Physical activity and sport motivation influencing runners' transport and cultural behavior at the Tokyo Marathon

Motivación en la actividad física y el deporte que influye en el comportamiento de transporte y cultural de los corredores en el Maratón de Tokio

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Abstract

Introduction: Mega sporting events not only promote physical activity but also offer opportunities to encourage environmentally sustainable behaviors. The Tokyo Marathon, as one of the World Marathon Majors, provides a unique context to examine how runners' environmental awareness and motivational drivers influence transport behavior and engagement in physical activity. Understanding these behavioral patterns is crucial for integrating sustainability with health promotion in large-scale sporting events.
Methodology: Guided by the Theory of Planned Behavior, this study surveyed 300 runners of diverse ages, nationalities, and experience levels using an online questionnaire. Key constructs measured included Environmental Awareness (EA), Runner Attitude (RA), Perceived Behavioral Control (PBC), Subjective Norms (SN), Green Marathon Perceived Quality (PQ), and Physical Activity (PA). Followed by Structural Equation Modeling (SEM) to examine hypothesized relationships among variables.
Discussion: Results indicate that EA significantly predicts PBC, RA, and PQ, highlighting the role of environmental knowledge in shaping attitudes and perceptions of event quality. Physical activity is significantly influenced by PBC and RA, while SN and PQ show no significant effect. These findings emphasize the importance of intrinsic motivation and perceived behavioral control over social influence or perceived event quality in promoting sustainable and active transport behaviors.
Conclusions: Enhancing environmental awareness and fostering positive attitudes can effectively encourage eco-friendly and health-promoting behaviors in mega sporting events, offering actionable insights for event organizers, policymakers, and sport tourism planners aiming to combine sustainability with participant well-being.

Keywords

Mega sporting events, environmental awareness, runner attitude, tokyo marathon physical activity, sustainable transport, cultural behavior, SDG 3.

Resumen

Introducción: Los eventos deportivos de gran escala no solo promueven la actividad física, sino que también fomentan comportamientos sostenibles. El Maratón de Tokio, como uno de los World Marathon Majors, ofrece un contexto ideal para analizar cómo la conciencia ambiental y los factores motivacionales de los corredores influyen en el transporte y la actividad física.
Metodología: Basado en la Teoría del Comportamiento Planificado, se encuestaron 300 corredores de diversas edades, nacionalidades y niveles de experiencia mediante un cuestionario en línea. Se midieron Conciencia Ambiental (EA), Actitud del Corredor (RA), Control Conductual Percibido (PBC), Normas Subjetivas (SN), Calidad Percibida del Maratón Verde (PQ) y Actividad Física (PA). Los datos se analizaron con Análisis Factorial Confirmatorio (CFA) y Modelado de Ecuaciones Estructurales (SEM).
Discusión: Los resultados muestran que EA predice significativamente PBC, RA y PQ. La actividad física está influida por PBC y RA, mientras que SN y PQ no son significativos. Esto resalta la relevancia de la motivación intrínseca y el control percibido sobre la influencia social o la calidad percibida del evento para promover transporte activo y sostenible.
Conclusiones: Incrementar la conciencia ambiental y fomentar actitudes positivas puede impulsar comportamientos ecológicos y saludables en eventos deportivos de gran escala, ofreciendo recomendaciones prácticas para organizadores y responsables de políticas.Palabras clave

Palabras clave

Eventos deportivos de gran escala, conciencia ambiental, actitud del corredor, maratón de tokio, actividad física, transporte sostenible, comportamiento cultural, SDG 3.

Introduction

Mega sporting events not only serve as competitive platforms but also play a crucial role in promoting physical activity, shaping healthy lifestyles and encouraging environmentally sustainable practices (Alshikhy, et al., 2025). The Tokyo Marathon, as one of the World Marathon Majors, attracts thousands of participants from across the globe (Fourie & Santana-Gallego, 2022), offering a unique opportunity to explore how physical activity and sport perspectives influence runner transport behavior. From a Physical Activity and Sport perspective, athletes and recreational runners alike often consider transportation choices as an extension of their health and fitness goals (Xu & Zhou, 2025). For instance, selecting active transport methods such as walking or cycling to the event venue not only aligns with personal fitness objectives but also contributes to environmental sustainability. These behavioral patterns are shaped by a combination of motivational drivers, including Runner Attitude (RA), Perceived Behavioral Control (PBC), Green Marathon Perceived Quality (PQ), and Subjective Norms (SN). This study integrates the Theory of Planned Behavior (Ajzen, 1991) and sport science perspectives to understand the extent to which environmental awareness, perceived event quality, and social influences drive sustainable runner transport behavior. By emphasizing the role of physical activity and sport in shaping these determinants (Avraham, et al., 2024), the research aims to provide insights for event organizers, sport managers, and policymakers to promote sustainable transport options that also encourage health-enhancing physical activity. The Theory of Planned Behavior (TPB) is grounded in three primary constructs: attitude toward the behavior, subjective norms, and perceived behavioral control. Attitude reflects an individual's positive or negative evaluation of performing the behavior; subjective norms capture the perceived social pressure from important others to perform or not perform the behavior; and perceived behavioral control represents the perceived ease or difficulty of carrying out the behavior. Together, these constructs shape behavioral intentions, which in turn predict actual behavior. In the context of the Tokyo Marathon, TPB provides a robust framework to explain how environmental awareness, social expectations, and personal efficacy drive sustainable transport and active participation decisions.

Recent research has shown that environmental awareness positively influences attitudes and perceived behavioral control in sporting contexts (Tandamrong & Laphet, 2025), while perceived quality of event organization can enhance participant satisfaction and behavioral intentions. Furthermore, social norms have been identified as significant predictors of pro-environmental behavior in sport tourism and mass participation events (Tang et al., 2022). By applying these insights to the Tokyo Marathon context, this study bridges the gap between sport participation, environmental sustainability, and active transport behavior (Capdevila, et al., 2025).

Mega sporting events have become increasingly significant on both global and regional scales, serving as powerful platforms to foster community engagement, promote healthy lifestyles, and generate substantial economic and cultural benefits. Among these events, the Tokyo Marathon stands out as one of the most prestigious races in the world, being part of the World Marathon Majors (Sugawara, et al., 2022), alongside the Boston, London, Berlin, Chicago, and New York City marathons. First held in 2007, the Tokyo Marathon quickly grew in reputation, attracting elite athletes and recreational runners from around the globe. The race route is not only a test of endurance but also a cultural journey, passing iconic landmarks such as the Imperial Palace, Tokyo Station, and Asakusa, offering participants a unique combination of sport and sightseeing (Kumar, et al., 2025). While these events contribute immensely to host cities' economies through tourism, sponsorship, and media exposure, they also pose significant challenges, especially in terms of environmental impact. Large crowds, logistical requirements, and support services generate substantial waste, increase carbon footprints, and place pressure on local transportation systems. In the context of a global movement towards sustainability, it has become essential for mega sporting events to integrate environmental responsibility into their planning and execution. The Tokyo Marathon is recognized for its efforts to become a 'green marathon,' implementing initiatives such as waste sorting, the use of biodegradable materials, and encouraging public transportation for participants and spectators (Antunes, et al., 2025). However, the degree to which runners themselves are aware of and engaged in environmentally responsible behavior remains underexplored. Understanding runners' travel behaviors how they commute to the event, the transportation modes they choose, and the motivations behind these choices is critical to designing strategies that reduce environmental impact while enhancing the participant experience (Tangporm, et al., 2025).

In addition to environmental concerns, mega sporting events also play a vital role in promoting public health. Running, as a physical activity, contributes to cardiovascular health, mental well-being, and overall fitness (Hadyansah, et al., 2025). When combined with environmental awareness, events like the Tokyo Marathon have the potential to simultaneously foster sustainable practices and healthier lifestyles. The dual objectives of environmental sustainability and public health promotion make the Tokyo Marathon a particularly relevant case study for examining the intersection between sport, tourism, and environmental responsibility (Carrión-Bósquez, et al., 2025).

This research focuses on four interconnected dimensions: (1) environmental awareness among runners, (2) perceived quality of the marathon's environmental management, (3) the behavioral patterns of runners in traveling to participate in the Tokyo Marathon, and (4) cultural behavior, which reflects how cultural norms, values, and traditions influence runners' attitudes and choices regarding sustainable practices. By analyzing these factors, the study aims to identify the key drivers that influence sustainable travel behavior, as well as the barriers that may prevent runners from adopting greener transportation options (Tangporm, et al., 2025).

The study is guided by the Theory of Planned Behavior (TPB), which posits that human action is influenced by attitudes toward the behavior, subjective norms, and perceived behavioral control. Applying this framework allows for a deeper understanding of how environmental awareness and cultural behavior translate or fail to translate into actual behavior. Furthermore, the concept of Green Marathon Perceived Quality (PQ) is integrated into the model, acknowledging that participants' perceptions of the event's environmental initiatives shaped by both environmental awareness and cultural context can significantly influence their satisfaction and future participation intentions.

Related work

Literature Review

Environmental Awareness (EA)

Environmental awareness refers to the depth of individuals' understanding, concern, and knowledge about ecological issues and their willingness to act in ways that protect the environment (Tandamrong & Laphet, 2025). In the context of mass sporting events like marathons, such awareness directly influences participants' choices, particularly their transportation behavior. Recent evidence suggests that addressing environmental issues within athletic communities can shape sustainable travel intentions and actions.

For instance, Braksiek et al. (2021) applied the Theory of Planned Behavior to sports club members in Germany and found that environmental awareness, paired with perceived behavioral control and positive attitude, significantly predicted intentions toward environmentally friendly behaviors. Their findings underscore the importance of EA in shaping sustainable behavioral intentions in sporting contexts. Additionally, a study on green event initiatives, such as waste management and biodegradable materials, revealed that participants with higher EA rated perceived event quality higher, leading to greater satisfaction and commitment to sustainability (Carrión-Bósquez, et al., 2025; Laphet &Tandamrong, 2025)

Within the Tokyo Marathon context, promoting environmental awareness can be instrumental in encouraging runners to use low-impact transport modes like public transit, cycling, or walking thus blending environmental values with health behaviors. Providing pre-event educational materials, visible sustainability practices onsite (e.g., waste sorting, refillable water stations), and strong environmental messaging can heighten awareness levels among participants, leading to more sustainable transport decisions (Dhungana, et al., 2021).

Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (Ajzen, 1991) posits that human behavior is driven by behavioral intentions, which are influenced by three core constructs: attitude toward the behavior, subjective norms, and perceived behavioral control (PBC). In sport and physical activity domains, TPB remains a robust theoretical framework to understand and predict behavior changes.

Braksiek et al. (2021) employed TPB to assess environmentally friendly behavioral intentions among sports club members, demonstrating that attitudes, subjective norms, and PBC were significant predictors of intentions across genders and sports types. Their results validate TPB's efficacy in explaining intentions to carry out eco-conscious behaviors in sporting environments. Moreover, used TPB to analyze traffic violation behavior among e-bike riders in China, affirming that attitude, norms, and PBC significantly shaped intention and actual behavior.In the Tokyo Marathon scenario (Halim, et al., 2022), TPB can guide understanding of how runners decide on transport modes. Attitude reflects runners' positive evaluation of active and eco-friendly transport for health or environmental benefits; subjective norms capture the influence of peers, fellow runners, or cultural expectations promoting sustainable choices; and PBC denotes participants' confidence in using sustainable transport despite potential constraints like distance or convenience.

Perceived Quality (PQ) in Green Marathons

Perceived Quality (PQ) in green marathons not only influences participants' immediate satisfaction but also plays a crucial role in shaping their long-term attitudes towards environmental responsibility. When runners perceive that a marathon actively adopts sustainable practices, they are more likely to develop a positive association with the event's environmental values. This perception can lead to increased word-of-mouth promotion (Wang, et al., 2023), attracting more eco-conscious participants in future editions. Moreover, high PQ in environmentally sustainable logistics, such as the use of biodegradable materials, efficient shuttle services, and waste management systems, reinforces participants' trust in the event's commitment to ecological preservation (Martínez-Cevallos, et al., 2025)

In addition, transparent communication about environmental efforts strengthens perceived quality, as participants feel more engaged and informed about the event's sustainability initiatives. This sense of involvement may also motivate runners to extend their environmentally responsible behaviors beyond the race day, such as choosing public transportation, cycling, or walking for their commute (Kumar, et al., 2025).

Furthermore, organizers that prioritize environmental quality often implement feedback mechanisms, allowing participants to voice their opinions or suggestions. This participatory approach can enhance perceived quality by demonstrating that organizers value and respond to environmental concerns. Over time, these practices build a sustainable community ethos among runners, encouraging ongoing responsible behavior that benefits broader ecological goals. Ultimately, perceived quality acts as a vital driver linking environmental initiatives directly to participant behavior and commitment to sustainability beyond the marathon evento (Tangporm, et al., 2025).

Physical Activity (PA)

Physical activity refers to any bodily movement that results in energy expenditure, encompassing leisure, transport, sport, and health-related activity. Transport-related physical activity such as walking or cycling contributes to cardiovascular fitness, mental well-being, and reductions in non-communicable disease risks. Active commuting has seen renewed interest in recent years. Research indicates that active commuting results in fewer sick days up to 12% lower risk for short-term sickness absences and 18% lower risk for long-term absences in a Finnish cohort. These findings illustrate tangible physical and mental health benefits of integrating exercise into daily transportation. Within the framework of the Tokyo Marathon, reimagining runner transport behavior as active transport aligns the event with both sustainability and health promotion (Esteves Villanueva, et al., 2025). Choosing to walk or bike to the race site not only reduces carbon impact but also adds meaningful physical activity to participants' routines, reinforcing the holistic value of the marathon as both a sporting and environmental event.

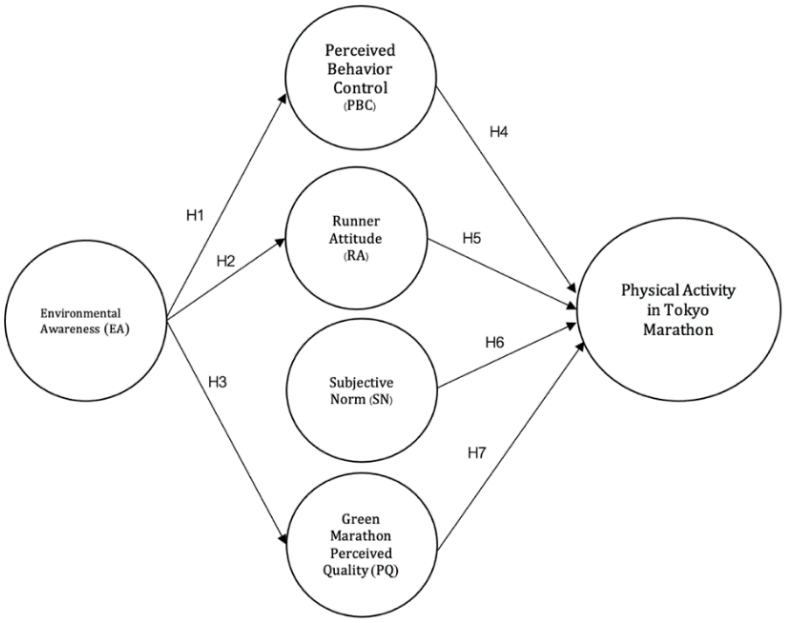
Based on the literature review, the research framework integrates concepts from environmental psychology, sustainable event management, and sports tourism behavior to examine the relationships among environmental awareness, perceived behavioral control, runner attitude, subjective norms, perceived quality of green marathon management, and runner behavior in transport to participate in the Tokyo Marathon.

The framework draws on the Theory of Planned Behavior (Ajzen, 1991), which posits that intention and behavior are shaped by attitudes, subjective norms, and perceived behavioral control. Environmental awareness is included as a precursor influencing these three TPB components, while perceived quality

of green marathon practices is hypothesized to have a direct effect on runner behavior. The framework assumes that higher environmental awareness leads to more favorable attitudes, stronger perceived behavioral control, and better perceptions of the event's environmental quality, all of which promote sustainable travel behavior (Izquierdo Rus, 2025).

This conceptualization allows for a multi-path analysis, where the impact of environmental awareness is both direct and mediated by other constructs. The model also acknowledges the role of subjective norms, recognizing that peer influence and social expectations can be powerful motivators for adopting eco-friendly behaviors.

Figure 1. Conceptual research framework



H1: Environmental Awareness (EA) positively influences Perceived Behavioral Control (PBC) of runners in the Tokyo Marathon.

In line with the Theory of Planned Behavior (Ajzen, 1991), perceived behavioral control a person's belief in their ability to enact a behavior is crucial for behavior adoption. In environmental psychology, stronger environmental awareness enhances individuals' confidence to choose sustainable transport options such as public transit or cycling. Supportive evidence comes from a study in Retos that found PBC to be the strongest predictor of sustainable bicycle use among university students highlighting how individuals who feel in control of their transport choices are more likely to adopt pro-environmental behavior

H2: Environmental Awareness (EA) positively influences Runner Attitude (RA) toward participating in the Tokyo Marathon *(*He, et al., 2022*)*.

People who are more environmentally aware typically hold more positive attitudes toward behaviors that align with sustainability values *(*Boermans, et al., 2024*)*. This alignment fosters appreciation for transport choices that benefit both personal health and the environment.

H3: Environmental Awareness (EA) positively influences Green Marathon Perceived Quality (PQ) in the Tokyo Marathon.

Participants with heightened environmental awareness are more likely to perceive and appreciate organizers' green initiatives. High perceived quality reflects better recognition of waste sorting, biodegradable materials, and sustainable event management.

H4: Perceived Behavioral Control (PBC) positively influences Physical Activity in the Tokyo Marathon.

When individuals feel they can control their transportation decisions (e.g., choose cycling or walking), they are more inclined to engage in physical activity improving both health and environmental outcomes.

H5: Runner Attitude (RA) positively influences Physical Activity in the Tokyo Marathon.

Positive attitudes toward active transportation, shaped by personal values and environmental awareness, can lead to actual physical action such as choosing to walk or bike to the marathon venue.

H6: Subjective Norm (SN) positively influences Physical Activity in the Tokyo Marathon.

Social influence from peers, family, or community can motivate individuals to adopt sustainable transport behaviors, aligning with broader TPB findings on norm-driven behavior change.

H7: Green Marathon Perceived Quality (PQ) positively influences Physical Activity in the Tokyo Marathon (Tangporm, et al., 2025).

When participants perceive the event as environmentally mindful, they are more likely to reciprocate by choosing sustainable and active modes of travel.

Research Design

This research employed a quantitative, descriptive, and correlational design to examine how motivational drivers from physical activity and sport perspectives influence sustainable runner transport behavior in the Tokyo Marathon 2025. Guided by the Theory of Planned Behavior (Ajzen, 1991), the study investigated the relationships among Environmental Awareness (EA), Runner Attitude (RA), Perceived Behavioral Control (PBC), Subjective Norms (SN), and Green Marathon Perceived Quality (PQ) in shaping sustainable transport and physical activity behavior. The design was both exploratory, seeking to understand global runners' perceptions, and explanatory, testing the hypothesized model of sustainable transport decision-making in a mega sporting event context. The methodology was structured and reported following the STROBE checklist for observational studies, ensuring transparency in reporting study design, sampling, data collection, and analysis.

Participants

The target population comprised the 36,175 registered runners who participated in the Tokyo Marathon 2025. From this population, a stratified sampling approach was employed to ensure diversity in age, gender, nationality, and running experience. A total of 300 valid responses were collected from international and domestic runners across all regions. Participants ranged in age from 20 to 60 years, with representation from elite athletes, experienced marathoners, and recreational runners. All participants voluntarily consented to take part in the study after being informed of its academic purpose. Ethical approval was obtained from the Tokyo Marathon Foundation's academic review board, as well as the ethics committee of Burapha University (Approval No. IRB2-120/2568).

Procedure

Data were collected through a structured online questionnaire distributed during and immediately after the Tokyo Marathon 2025. Survey links and QR codes were provided at the marathon expo, race registration centers, and official digital channels, ensuring accessibility for international participants. The data collection period lasted four weeks following the event. Respondents were assured of confidentiality and anonymity to encourage honest and accurate responses.

Instrument

The questionnaire consisted of four main sections. Part 1 gathered demographic information (gender, age, nationality, education, occupation, and running experience). Part 2 measured Environmental Awareness (EA), focusing on runners' ecological knowledge and commitment to sustainable behavior. Part 3 assessed the Theory of Planned Behavior (RA, PBC, and SN) using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Part 4 evaluated Perceived Quality (PQ) of the Tokyo Marathon's environmental management, including waste sorting, public transport promotion, and eco-

friendly logistics. Additionally, participants self-reported their transport behavior and active commuting choices (e.g., walking, cycling, or using public transit to the event).

The instrument was pilot tested with 30 runners to verify clarity, reliability, and validity. Cronbach's alpha values for all constructs exceeded 0.85, confirming strong internal consistency. Content validity was established through expert review in sports management, environmental psychology, and sustainable tourism, with Index of Item Objective Congruence (IOC) scores above 0.70. The study followed ethical standards consistent with international research guidelines.

Data analysis

Data collection was carried out online through Facebook and LINE groups using Google Forms to ensure convenient access for both domestic and international runners. The responses were processed through a multi-step statistical procedure. First, descriptive statistics (frequency, percentage, mean, and standard deviation) were applied to summarize demographic profiles and general characteristics of the participants. Next, Confirmatory Factor Analysis (CFA) was conducted to validate the measurement model, examining the relationship between latent constructs (EA, RA, PBC, SN, PQ, and PA) and their observed indicators. Model reliability was confirmed through Cronbach's alpha coefficients, with all constructs meeting the ≥ 0.70 threshold, ensuring acceptable internal consistency. Both convergent and discriminant validity were evaluated using Average Variance Extracted (AVE) and the Fornell-Larcker criterion, ensuring the constructs measured distinct yet related concepts. Following this, Structural Equation Modeling (SEM) was employed to test the hypothesized model and evaluate the overall fit indices.

Additionally, bootstrapping procedures were used to generate confidence intervals for the estimated path coefficients, enhancing the robustness of the hypothesis testing. Significance levels were assessed to determine the strength, direction, and statistical validity of the relationships among Environmental Awareness, Theory of Planned Behavior constructs, Perceived Quality, and Physical Activity.

Results

Based on data collected from 300 valid respondents, the findings indicate that the majority were international runners traveling to participate in the Tokyo Marathon, representing the global athletic community targeted in this study. Most individuals reported having engaged in a Green Marathon or similar sustainable sporting events at least once before, reflecting prior experience with environmentally responsible sport participation. However, the relatively small proportion of first-time runners suggests that generalizability toward newcomers may be limited.

In terms of gender distribution, female participants accounted for 52.7%, followed by male runners at 44.0%, and 3.3% identified as other or alternative gender identities. The most prevalent age group was 20–29 years old (48.0%), followed by 30–39 years old (27.3%), with smaller proportions in the 40–49 age group (15.7%) and the 50–59 age group (9.0%). These distributions indicate that the Tokyo Marathon continues to attract a younger cohort of international runners motivated by both physical activity and global sport participation.

Regarding occupation, students comprised the largest group (28.7%), reflecting the appeal of sport tourism and active lifestyle motivations among younger demographics. They were followed by entrepreneurs (21.0%) and corporate employees (20.3%), while self-employed individuals (15.0%) and civil servants or government employees (15.0%) formed smaller groups. In terms of economic background, the majority earned less than 25,000 baht (38.3%), followed by 25,001–35,000 baht (24.0%), 35,001–55,000 baht (20.0%), and 17.7% earned above 55,000 baht. These figures suggest that participation in the Tokyo Marathon cuts across a range of income levels, reflecting the diverse motivational drivers linked to both health enhancement and sport experience.

With respect to participation frequency, most respondents had competed in the marathon twice (46.0%), followed by 3–5 times (32.7%), and more than 5 times (10.3%), while 11.0% were first-time participants. The predominance of repeat runners highlights strong motivational factors related to sustained sport involvement, physical activity benefits, and loyalty toward mega sporting events.

Overall, the demographic profile illustrates that the sample is dominated by young international runners motivated by both physical activity and sport-related experiences, with diverse occupational and income backgrounds. The findings emphasize that motivational drivers—ranging from health, physical fitness, and active lifestyle benefits to the prestige of participating in a global sporting event—play a central role in shaping transport behavior among Tokyo Marathon participants The measurement model's fit statistics are summarized in Table 1, providing an overview of the model evaluation.

Table 1. Summarizes the fit statistics of the measurement model

	Saturated model	Estimated model
SRMR	0.060	0.080
d_ULS	1.676	2.997
d_G	0.962	1.140

Note: RMSEA = Root means square error approximation.

Table 1 presents the fit statistics of the measurement model, which was assessed to evaluate whether the proposed constructs adequately represent the data collected from Tokyo Marathon participants. The SRMR values (0.060 for the saturated model and 0.080 for the estimated model) fall within the recommended threshold of ≤ 0.08, indicating that the measurement model achieves an acceptable fit between the observed and predicted correlations. The d_ULS (1.676 for the saturated model and 2.997 for the estimated model) and d_G (0.962 for the saturated model and 1.140 for the estimated model) values are within acceptable ranges, supporting the model's adequacy in capturing relationships among the constructs.

Overall, these indices suggest that the measurement model demonstrates a satisfactory fit to the data, providing confidence that the latent variables such as Environmental Awareness, Physical Activity Self-Determination, and Green Marathon Perceived Quality are appropriately measured and can be validly used in subsequent structural analysis.

The assessment of the measurement model adhered to the guidelines proposed by Hair et al. (2017), focusing on evaluating the reliability, convergent validity, and discriminant validity of the key constructs: Environmental Awareness (EA), Perceived Behavioral Control (PBC), Runner Attitude (RA), Subjective Norms (SN), Green Marathon Perceived Quality (PQ), and Physical Activity in the Tokyo Marathon (PA).

As shown in Table 2, all factor loadings exceeded the recommended threshold of 0.70 (Nunnally, 1978), ranging from 0.737 to 0.905, with t-values far above 1.96, confirming strong item reliability. Internal consistency was verified by Cronbach's alpha (α) and Composite Reliability (CR), with all constructs surpassing the minimum acceptable level of 0.70. For example, EA achieved CR = 0.929 and α = 0.904, while PA reported CR = 0.905 and α = 0.868, both of which reflect high internal consistency.

Convergent validity was confirmed through Average Variance Extracted (AVE), with all constructs achieving values above the recommended cutoff of 0.50 (Fornell & Larcker, 1981). The AVE scores ranged from 0.607 (PQ) to 0.724 (EA), indicating that a substantial proportion of variance is explained by the respective latent constructs. Furthermore, Variance Inflation Factor (VIF) values ranged from 1.689 to 3.761, all below the critical value of 5.0, suggesting that multicollinearity was not a concern.

Discriminant validity was examined using the Fornell–Larcker criterion, with results presented in Table 3. The square roots of AVE for each construct (diagonal values) were greater than their correlations with other constructs, confirming discriminant validity. For example, the square root of AVE for Environmental Awareness (0.851) exceeded its highest correlation with other variables, while Physical Activity (0.809) was also greater than its correlations with related constructs such as Runner Attitude (0.736) and Perceived Quality (0.752). These results indicate that each construct is conceptually distinct and not redundant with others.

Overall, the measurement model demonstrates adequate reliability, convergent validity, and discriminant validity, confirming that the constructs spanning psychological drivers, motivational factors, and perceived event quality are appropriately measured and robust for subsequent structural analysis.

Table 4 presents the cross-loading values for all items across the six constructs: Environmental Awareness (EA), Perceived Behavioral Control (PBC), Runner Attitude (RA), Subjective Norms (SN), Perceived Quality (PQ), and Physical Activity (PA). A measurement item demonstrates discriminant validity when its loading on the intended construct is higher than its loadings on other constructs (Hair et al., 2017).

The results in Table 4 confirm that all items loaded more strongly on their associated constructs than on other constructs. For instance, EA5 (0.905) loaded highest on Environmental Awareness compared to other constructs (e.g., 0.760 on RA, 0.764 on SN, 0.771 on PQ, 0.723 on PA). Similarly, PBC3 (0.847) showed its strongest loading on Perceived Behavioral Control, while its correlations with other constructs remained lower. For Runner Attitude, items such as RA3 (0.806) and RA5 (0.804) clearly demonstrated stronger associations with RA than with alternative constructs.

The Subjective Norms construct also showed consistent patterns, with SN5 (0.822) exceeding its cross-loadings with EA (0.693) and PQ (0.689). Items for Perceived Quality were most strongly associated with their construct, as seen in PQ1 (0.806), while Physical Activity indicators such as PA3 (0.858) and PA4 (0.839) displayed high loadings on their intended construct, confirming construct distinctiveness.

Overall, the cross-loading results indicate that each construct is empirically distinct, and the measurement model satisfies the discriminant validity criterion. This reinforces the earlier findings from the Fornell–Larcker criterion (Table 3), confirming that the latent constructs psychological drivers, social influences, perceived event quality, and physical activity are well represented by their respective measurement items.

Table 2. Measurement model results.

Constructs	Measurement Label	VIF	Loading	t-value
Environment Awareness)EA(CR=.929; α = .904; AVE = .724	EA1. How much do runners understand the environmental impacts of this event?	2.047	0.799	22.898
	EA2. How much do runners prioritize environmental conservation during the marathon?	2.700	0.860	38.267
	EA3. Do runners feel their environmental knowledge is sufficient?	3.270	0.869	37.318
	EA4. To what extent do runners perceive their role in reducing environmental impacts?	2.434	0.815	27.409
	EA5. How adequate are the environmental information and guidance provided by the event?	3.761	0.905	58.562
Perceived Behavioral Control)PBC(CR= .890; α = .919; AVE = .695	PBC1. How much do runners feel they can practice environmentally friendly behaviors?	2.071	0.812	27.236
	PBC2. How much do runners perceive they have control over reducing environmental impacts?	1.938	0.794	24.704
	PBC3. To what extent do runners see obstacles to practicing eco-friendly behaviors?	2.470	0.847	34.825
	PBC4. How confident are runners in their ability to change their environmental behaviors?	2.185	0.830	33.369
	PBC5. How much do community support and event organization influence their control over behaviors?	2.362	0.847	38.104
Runner Attitude)RA(CR= .890; α = .846; AVE = .619	RA1. I How important do runners perceive environmental preservation?	1.794	0.775	27.840
	RA2. How much do runners believe promoting sustainable running is their responsibility?	1.791	0.777	19.916
	RA3. Do runners see being a “green runner” as important in their lives?	1.934	0.806	39.728
	RA4. Does environmental knowledge influence runners’ attitudes?	1.689	0.770	33.776
	RA5. What are runners’ views on sustainability in event organization?	1.917	0.804	37.845
Subjective Norms)SN(CR= 898.; α = .857; AVE = .637	SN1. How much do runners feel that social norms, cultural expectations, and societal values influence their eco-friendly behaviors?	2.073	0.813	25.573
	SN2. To what extent do social support from community, family, and cultural networks impact their environmentally responsible actions?	1.693	0.770	19.602
	SN3. How strongly do social and cultural values regarding sports, environment, and sustainability influence runners’ behaviors?	1.905	0.792	24.484
	SN4. Do runners perceive friends’, community, and cultural expectations as significant motivators for their green behaviors?	1.758	0.792	28.300
	SN5. How much does social pressure, rooted in cultural norms and traditions, impact runners’ commitment to sustainability?	2.026	0.822	32.238
Green Marathon Perceived Quality)PQ(CR= .885; α = .893; AVE = .607	PQ1. How much do runners perceive the quality of the green marathon as environmentally friendly?	1.869	0.806	27.715
	PQ2. To what extent do runners think the event is well-organized and offers good services?	1.784	0.765	19.777
	PQ3. How high is the perceived quality of the race route and venues?	2.004	0.791	23.040
	PQ4. How much importance do runners place on recycled materials and waste management?	1.927	0.790	25.435
	PQ5. How reliable and internationally standardized do runners see the event?	1.783	0.743	16.567
Physical Activity in the Tokyo Marathon.)PA(CR= .905;	PA1. How much do runners feel that participating in the marathon enhances their physical health and fitness?	1.946	0.785	27.840
	PA2. To what extent do runners view marathon training and participation as enhancing discipline and commitment in daily life?	1.722	0.737	19.916

α = .868; AVE = .655	PA3. How important are psychological benefits, such as happiness and relaxation, from participating in the marathon?	2.463	0.858	39.728
	PA4. How much does participating in this marathon inspire runners to continue exercising in the future?	2.361	0.839	33.776
	PA5. To what extent do runners perceive marathon participation as connected to promoting a sustainable lifestyle?	2.246	0.823	37.845

Table 3. Discriminant validity using the Fornell–Larcker criterion

Construct	EA	PBC	RA	SN	PQ	PA
Environment Awareness)EA(	0.851					
Perceived Behavioral Control)PBC(	0.850	0.826				
Runner Attitude)RA(	0.779	0.776	0.786			
Subjective Norms)SN(	0.845	0.840	0.787	0.798		
Green Marathon Perceived Quality)PQ(	0.839	0.822	0.849	0.843	0.779	
Physical Activity in the Tokyo Marathon.)PA(	0.774	0.844	0.736	0.755	0.752	0.809

Notes: the values of the square root of AVE are presented through the italicized diagonal elements. the other elements present the mutual correlations among the constructs.

Table 4. Cross loading

Items Codes	EA	PBC	RA	SN	PQ	PA
EA1	0.799	0.728	0.639	0.646	0.698	0.666
EA2	0.860	0.739	0.632	0.756	0.728	0.652
EA3	0.869	0.687	0.643	0.680	0.670	0.619
EA4	0.815	0.701	0.631	0.744	0.696	0.627
EA5	0.905	0.759	0.760	0.764	0.771	0.723
PBC1	0.616	0.812	0.618	0.676	0.634	0.717
PBC2	0.712	0.794	0.653	0.649	0.639	0.684
PBC3	0.693	0.847	0.633	0.707	0.671	0.716
PBC4	0.740	0.830	0.631	0.710	0.724	0.682
PBC5	0.746	0.847	0.670	0.727	0.723	0.689
RA1	0.577	0.606	0.775	0.643	0.629	0.557
RA2	0.621	0.556	0.777	0.570	0.689	0.540
RA3	0.640	0.646	0.806	0.642	0.680	0.612
RA4	0.609	0.617	0.770	0.617	0.670	0.599
RA5	0.616	0.623	0.804	0.623	0.669	0.582
SN1	0.683	0.652	0.619	0.813	0.654	0.546
SN2	0.691	0.676	0.630	0.770	0.682	0.602
SN3	0.596	0.630	0.602	0.792	0.607	0.573
SN4	0.702	0.696	0.660	0.792	0.721	0.651
SN5	0.693	0.692	0.624	0.822	0.689	0.627
PQ1	0.705	0.649	0.664	0.686	0.806	0.588
PQ2	0.677	0.731	0.669	0.742	0.765	0.643
PQ3	0.620	0.590	0.648	0.569	0.791	0.555
PQ4	0.682	0.681	0.692	0.704	0.790	0.609
PQ5	0.573	0.532	0.631	0.563	0.743	0.525
PA1	0.617	0.614	0.594	0.523	0.570	0.785
PA2	0.534	0.625	0.517	0.577	0.553	0.737
PA3	0.683	0.729	0.639	0.630	0.667	0.858
PA4	0.618	0.713	0.550	0.641	0.583	0.839
PA5	0.673	0.724	0.669	0.673	0.662	0.823

Table 5. Path analyses (direct effects).

Direct Effect	Path	t-Value	P-Values	Results
H1	EA → PBC	37.297***	0.000	Accepted
H2	EA → RA	26.510***	0.000	Accepted
H3	EA → PQ	39.083***	0.000	Accepted
H4	PBC → PA	8.925***	0.000	Accepted
H5	RA → PA	2.269*	0.023	Accepted
H6	SN → PA	0.747	0.455	Rejected
H7	PQ → PA	0.661	0.509	Rejected

Notes: *p < 0.05, **p < 0.01, ***p < 0.001

The results in Table 5 and the structural equation model (Figure) demonstrate the relationships among Environmental Awareness (EA), Perceived Behavior Control (PBC), Runner Attitude (RA), Subjective Norm (SN), Green Marathon Perceived Quality (PQ), and Physical Activity in the Tokyo Marathon (PA).

H1 (EA → PBC): Supported (t = 37.297, p < 0.001). This indicates that higher environmental awareness significantly enhances runners' perceived behavioral control, meaning that awareness of environmental issues empowers athletes to feel more capable of engaging in eco-friendly physical activities.

H2 (EA → RA): Supported (t = 26.510, p < 0.001). Environmental awareness has a strong positive influence on runner attitudes, suggesting that awareness fosters favorable attitudes toward participating in sustainable sporting events.

H3 (EA → PQ): Supported (t = 39.083, p < 0.001). Participants with higher environmental awareness tend to perceive the green marathon quality more positively, highlighting the importance of ecological knowledge in shaping perceptions of event quality.

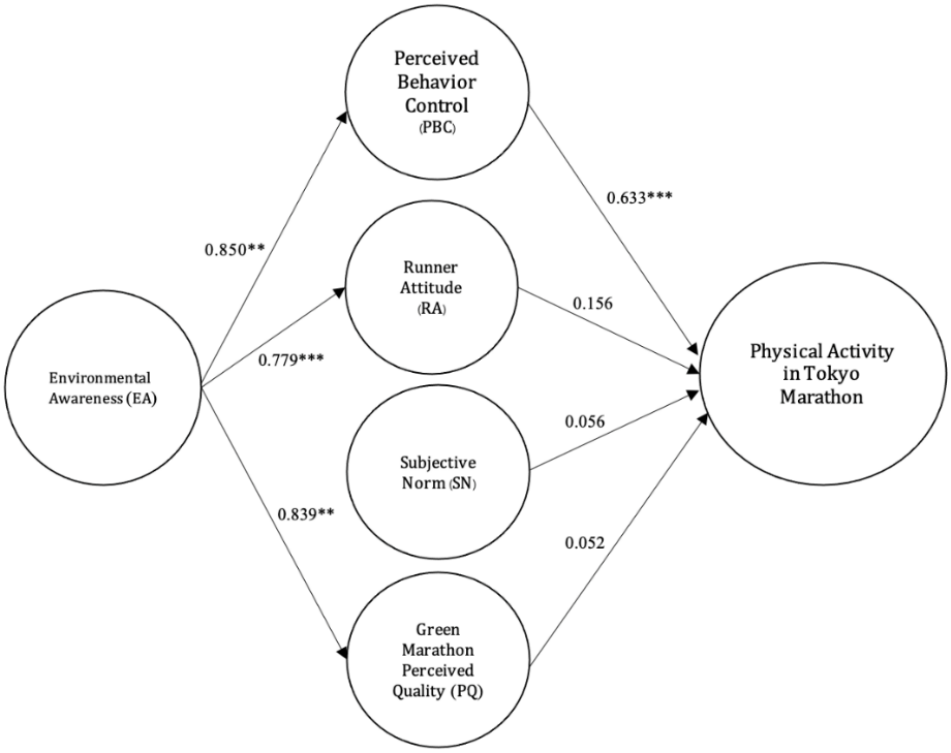
H4 (PBC → PA): Supported (t = 8.925, p < 0.001). Perceived behavioral control strongly predicts physical activity in the Tokyo Marathon, confirming that confidence in one's ability directly drives actual participation.

H5 (RA → PA): Supported (t = 2.269, p = 0.023). Runner attitude also exerts a significant influence on physical activity, showing that positive attitudes can motivate participation.

H6 (SN → PA): Not supported (t = 0.747, p = 0.455). Subjective norm (perceived social pressure) does not significantly affect physical activity, indicating that external expectations from peers or society may not be a decisive factor.

H7 (PQ → PA): Not supported (t = 0.661, p = 0.509). Green marathon perceived quality does not significantly drive physical activity, suggesting that even if participants view the marathon as environmentally friendly, this perception alone does not strongly determine their engagement.

Figure 2. Results of PLS-SEM



The structural model (Figure 2) visualizes these relationships: Environmental Awareness strongly predicts PBC, RA, and PQ (β = 0.850, 0.779, and 0.839 respectively), Among the predictors of Physical Activity in the Tokyo Marathon, only PBC (β = 0.633) and RA (β = 0.156) are significant, The paths from SN (β = 0.056) and PQ (β = 0.052) to physical activity are weak and not statistically significant.

Discussion

The findings of this study provide valuable insights into the motivational drivers influencing runner transport behavior and physical activity at the Tokyo Marathon, emphasizing the interplay between environmental awareness, psychological constructs, and perceived event quality. Consistent with the Theory of Planned Behavior (Ajzen, 1991), Environmental Awareness (EA) emerged as a significant antecedent for Perceived Behavioral Control (PBC), Runner Attitude (RA), and Green Marathon Perceived Quality (PQ). The strong positive effects of EA on PBC ($t = 37.297$, $p < 0.001$) suggest that runners who are more knowledgeable and conscious of environmental issues feel empowered to engage in sustainable behaviors, such as choosing active transportation modes or utilizing public transit. To strengthen the interpretation, these findings can be compared with recent studies published in Retos (e.g., Antunes et al., 2025; Esteves Villanueva et al., 2025; Izquierdo Rus, 2025; Tangporm et al., 2025), which highlight the interplay between environmental values, physical activity, and sustainable behaviors in diverse contexts. Expanding the discussion in this manner provides stronger theoretical grounding and situates the study within the most recent academic debates.

This aligns with previous research indicating that heightened environmental awareness enhances confidence in enacting eco-friendly practices (Braksiek et al., 2021; Triantafyllidis & Kaplanidou, 2022). The significant influence of EA on RA ($t = 26.510$, $p < 0.001$) also underscores the role of environmental knowledge in shaping attitudes toward sustainability in sports. Runners with higher environmental consciousness demonstrated stronger positive attitudes toward participating in a "green marathon," reflecting an internalized value system where personal health, physical activity, and ecological responsibility are closely linked (Gkarane, et al., 2025). This result resonates with prior literature emphasizing the integration of environmental values into sport-related behaviors (Tangporm, et al., 2025). Similarly, the positive effect of EA on PQ ($t = 39.083$, $p < 0.001$) highlights that participants with greater ecological awareness perceive the event's environmental management more favorably. This reinforces the notion that perceptions of organizational sustainability practices can be influenced by prior knowledge and personal commitment to environmental stewardship, which may enhance satisfaction and engagement in long-term eco-conscious behaviors.

Regarding determinants of physical activity, both PBC ($t = 8.925$, $p < 0.001$) and RA ($t = 2.269$, $p = 0.023$) significantly predicted participation. These findings indicate that runners' confidence in their ability to act sustainably and their favorable attitudes toward active transport are key drivers of actual behavior. In contrast, Subjective Norms (SN) and Perceived Quality (PQ) did not significantly influence physical activity, suggesting that external social pressures and perceived event quality alone are insufficient to motivate behavior. This may reflect a highly individualized decision-making process among runners, where personal values, capabilities, and attitudes override societal or organizational cues. It also highlights the importance of intrinsic motivation in sport-related environmental behaviors, consistent with sport psychology research emphasizing self-determined engagement over externally imposed expectations (Valero-Valenzuela A, et al., 2024; Kudinska, et al., 2025).

Overall, these findings suggest that interventions aimed at promoting sustainable runner transport should focus on enhancing environmental awareness and fostering positive attitudes, alongside supporting runners' perceived behavioral control. Practical strategies could include pre-event education on ecological impacts, visible sustainability practices at the marathon, and opportunities for participants to engage in active commuting. While PQ and SN are valuable for overall event experience and community-building, they appear less influential in directly shaping transport-related physical activity.

Conclusion

This study examined the motivational drivers influencing runner transport behavior and physical activity in the context of the Tokyo Marathon, integrating concepts from the Theory of Planned Behavior, environmental awareness, and green marathon perceived quality. The findings reveal that Environmental Awareness (EA) serves as a foundational determinant, significantly enhancing Perceived Behavioral Control (PBC), Runner Attitude (RA), and perceptions of Green Marathon Quality (PQ). Runners who are more environmentally conscious feel more capable of adopting sustainable transport options, hold more

favorable attitudes toward eco-friendly behaviors, and recognize the marathon's environmental initiatives more positively. These results underscore the centrality of knowledge and awareness in shaping both psychological determinants and perceptions of event sustainability.

The study further demonstrates that actual physical activity among participants is strongly influenced by PBC and RA, suggesting that confidence in one's ability to engage in eco-friendly behaviors and positive attitudes toward active transport are critical for translating intentions into action. In contrast, Subjective Norms (SN) and PQ were not significant predictors of physical activity, highlighting that external social pressures and perceived event quality alone are insufficient to drive behavior. This emphasizes the importance of intrinsic motivation and personal efficacy in fostering sustainable transport practices within sport tourism contexts.

From a practical perspective, the findings provide actionable insights for marathon organizers, policymakers, and sport managers. Efforts to enhance environmental awareness through pre-event education, visible sustainability initiatives, and opportunities for active commuting can effectively promote both health-enhancing physical activity and environmentally responsible behaviors. While social influence and perceived event quality contribute to overall satisfaction, fostering personal attitudes and self-efficacy appears to be more effective in shaping sustainable transport behavior.

In conclusion, the research highlights the interplay between environmental awareness, psychological drivers, and physical activity, demonstrating that individual knowledge and attitudes are key levers for promoting sustainable and health-conscious behaviors in mega sporting events. By leveraging these insights, events like the Tokyo Marathon can serve as models for integrating environmental responsibility with sport participation, offering both ecological and public health benefits.

Limitation

This study has several limitations. First, data were self-reported via online questionnaires, which may be affected by social desirability bias or recall errors. Second, the sample of 300 runners, mainly young international participants, limits generalizability to first-time, older, or local runners. Third, the cross-sectional design prevents causal inferences, capturing only a single point in time. Future studies should also consider longitudinal approaches, incorporate objective measures (e.g., GPS-based transport tracking), and compare multiple marathon contexts to enhance external validity.

Additionally, the study focused on key constructs such as Environmental Awareness, Perceived Behavioral Control, Runner Attitude, Subjective Norms, and Green Marathon Perceived Quality, while other factors like convenience, weather, transportation infrastructure, or prior marathon experience were not examined. Finally, the Tokyo Marathon's prestige and environmental initiatives may differ from other events, limiting applicability to smaller or less environmentally focused marathons.

Future research should use longitudinal designs, diversify samples, include objective measures, and consider additional contextual factors to better understand sustainable transport and physical activity in mega sporting events.

Author contribution

Design research, K.M., W.S. and T.G; methodology, K.M. and T.G; software, W.S. and T.G; validation, K.M. and W.S.; formal analysis, K.M. and W.S.; investigation, K.M. and W.S.; data curation, K.M; writing - original draft preparation, K.M. and W.S; writing - review and editing, K.M., W.S., and T.G.; Project administration, K.M. W.S., and T.G. Summarize results W.S. and T.G., Provide Recommendations T.G. All authors have read and agreed to the published version of the manuscript. And essentially intellectual contributor: T.G.

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