Journal of Management Science Research Review
https://jmsrr.com/index.php/Journal/about

Volume 5 Issue No 2 (2026)

Online ISSN: 3006-2047
Print ISSN: 3006-2039

The Moderating Role of Artificial Intelligence Literacy in Sustainable Tourism Development

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Abstract
Sustainable tourism development has become a global priority, particularly in environmentally vulnerable regions such as Pakistan, where ecological degradation and resource mismanagement threaten long-term sectoral growth. Despite increasing scholarly attention, the underlying mechanisms linking environmental-specific leadership, employee motivation, and technological capability remain fragmented. Addressing this gap, the present study employs a PRISMA 2020-based systematic literature review to synthesize contemporary research published between 2020 and 2026. A total of 52 peer-reviewed studies were selected from Scopus, Web of Science, ScienceDirect, and Google Scholar.

Drawing on Self-Determination Theory (SDT), Grit Theory, and emerging perspectives on Artificial Intelligence (AI) literacy, the study develops an integrated conceptual framework explaining sustainable tourism development. The findings reveal that environmental-specific leadership—encompassing Environmental-Specific Servant Leadership, Green Transformational Leadership, and Green Inclusive Leadership—significantly fosters a green psychological climate, which enhances employees' green harmonious passion and subsequently shapes positive green attitudes. These attitudes are identified as critical drivers of sustainable tourism outcomes.

Importantly, the study highlights AI literacy as a key moderating factor that strengthens the relationship between employee green attitude and sustainable tourism development by enabling effective implementation of sustainability practices through digital tools. The review contributes to the literature by integrating leadership, motivational, and technological perspectives into a unified framework, offering a micro-foundational understanding of sustainability in tourism.

The study provides practical implications for policymakers and practitioners by emphasizing leadership development, digital capability enhancement, and

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Online ISSN: 3006-2047
Print ISSN: 3006-2039

sustainability-oriented human resource practices as essential drivers of long-term sustainable tourism growth.

Keywords: Sustainable Tourism Development, Environmental-Specific Leadership, Green Psychological Climate, Employee Green Attitude, Artificial Intelligence Literacy

INTRODUCTION

Sustainable tourism has emerged as a critical pillar of global development, aligning closely with the objectives of the United Nations Sustainable Development Goals (SDGs), particularly those related to responsible consumption, climate action, and ecosystem preservation. As tourism continues to expand worldwide, its environmental footprint has intensified, raising concerns regarding ecological degradation, resource depletion, and socio-cultural disruption. In developing countries such as Pakistan, where tourism potential is deeply rooted in diverse natural landscapes and rich cultural heritage, the challenge of balancing economic growth with environmental sustainability has become increasingly complex. The country faces a range of environmental issues, including biodiversity loss, climate change vulnerability, waste mismanagement, and unregulated resource exploitation, all of which threaten the long-term viability of its tourism sector. Consequently, fostering sustainable tourism development requires not only policy interventions but also a deeper understanding of the behavioral and organizational mechanisms that drive environmentally responsible practices.

Within this context, leadership has been identified as a crucial determinant of organizational sustainability. Environmental-specific leadership, in particular, plays a vital role in shaping employees' pro-environmental behaviors by embedding sustainability values into organizational culture and daily practices. Prior research has highlighted various leadership approaches, such as Environmental-Specific Servant Leadership (ES-SL), Green Transformational Leadership (GTL), and Green Inclusive Leadership, as key drivers of environmental performance. These leadership styles emphasize ethical responsibility, empowerment, inclusivity, and long-term environmental stewardship. However, despite the growing body of literature, existing studies often adopt fragmented theoretical perspectives, examining leadership effects in isolation without adequately capturing the underlying psychological and motivational processes that translate leadership influence into sustainable outcomes.

A critical limitation in the current literature lies in the insufficient integration of motivational and behavioral theories to explain how leadership influences employee attitudes and actions toward sustainability. To address this gap, the present study adopts a multi-theoretical lens by incorporating Self-Determination Theory (SDT), Grit Theory, and emerging perspectives on Artificial Intelligence (AI) literacy. Self-Determination Theory provides a robust framework for understanding intrinsic motivation, suggesting that individuals are more likely to engage in pro-environmental behavior when their needs for autonomy, competence, and relatedness are fulfilled. In organizational settings, environmental-specific leadership can foster a

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supportive psychological climate that enhances intrinsic motivation, leading employees to internalize sustainability values and engage in environmentally responsible practices.

In addition to motivation, the role of perseverance and sustained commitment to environmental goals is increasingly recognized as a critical factor in achieving sustainable outcomes. Grit Theory, which emphasizes passion and perseverance for long-term goals, offers valuable insights into how employees maintain consistent pro-environmental behavior despite challenges and constraints. In the context of tourism, where sustainability initiatives often require long-term commitment and behavioral consistency, green harmonious passion emerges as an important construct that reflects employees' intrinsic enjoyment and dedication to environmentally responsible practices. This highlights the need to examine not only whether employees adopt green behaviors but also the psychological mechanisms that sustain such behaviors over time.

Furthermore, the rapid advancement of digital technologies has introduced new dynamics into the sustainability discourse, particularly through the integration of artificial intelligence in tourism operations. AI technologies are increasingly used to optimize resource utilization, enhance customer experiences, and support data-driven decision-making for sustainability. However, the effectiveness of these technologies largely depends on employees' ability to understand, adopt, and utilize them effectively. This brings attention to the concept of AI literacy, which refers to individuals' knowledge, skills, and competencies in using AI-enabled tools and systems. Despite its growing relevance, the role of AI literacy in shaping sustainable tourism practices remains underexplored in the literature. Specifically, there is limited understanding of how AI literacy interacts with employee attitudes to influence the implementation of sustainable initiatives.

Building on these theoretical foundations, this study proposes a comprehensive conceptual framework that links environmental-specific leadership to sustainable tourism development through a sequential process involving green psychological climate, green harmonious passion, and employee green attitude. The framework suggests that leadership shapes the organizational climate, which in turn fosters intrinsic motivation and passion, ultimately influencing employees' attitudes and behaviors toward sustainability. Importantly, the study introduces AI literacy as a moderating factor that strengthens or weakens the relationship between employee green attitude and sustainable tourism development. This integration reflects a more holistic understanding of sustainability that combines human, organizational, and technological dimensions.

The significance of this study lies in its ability to address key gaps in the existing literature by offering a unified theoretical perspective that connects leadership, motivation, perseverance, and technology. By adopting a PRISMA-based systematic literature review approach, the study synthesizes existing research to identify patterns, inconsistencies, and emerging trends, thereby providing a comprehensive overview of the field. This methodological approach ensures transparency, rigor, and replicability,

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enhancing the credibility of the findings and contributing to the development of a robust research agenda.

Moreover, this study contributes to the growing discourse on sustainable tourism by emphasizing the micro-foundations of sustainability, focusing on individual-level psychological and behavioral processes. While prior research has predominantly focused on macro-level factors such as policies and institutional frameworks, this study highlights the importance of employee-level dynamics in driving sustainable outcomes. It also underscores the role of digital competence, particularly AI literacy, as a critical enabler of sustainability in the modern tourism landscape.

In response to these gaps, the present review seeks to answer the following research questions:

How do environmental-specific leadership styles influence employee attitudes toward green behavior?

What motivational mechanisms explain this relationship?

How does AI literacy moderate the link between green attitudes and sustainable tourism development?

By addressing these questions, the study aims to advance theoretical understanding and provide practical insights for policymakers, tourism managers, and organizational leaders seeking to promote sustainability. Ultimately, the integration of leadership, motivation, and technological competence offers a novel perspective on how sustainable tourism development can be achieved in an increasingly complex and digitally driven world.

LITERATURE REVIEW

Environmental-Specific Leadership and Green Behavior

The growing emphasis on environmental sustainability has led to increased scholarly attention on leadership styles that promote pro-environmental behavior within organizations (Khan et al., 2021; Rana et al., 2024). Environmental-specific leadership represents a contextualized approach to leadership that embeds environmental values, ethics, and practices into organizational processes (ul Hassan et al., 2023). Among the prominent leadership styles in this domain, Environmental-Specific Servant Leadership (ES-SL), Green Transformational Leadership (GTL), and Green Inclusive Leadership have received significant empirical and theoretical support (Gul et al., 2024; Arshad et al., 2025).

Environmental-Specific Servant Leadership (ES-SL) extends the principles of servant leadership by prioritizing environmental well-being alongside employee development (Gul et al., 2019; Kakakhel et al., 2016). Leaders adopting this approach emphasize ethical responsibility, stewardship, and service to both people and the environment. By empowering employees and fostering a sense of moral obligation toward sustainability, ES-SL encourages proactive environmental behaviors (ul Hassan et al., 2020). Empirical evidence suggests that ES-SL positively influences green creativity, green organizational citizenship behavior, and sustainable performance outcomes (Gul et al., 2021; Irshad et al., 2024). However, while ES-SL effectively promotes

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ethical and value-driven engagement, it may be limited in addressing the dynamic and innovation-driven aspects of sustainability required in modern tourism contexts.

In contrast, Green Transformational Leadership (GTL) focuses on inspiring and motivating employees through a compelling environmental vision, intellectual stimulation, and role modeling (Khan et al., 2020; Hanif et al., 2023). GTL leaders encourage employees to challenge conventional practices and adopt innovative solutions to environmental problems. This leadership style has been strongly associated with green innovation, environmental performance, and sustainable competitive advantage (Atif et al., 2024; Alam et al., 2025). Despite its strengths, GTL often emphasizes top-down influence, which may limit employee participation and inclusivity in decision-making processes.

To address this limitation, Green Inclusive Leadership has emerged as a complementary approach that emphasizes openness, accessibility, and the active involvement of employees in environmental decision-making (Gul et al., 2025; Mumtaz et al., 2025). By fostering a participatory environment, inclusive leaders enhance employees' sense of belonging and psychological ownership of sustainability initiatives. This, in turn, strengthens the green psychological climate—defined as shared perceptions of organizational commitment to environmental sustainability—and enhances employee engagement in pro-environmental behaviors (ul Hassan et al., 2025). While each leadership style contributes uniquely to sustainability, the literature remains fragmented, with limited integration of these perspectives into a cohesive framework. This highlights the need for a more holistic understanding of how different leadership approaches collectively shape employee attitudes and behaviors toward sustainability.

Self-Determination Theory (SDT)

Self-Determination Theory (SDT) provides a robust psychological framework for understanding the motivational mechanisms underlying pro-environmental behavior (Hassan et al., 2026; Fahad et al., 2025). According to SDT, human behavior is driven by intrinsic motivation when three fundamental psychological needs—autonomy, competence, and relatedness—are satisfied. In organizational contexts, these needs play a critical role in shaping employees' attitudes and behaviors toward sustainability. Environmental-specific leadership contributes to the fulfillment of these psychological needs in several ways (ul Hassan et al., 2023). First, by encouraging employees to take initiative in sustainability practices, leaders promote a sense of autonomy. Employees who feel empowered to make decisions regarding environmental practices are more likely to internalize sustainability goals and engage in voluntary pro-environmental behaviors (Rana et al., 2024). Second, leadership facilitates competence by providing training, resources, and knowledge related to environmental practices (Irshad et al., 2024). This enhances employees' confidence in their ability to contribute effectively to sustainability initiatives. Third, leadership fosters relatedness by creating a shared vision and collective identity centered around environmental responsibility (Gul et al., 2024), strengthening employees' emotional connection to organizational sustainability goals.

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When these psychological needs are satisfied, employees are more likely to develop intrinsic motivation toward environmental behavior, leading to stronger and more persistent pro-environmental attitudes (Hassan et al., 2026). Unlike extrinsic motivation, which relies on external rewards or pressures, intrinsic motivation results in deeper internalization of values, making behavior more consistent and self-sustaining. However, despite its explanatory power, SDT has been underutilized in tourism sustainability research, particularly in linking leadership practices to psychological and attitudinal outcomes. This gap underscores the importance of integrating SDT into the study of environmental leadership and sustainable tourism development.

Grit Theory and Sustainable Behavior

While motivation is essential for initiating pro-environmental behavior, sustaining such behavior over time requires perseverance and long-term commitment. Grit Theory, which conceptualizes grit as a combination of passion and perseverance toward long-term goals, offers valuable insights into the persistence of sustainable behavior (Hanif et al., 2023; Fahad et al., 2025). In the context of tourism, where environmental initiatives often involve gradual and long-term changes, grit becomes a critical psychological resource.

Employees with high levels of grit are more likely to remain committed to sustainability goals despite challenges such as resource constraints, organizational resistance, or lack of immediate rewards (Mumtaz et al., 2025). This sustained effort is particularly important in achieving long-term environmental outcomes, such as reducing carbon emissions, conserving biodiversity, and promoting responsible tourism practices (Alam et al., 2025).

The concept of green harmonious passion further refines this perspective by emphasizing intrinsic enjoyment and alignment with environmental values (Gul et al., 2025). Unlike obsessive passion, which may lead to burnout, harmonious passion supports balanced and sustainable engagement in pro-environmental activities. Despite its relevance, the application of Grit Theory in environmental and tourism research remains limited. Most studies focus on short-term behavioral outcomes without adequately addressing the role of perseverance in sustaining environmental practices. Integrating grit into the sustainability framework provides a deeper understanding of how employees maintain consistent pro-environmental behavior over time, bridging the gap between initial motivation and long-term outcomes.

Artificial Intelligence Literacy as a Moderator

The rapid advancement of digital technologies, particularly artificial intelligence (AI), has introduced new opportunities and challenges for sustainable tourism development (Atif et al., 2024; Arshad et al., 2025). AI-driven systems are increasingly being used to optimize resource utilization, enhance operational efficiency, and support data-driven decision-making. In the tourism sector, applications of AI include smart waste management systems, energy optimization technologies, predictive modeling of tourist flows, and carbon footprint monitoring (Khan et al., 2020).

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These innovations have the potential to significantly enhance sustainability outcomes by reducing environmental impact and improving resource efficiency. However, the effectiveness of these technologies largely depends on employees' ability to understand, adopt, and utilize them effectively. This highlights the importance of AI literacy, defined as the knowledge, skills, and competencies required to interact with and leverage AI technologies (Hassan et al., 2026).

Employees with higher levels of AI literacy are better equipped to integrate technological solutions into their daily tasks, thereby enhancing the implementation of sustainable practices (Irshad et al., 2024). Importantly, AI literacy also plays a moderating role in the relationship between employee green attitude and sustainable tourism development (ul Hassan et al., 2025). While positive attitudes toward sustainability are necessary, they may not be sufficient to drive meaningful outcomes in the absence of technological competence.

Employees who possess both strong green attitudes and high AI literacy are more likely to translate their intentions into effective actions, leveraging AI tools to achieve sustainability goals (Gul et al., 2024). Conversely, low levels of AI literacy may weaken this relationship, as employees may lack the necessary skills to implement sustainable solutions effectively. Despite its growing importance, the intersection of AI literacy and sustainability remains underexplored in the literature. Most studies examine technological adoption or environmental behavior independently, without considering their interaction. This study addresses this gap by integrating AI literacy as a key moderating variable, offering a more comprehensive understanding of how human and technological factors jointly influence sustainable tourism development.

METHODOLOGY

PRISMA Framework

This study adopts the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure methodological rigor, transparency, and replicability in the systematic literature review process. The PRISMA approach is widely recognized for its structured and standardized procedure in identifying, screening, and synthesizing relevant academic literature.

The review process was conducted in four sequential stages:

Identification

In this phase, a comprehensive search was conducted across multiple academic databases to identify potentially relevant studies. The aim was to capture a broad spectrum of literature related to environmental-specific leadership, sustainability, motivation, and AI in tourism contexts.

Screening

After removing duplicate records, the remaining studies were screened based on titles and abstracts. This step ensured the exclusion of irrelevant studies that did not align with the research objectives.

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Eligibility
Full-text articles were assessed against predefined inclusion and exclusion criteria. This phase ensured that only high-quality and contextually relevant studies were retained.

Inclusion
The final set of studies included in the review formed the basis for thematic analysis and conceptual synthesis.
This structured approach enhances the credibility of the review by minimizing bias and ensuring a systematic selection of literature.

Search Strategy
A comprehensive and systematic search strategy was employed to identify relevant studies. Four major academic databases were selected due to their extensive coverage of high-quality, peer-reviewed research:
Scopus
Web of Science
ScienceDirect
Google Scholar
The search was limited to studies published between **2020 and 2026**, reflecting the most recent developments in environmental leadership, sustainability, and AI integration. This timeframe is particularly relevant given the rapid evolution of digital technologies and increasing global emphasis on sustainable tourism.
The following search string was used:
(("Green Transformational Leadership" OR "Environmental-Specific Servant Leadership" OR "Green Inclusive Leadership")
AND ("Sustainable Tourism")
AND ("Self-Determination Theory" OR "Grit")
AND ("Artificial Intelligence" OR "AI literacy"))
To ensure quality and relevance, the following inclusion criteria were applied:
Articles published in **peer-reviewed journals**
Studies written in **English**
Research focusing on **tourism, hospitality, or organizational sustainability contexts**
Exclusion criteria included conference papers, book chapters, non-English publications, and studies lacking empirical or theoretical relevance to the research framework.

Study Selection Process
The study selection process followed a rigorous multi-stage filtering procedure. A total of **1,247 records** were initially identified across the selected databases. After removing **298 duplicate records**, **949 studies** remained for screening.
During the screening phase, **811 studies** were excluded based on titles and abstracts due to lack of relevance. The remaining **138 full-text articles** were assessed for

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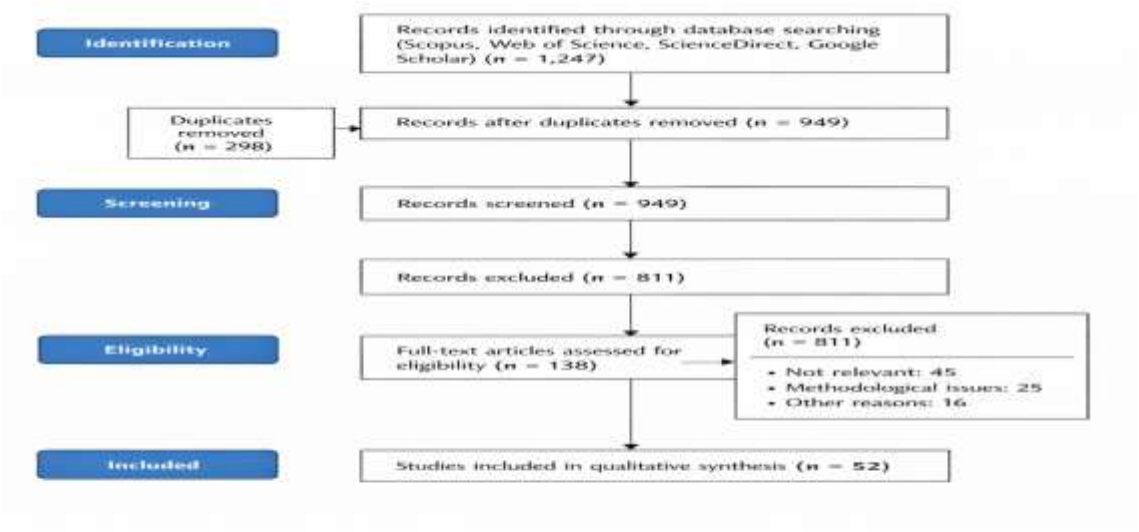
eligibility. Of these, **86 studies** were excluded due to insufficient theoretical alignment, lack of empirical rigor, or irrelevance to the tourism context.
Ultimately, **52 studies** were included in the final review. These studies formed the basis for thematic categorization and conceptual synthesis.
The entire selection process is illustrated in **Figure 1**, following PRISMA 2020 guidelines, ensuring clarity and transparency in the review procedure.

Process Stage	Number of Studies
Records identified	1,247
Duplicates removed	298
Records screened	949
Records excluded	811
Full-text assessed	138
Full-text excluded	86
Studies included	52

FIGURE 1. PRISMA Flow Diagram of the Study Selection Process



RESULTS

Thematic Distribution

The selected studies were categorized into five major thematic areas to facilitate structured analysis:

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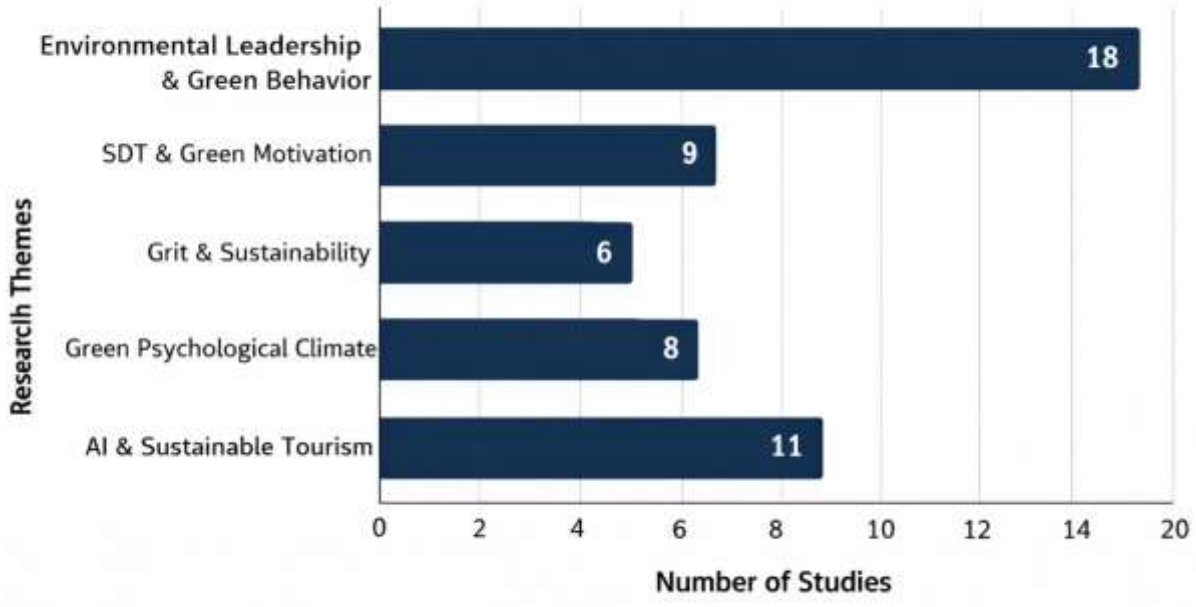
Theme	Number of Studies
Environmental Leadership & Green Behavior	18
SDT & Green Motivation	9
Grit & Sustainability	6
Green Psychological Climate	8
AI & Sustainable Tourism	11

FIGURE 2. Distribution of Studies Across Key Research Themes



Note. Based on 52 studies included in the systematic review (2020–2026).

The distribution indicates that **environmental leadership and green behavior** constitute the most extensively studied area, reflecting the central role of leadership in sustainability research. In contrast, **grit and AI literacy** remain relatively underexplored, highlighting significant research gaps.

Key Findings

The findings reveal strong empirical support for the positive influence of environmental-specific leadership on employee green attitudes and behaviors. Leadership styles such as ES-SL, GTL, and green inclusive leadership consistently demonstrate their ability to foster a **green psychological climate**, which acts as a critical mediating mechanism.

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Furthermore, the results indicate that **green harmonious passion** plays a vital role in translating organizational climate into individual-level attitudes. Employees who experience intrinsic motivation and emotional alignment with environmental goals are more likely to engage in sustainable practices.

Self-Determination Theory provides a robust explanation for these dynamics, emphasizing the importance of intrinsic motivation in shaping pro-environmental behavior. Simultaneously, Grit Theory highlights the role of perseverance in sustaining such behaviors over time.

Importantly, the findings underscore the growing significance of **AI literacy** in enhancing sustainability outcomes. Employees with higher AI literacy are better equipped to utilize technological tools, enabling them to translate their green attitudes into measurable and impactful sustainability practices.

Synthesis of Findings

The synthesis of findings suggests a multi-layered mechanism underlying sustainable tourism development. Environmental-specific leadership acts as a foundational driver, shaping organizational climate and influencing employee motivation. This, in turn, fosters green passion and attitudes, which directly impact sustainable outcomes.

AI literacy emerges as a critical **boundary condition**, amplifying the effectiveness of green behaviors. The integration of human (leadership and motivation) and technological (AI literacy) factors provides a more comprehensive understanding of sustainability in tourism.

Collectively, these elements form an **integrated pathway**, highlighting the interdependence of leadership, psychological processes, and digital competence in achieving sustainable tourism development.

PROPOSED FRAMEWORK

Based on the systematic review, the study proposes the following conceptual framework:

Environmental-Specific Leadership → Green Psychological Climate → Green Harmonious Passion → Employee Green Attitude → Sustainable Tourism Development

This relationship is **moderated by AI Literacy**, which strengthens the link between employee green attitude and sustainable tourism outcomes.

The framework provides a **holistic representation** of the cognitive, emotional, and behavioral processes underlying sustainability, while also incorporating technological capability as a key enabling factor.

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Figure 3. Integrated conceptual framework

DISCUSSION

The findings of this study contribute to the literature by integrating multiple theoretical perspectives into a unified framework. The combination of Self-Determination Theory and Grit Theory offers a comprehensive explanation of both the **initiation and persistence** of pro-environmental behavior.

Environmental-specific leadership fosters intrinsic motivation by satisfying employees' psychological needs, thereby encouraging the internalization of sustainability values. At the same time, grit ensures that these behaviors are sustained over time, even in the face of challenges.

The inclusion of AI literacy introduces a novel dimension, highlighting the role of digital competence in modern sustainability practices. In an increasingly technology-driven environment, the ability to leverage AI tools becomes essential for translating attitudes into actionable outcomes.

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This integrated perspective advances the understanding of sustainable tourism by bridging the gap between **human behavior and technological innovation**.

PRACTICAL IMPLICATIONS

The findings offer several practical implications, particularly for the tourism sector in Pakistan and other developing economies.

First, organizations should invest in **leadership development programs** that emphasize environmental responsibility and sustainability-oriented decision-making. Training leaders in ES-SL, GTL, and inclusive leadership can significantly enhance organizational sustainability performance.

Second, there is a need to promote **AI literacy among employees** through targeted training and capacity-building initiatives. Enhancing digital competence will enable employees to effectively utilize AI-driven tools for sustainability.

Third, organizations should adopt **sustainability-oriented HR practices**, including green training, performance evaluation, and reward systems that encourage pro-environmental behavior.

Finally, policymakers should align **digital transformation strategies with environmental policies**, ensuring that technological advancements contribute to sustainable development goals.

LIMITATIONS AND FUTURE RESEARCH

Despite its contributions, this study has several limitations. First, the availability of empirical research on AI literacy in tourism remains limited, which may restrict the generalizability of findings. Second, the review focuses on studies published in English, potentially excluding relevant research in other languages.

Future research should address these limitations by adopting **longitudinal designs** to examine the dynamic nature of sustainability practices over time. Additionally, cross-cultural studies can provide insights into how contextual factors influence the relationship between leadership, motivation, and sustainability.

Further research is also needed to explore **advanced AI applications** and their impact on sustainable tourism, as well as the role of emerging technologies such as blockchain and the Internet of Things (IoT).

CONCLUSION

This study provides a comprehensive synthesis of literature on environmental-specific leadership, motivation, and technological competence in the context of sustainable tourism development. The findings highlight the critical role of leadership in shaping employee attitudes and behaviors, supported by intrinsic motivation and sustained through perseverance.

Importantly, the study identifies AI literacy as a key moderating factor that enhances the translation of green attitudes into practical sustainability outcomes. This underscores the importance of integrating human and technological capabilities in achieving sustainable development.

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Overall, the study contributes to the literature by offering a **holistic and integrated framework**, providing valuable insights for researchers, practitioners, and policymakers. Investing in leadership development and digital capabilities will be essential for achieving long-term sustainability in the tourism sector.

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