promote green travel.

The significant indirect effect through digital transformation demonstrates a capability-building mechanism. Transformational leaders do not only persuade employees to act; they help create an organizational environment in which green choices require less effort and uncertainty. This mechanism is valuable because it may influence behavior even among individuals whose environmental motivation is moderate. Digital systems can change defaults, simplify planning, and make sustainable options more usable. However, the smaller magnitude of this indirect effect relative to the awareness route suggests that digital convenience should be paired with a compelling sustainability rationale.

Sustainability awareness as a cognitive pathway

The strong relationship between transformational leadership and sustainability awareness confirms that leaders are important sense-givers. They select what deserves attention, connect environmental issues to organizational purpose, and translate distant climate consequences into decisions employees can understand. The result closely parallels Ren et al. (2024), who identified environmental awareness as a mechanism between environmentally specific transformational leadership and pro-environmental performance. It also shows that a broader transformational style can raise sustainability awareness when leaders explicitly promote ethical and environmental responsibility.

Sustainability awareness was the strongest direct predictor of participation behavior among the focal mediators. This supports the theory of planned behavior's emphasis on evaluative beliefs and attitudes Ajzen (1991), while remaining consistent with research on environmental concern and sustainable transport acceptance (He et al., 2024; Waqas et al., 2018). Individuals who understand the environmental effects of transportation and the contribution of low-carbon alternatives are more likely to modify routines, support initiatives, and express future participation. Awareness does not remove every structural barrier, but it makes the environmental value of available choices salient enough to motivate action.

The awareness indirect effect was larger than the digital indirect effect. This comparison is one of the study's main findings because the two mediators were estimated simultaneously. Leadership appears to influence green transportation more strongly by changing how employees interpret sustainability than by digital enablement alone. In practical terms, an application or platform may be unused if employees do not see why a different travel choice matters. Conversely, awareness can motivate individuals to search for alternatives even in imperfect digital environments. The most credible strategy is therefore not awareness instead of technology, but awareness that gives digital tools purpose.

Government support: additive enabling condition, not amplifier

The positive main effect of government support confirms that public infrastructure, incentives, policies, campaigns, regulation, and investment matter for green transportation participation. This is consistent with institutional theory and sustainable transportation studies emphasizing policy credibility and enabling conditions (Scott, 2014; Waqas et al., 2018). It is also aligned with Vietnam's formal commitment to green energy transition in transport (Vietnam, 2022). Respondents who perceived stronger public support were more likely to participate, even after organizational leadership, digital transformation, and awareness were controlled.

Contrary to H7a and H7b, government support did not strengthen the effects of digital transformation or sustainability awareness. Several explanations are plausible. First, the measured government support may operate as a broad public good that benefits respondents directly rather than changing the marginal return to organizational resources. Infrastructure, regulation, and campaigns can raise participation across the board, producing an additive effect. Second, perceived government support may be too general to match specific digital services or travel modes. A respondent may perceive strong national policy but still face local gaps in route coverage, sidewalks, cycling safety, or charging facilities. Third, strong awareness may motivate behavior under both lower and higher perceived support, while digital transformation may mainly affect organizational processes rather than public transport service quality.

The nonsignificant interactions refine, rather than negate, institutional theory. Institutional support can matter without moderating every organizational relationship. Guo et al. (2023) found that government support can condition digital development in the context of green finance and innovation, but boundary effects are likely to depend on the level of analysis and the specificity of the policy-resource match. In the present individual behavior model, support appears to create a general enabling baseline. Future studies should distinguish national policy awareness, local infrastructure quality, mode-specific subsidies, enforcement, and trust in implementation to determine which institutional dimensions truly interact with organizational capabilities and cognition.

Theoretical Contributions

First, the study extends transformational leadership theory into sustainable mobility. Prior leadership research has established effects on organizational change, innovation, and employee environmental behavior, but commuting and green transportation participation often sit outside formal job descriptions. Demonstrating a significant direct and total effect on this outcome expands the behavioral reach of leadership and positions the organization as a meaningful arena for societal sustainability transitions. The result suggests that leadership can influence boundary-spanning behaviors when those behaviors are connected to collective purpose, ethical responsibility, and organizational practices.

Second, the study integrates the resource-based view and dynamic capability theory with a behavioral-cognitive explanation. Transformational leadership was conceptualized as an intangible strategic resource that helps build digital transformation capability. Digital transformation then reduced behavioral friction, while sustainability awareness shaped evaluations and meaning. This integration avoids a common limitation in sustainability research: assuming that organizational capability automatically becomes individual behavior. The model explicitly identifies two transmission mechanisms and shows that both are needed to explain how leadership reaches green mobility participation.

Third, the parallel mediation design yields a more precise account than a single-mediator or serial model. The results show that digital transformation and sustainability awareness each carried a significant, unique portion of the leadership effect. The cognitive path was somewhat stronger, but neither rendered the other redundant. This finding supports a complementary mechanism perspective: capability makes action easier, while awareness makes action worthwhile. It also shows why studies that model only technology or only environmental cognition may overestimate one pathway by omitting the other.

Fourth, the study distinguishes the main and moderating roles of government support. Institutional theory is often invoked to predict that favorable policy conditions strengthen organizational effects, yet the data supported only a positive main effect. This result contributes a useful boundary condition: public support may act as an independent enabling resource rather than a multiplier of leadership-derived digital capability or awareness. The distinction encourages more careful theorizing about whether institutional variables provide baseline resources, legitimacy, constraints, or true interaction effects.

Fifth, the study contributes evidence from Vietnam, an emerging economy in which motorization, urban growth, digital transformation, and climate policy are unfolding simultaneously. Much sustainable mobility theory has been developed in settings with mature public transportation and digital services. The Vietnamese context shows that leadership and awareness remain important even where institutional and infrastructural conditions are still evolving. It also demonstrates that organizational action can complement, but not substitute for, public investment and transport-system reform.

Practical and Policy Implications

For organizational leaders, the results imply that green commuting should be treated as part of transformation strategy rather than as an isolated environmental campaign. Leaders can articulate a mobility vision linked to emissions reduction, employee well-being, and organizational responsibility; model lower-carbon travel when feasible; invite employees to redesign commuting practices; and recognize teams that develop workable solutions. Leadership development programs should connect the four transformational behaviors to concrete sustainability actions. Vision without operational support is unlikely to be sufficient, but it is the mechanism that gives digital investments and awareness initiatives legitimacy.

Organizations should also build a mobility-relevant digital layer. Useful interventions include integrated commuting portals, real-time public transport information, digital carpool matching, bicycle and electric-mobility maps, parking and charging information, remote-meeting policies, hybrid-work scheduling, and dashboards that show aggregate travel emissions. Digital tools should reduce steps and uncertainty rather than add another reporting burden. Their design should be inclusive of employees with different digital skills, locations, schedules, and mobility constraints. Because the estimated digital effect was positive but modest,

organizations should evaluate actual usage and behavioral conversion rather than equating technology deployment with impact.

Sustainability awareness deserves equal or greater managerial attention. The larger indirect effect through awareness suggests that employees need a clear explanation of how travel choices affect emissions, air quality, congestion, health, and community well-being. Awareness programs should avoid generic slogans. They can use locally relevant emissions information, travel-choice comparisons, peer examples, commuting challenges that are safe and voluntary, and feedback on organizational progress. Communications should recognize real constraints and avoid moralizing; the objective is to help employees make better choices when viable alternatives exist.

Human resource and facilities policies can align the capability and awareness pathways. Examples include public-transport benefits, secure bicycle parking, showers, flexible start times, remote-work options, electric charging, pooled vehicles, and reimbursement rules that do not privilege private fossil-fuel travel. Employee surveys can identify route-specific barriers, while pilot programs can test solutions before broader implementation. The strong effects of leadership on both mediators indicate that these initiatives need visible senior sponsorship and cross-functional ownership rather than being delegated solely to a sustainability office.

For policymakers, the positive main effect of government support indicates that infrastructure and policy remain essential. Investment should focus on reliable public transport, safe walking and cycling networks, interoperable digital information, accessible charging, and transparent incentives. Public campaigns should be coordinated with service improvements; awareness without feasible alternatives can produce frustration, while infrastructure without understandable information can be underused. Vietnam's transport energy-transition program provides an overarching direction, but local implementation, service quality, and equity will determine whether citizens can act on it.

The absence of moderation suggests that governments should not assume that organizational digitalization or environmental awareness will automatically become more effective simply because policy support is perceived as strong. Mode-specific and place-specific coordination is needed. Public agencies can partner with employers to integrate route data, commuter benefits, demand management, and workplace travel plans. Evaluations should track not only policy awareness but actual changes in mode share, vehicle kilometers, and emissions. Such collaboration can connect national goals with the daily decisions in which transport decarbonization is ultimately realized.

Limitations and Future Research

Several limitations qualify the findings. First, the cross-sectional design does not establish temporal or causal order. The theorized direction from leadership to digital transformation, awareness, and behavior is well grounded, but reciprocal relationships are possible. Employees who work in digitally mature or sustainability-oriented organizations may evaluate their leaders more positively, and individuals who already use green transportation may notice sustainability support more readily. Longitudinal studies should measure leadership and organizational capability before subsequent mobility behavior, while field experiments could test leader communication, digital tools, or commuting benefits.

Second, all substantive variables were self-reported by the same respondents. Anonymity, construct separation, and the single-factor diagnostic reduce but do not eliminate common method concerns. Future research should combine employee perceptions with leader reports, objective indicators of digital capability, policy databases, and behavioral data from transport cards, mobility applications, parking systems, or travel diaries. Multi-source designs would also allow researchers to distinguish perceived support from actual service availability.

Third, the purposive-convenience sample limits population inference. Although the sample was large and diverse across demographic and organizational categories, it was not a probability sample of all Vietnamese employees or commuters. Respondents were relatively well educated and were reached through organizational networks. Replication should use stratified sampling across cities, provinces, industries, and rural-urban locations.

Comparative studies could examine whether the model differs in countries with more mature public transport, different motorcycle dependence, or stronger local government capacity.

Fourth, each construct was modeled as a unidimensional reflective factor with six indicators. Transformational leadership can be represented by four dimensions, and digital transformation can include strategy, technology, data, process, culture, and human capability. Government support can also be decomposed into infrastructure, incentives, regulation, communication, and implementation trust. Future research should test higher-order specifications and determine which dimensions have the greatest behavioral relevance. The slightly lower loading of the walking-and-cycling item also suggests that green transportation participation may contain distinct mode-specific facets.

Fifth, the GTPB measure combines current behavior, preference, advocacy, and future intention. This breadth is appropriate for participation but does not provide a precise estimate of actual emissions reduction. Future studies should separate intention from observed frequency and distinguish public transport, walking, cycling, shared mobility, and electric vehicle use. Travel distance, household responsibilities, disability access, weather, urban density, and income should be included as controls or boundary conditions. Habit and perceived behavioral control may also explain why awareness translates into action for some employees but not others.

Finally, the study tested parallel rather than serial mediation because the estimated model included direct paths from leadership to each mediator and from each mediator to behavior, but no path from digital transformation to sustainability awareness. Future work can compare parallel, serial, and reciprocal mechanisms. Digital tools may increase awareness through carbon feedback, while sustainability awareness may increase employees' willingness to adopt digital mobility services. Artificial intelligence, personalized recommendations, privacy concerns, algorithmic trust, and awareness of technology benefits are promising additions, particularly as smart mobility systems expand.

CONCLUSION

Sustainable transportation is not only an engineering or policy problem; it is also a leadership, capability, and cognition problem. Using data from 512 employees and managers in Vietnam, this study shows that transformational leadership is associated with greater participation in green transportation both directly and indirectly. Digital transformation provides an enabling pathway by making information, coordination, and organizational adaptation easier. Sustainability awareness provides a cognitive pathway by clarifying the environmental meaning of travel choices. Both mechanisms matter, and awareness carries the somewhat larger indirect effect.

Government support also matters, but not in the originally expected way. Perceived infrastructure, policies, incentives, campaigns, regulation, and investment had a small positive direct effect, while neither interaction was significant. Public support therefore appears to raise the general feasibility or legitimacy of green transportation rather than amplify the effects of organizational digital transformation or sustainability awareness. The central implication is a coordinated one: leaders should inspire and model change, organizations should build usable digital and policy supports, employees should understand why mobility choices matter, and governments should provide reliable options. Green transportation participation becomes more likely when these elements operate together, even if their effects are additive rather than multiplicative.

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