



Sustainable Intelligence and Pro-Environmental Behaviour: A Systematic Review and Future Research Agenda

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Abstract: Sustainable Intelligence (SI) has emerged as a capability-oriented construct that explains how individuals and organizations interpret and respond to sustainability challenges. However, its behavioural significance remains unclear, particularly in relation to the well-established pro-environmental behaviour (PEB) literature, which is primarily grounded in intention-based and norm-based theoretical frameworks. This study conducts a systematic literature review of 60 peer-reviewed articles published between 2010 and 2025 to examine the conceptual evolution, operationalization, and behavioural grounding of SI, and to determine its position within the broader knowledge structure of PEB research. Guided by the SPAR-4-SLR protocol, the study integrates bibliometric mapping using VOSviewer with structured qualitative synthesis based on the Theory-Context-Characteristics-Methodology (TCCM) framework. The findings reveal that while PEB research demonstrates theoretical maturity and strong anchoring in established behavioural models, SI scholarship remains conceptually fragmented and predominantly descriptive. Empirical validation of SI is limited, with only a small subset of studies directly linking SI to observable pro-environmental behaviour; most rely on attitudinal or intention-based proxies.

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The review further shows that SI is not yet structurally embedded within the dominant behavioural architecture of sustainability research. We argue that SI may function as an upstream cognitive-ethical capability that shapes the formation of sustainability-relevant judgements prior to intention and action. By consolidating definitions, clarifying construct boundaries, and identifying structural gaps in behavioural validation, this study repositions Sustainable Intelligence as a theoretically meaningful and potentially integrative antecedent within sustainability behaviour research, while outlining directions for more robust empirical development.

1. INTRODUCTION

Tourism sustainability continues to face a persistent behavioural challenge. Despite growing environmental awareness, regulatory frameworks, and sustainability certifications, tourist behaviour often remains inconsistent with environmental goals (A. Maki et al., 2019). Overcrowding, waste generation, ecosystem degradation, and heritage site deterioration reflect a recurring gap between sustainability discourse and actual pro-environmental behaviour (PEB). Understanding what drives environmentally responsible action in tourism contexts, therefore, remains central to contemporary tourism scholarship (Amjad Abu Elsamem et al., 2025).

Research on pro-environmental behaviour (PEB) in tourism has developed substantial theoretical depth (Hongmei Zhang et al., 2019). Drawing from social psychology, scholars have applied frameworks such as the Theory of Planned Behaviour, norm activation theory, and value-belief-norm theory to explain environmentally responsible actions across destinations, hospitality settings, and heritage environments (Iana Bilynets & Ljubica Knezevic Cvelbar, 2022). Attitudes, subjective norms, personal norms, and perceived behavioural control consistently emerge as significant predictors of sustainable choices (L Wang et al., 2023). This stream of research has strengthened explanatory precision and offered practical guidance for destination management.

However, an important conceptual asymmetry persists. Most behavioural models focus on motivational and normative drivers that translate existing cognitions into intention (Lin et al., 2022). They assume that individuals are already capable of recognizing environmental consequences, evaluating ethical trade-offs, and integrating long-term sustainability considerations into their decision-making (Birgitta Gatersleben et al., 2012). In tourism settings, where leisure framing, experiential consumption, and temporary detachment from

everyday norms often shape behaviour (M Tamar et al., 2021), the formation of sustainability-oriented judgement may itself require a distinct cognitive-ethical capability (Lin et al., 2022).

Sustainable Intelligence (SI) has emerged as a construct intended to capture this integrative capability (Choong-Ki Lee et al., 2021; Jae Ho Lee et al., 2022). SI is generally described as the ability to understand sustainability challenges, apply systems thinking, incorporate ethical reasoning, and anticipate long-term consequences in decision-making processes (Lars Moratis & Frans Melissen, 2019). Within tourism research, SI has been linked to conservation-oriented behaviour in heritage destinations and environmentally responsible conduct among visitors. These studies suggest that SI may shape how tourists interpret sustainability issues before forming behavioural intentions (Jan Beyne et al., 2021).

However, the development of SI within tourism remains conceptually fragmented and empirically limited. Definitions vary across studies, measurement approaches lack standardization, and behavioural validation is concentrated in a narrow range of contexts (Choong-Ki Lee et al., 2021). More critically, SI has not been systematically positioned within the broader theoretical architecture of pro-environmental behaviour research (Jae Ho Lee et al., 2022). It remains unclear whether SI represents a distinct explanatory construct, overlaps with established predictors such as environmental awareness and personal norms, or functions as a higher-order capability influencing the formation of sustainability-related judgements (Yaiza López-Sánchez & Juan Ignacio Pulido-Fernández, 2015).

To address these gaps, a structured synthesis is required that both maps the intellectual structure of pro-environmental behaviour research and critically examines the conceptual evolution of Sustainable Intelligence. Accordingly, this study conducts a systematic literature review combined with bibliometric analysis to answer the following research questions:

RQ1: What are the dominant themes, theories, and behavioural mechanisms in pro-environmental behaviour research within tourism and related sustainability contexts?

RQ2: How has Sustainable Intelligence been conceptually defined, operationalized, and empirically tested across tourism and sustainability studies?

RQ3: Where does Sustainable Intelligence conceptually fit within the established knowledge structure of pro-environmental behaviour research?

By integrating bibliometric mapping with qualitative synthesis, this review consolidates fragmented SI scholarship and situates it within the mature field of tourism pro-environmental behaviour research (A. Maki et al., 2019). In doing so, the study advances conceptual clarity and offers a theoretically grounded foundation for future empirical investigation of Sustainable Intelligence as a potential upstream capability shaping sustainable tourist behaviour (Yae-Na Park et al., 2021).

2. METHODOLOGY

This study adopts a multi-layer review design that integrates large-scale bibliometric mapping with structured qualitative synthesis to position Sustainable Intelligence (SI) within the broader intellectual architecture of pro-environmental behaviour research. The design was developed to address three objectives: identifying the dominant theoretical and thematic structures within PEB scholarship (RQ1), examining the conceptual and empirical evolution of SI (RQ2), and determining SI conceptual position within established behavioural frameworks (RQ3). By combining macro-level field mapping with focused systematic analysis, the study enables both structural and construct-level evaluation.

At the macro level, bibliometric mapping was conducted using 1000 Web of Science (WoS) records published between 2010 and 2025. The search incorporated combinations of “pro-environmental behavio*,” “environmental behavio*,” and “PEB” to capture the dominant behavioural discourse in sustainability research. Records were exported in full bibliographic format, including author keywords and indexed keywords. VOSviewer was used to generate keyword co-occurrence networks, applying a minimum-occurrence threshold to ensure conceptual relevance and reduce noise from low-frequency terms (Van Eck, N. J., & Waltman, L., 2009). Network visualization and cluster detection were used to identify dominant thematic groupings, while overlay mapping examined the temporal evolution of keywords across publication years. This procedure provides structural insight into theoretical centrality, thematic density, and the relative positioning of constructs within the field.

To complement the field-level mapping with a deeper conceptual examination, a systematic screening process was conducted following the SPAR-4-SLR framework (Paul et al., 2021; Paul, J., & Criado, A., 2020). Searches were performed in both Web of Science and Scopus for the period 2010-2025 using combined behavioural and intelligence-related terms: (“pro-environmental behavio*” OR “environmental behavio*” OR “PEB”) AND (“sustainable intelligence” OR “SI”). The initial search yielded 495 records. Duplicate removal was conducted using database filters and manual cross-checking. Titles and abstracts were screened for conceptual relevance to sustainability behaviour and intelligence-related constructs. Full-text assessment was then undertaken to ensure alignment with the study’s research questions.

Inclusion criteria required that studies be peer-reviewed journal articles explicitly addressing sustainability-oriented behaviour or Sustainable Intelligence, with sufficient conceptual or methodological detail to enable analytical coding (Snyder, H., 2018). Studies that focused solely on technical environmental performance, engineering optimization, or policy evaluation, without behavioural components, were excluded. Only English-language publications were retained to ensure consistency in interpretive analysis.

Following screening, 60 articles were retained for structured qualitative synthesis. Data extraction was conducted systematically using a coding template capturing theoretical foundations, conceptual definitions, research context, methodological design, sample characteristics, measurement approaches, and behavioural outcomes. To enhance analytical reliability, constructs were cross-compared across studies to identify definitional convergence and divergence.

Within the final dataset, 11 studies explicitly examined Sustainable Intelligence. These were subjected to a focused conceptual synthesis using the Theory-Context-Characteristics-Methodology (TCCM) framework (Paul, J., & Criado, A., 2020). This allowed for a structured comparison of SI’s theoretical grounding, dimensional structure, contextual applications, and behavioural operationalization. The remaining 49 PEB-focused studies served as a benchmarking dataset to assess methodological diversity and theoretical maturity relative to SI research.

Findings are reported sequentially, beginning with field-level bibliometric mapping (Donthu et al, 2021), followed by methodological profiling, and

concluding with a focused synthesis of SI research. This layered reporting structure ensures coherence between analytical levels and enables systematic positioning of Sustainable Intelligence within sustainability behaviour literature.

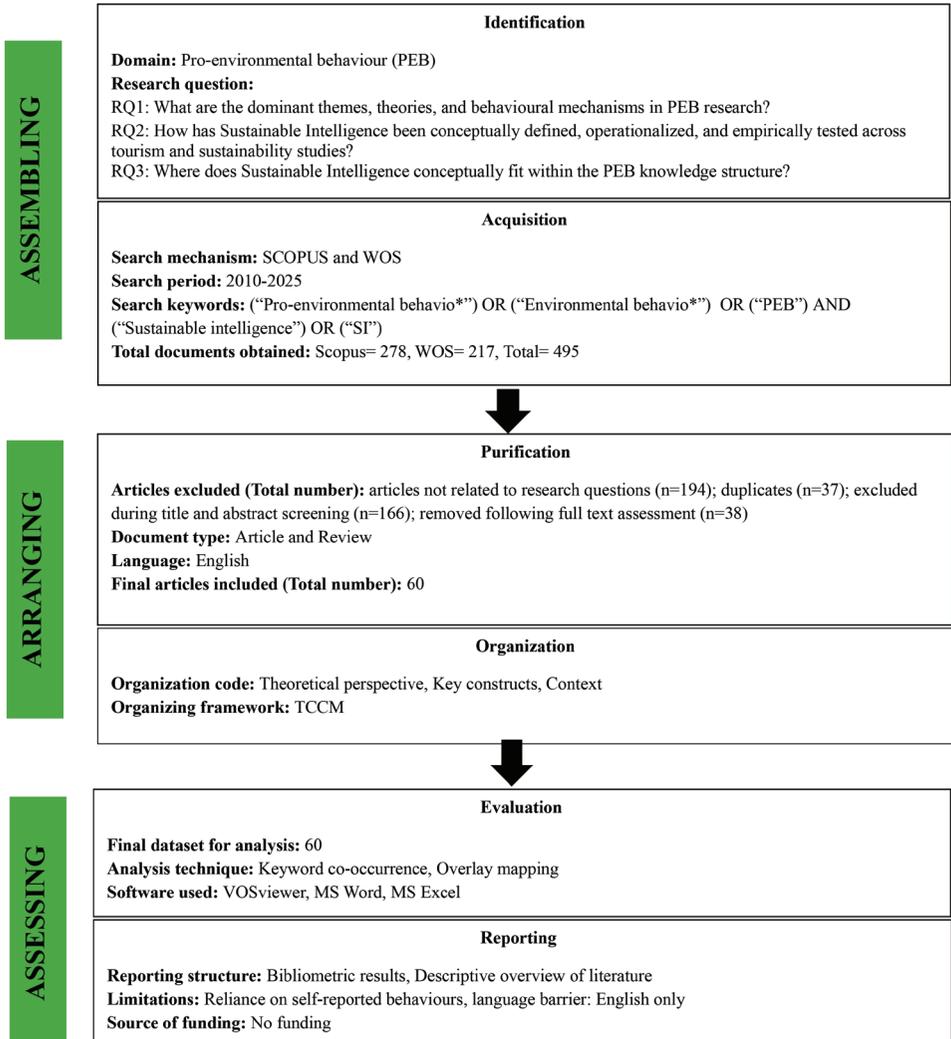


Figure 1: SPAR-4 Protocol

2.1. Keyword Co-occurrence Analysis

The keyword co-occurrence network of 1000 Web of Science records reveal a structurally consolidated knowledge system for pro-environmental behaviour (PEB) dominated by intention- and norm-based constructs. Central nodes

diversification, the field's core explanatory logic remains intention-driven. Intelligence-based constructs do not exhibit visible temporal prominence or cluster centrality, reinforcing the observation that Sustainable Intelligence has not yet gained traction within the evolving behavioural discourse. The temporal analysis, therefore, strengthens the argument that SI represents an emergent upstream capability perspective rather than an established determinant within the trajectory of PEB research (Birgitta Gatersleben et al., 2012).

2.3. Methodological Distribution of Sustainable Intelligence Studies

The methodological distribution of Sustainable Intelligence (SI) research indicates a strong empirical orientation. Of the 11 identified SI studies, 82% employ empirical designs, while 18% are conceptual in nature, with no literature reviews or alternative methodological approaches observed.

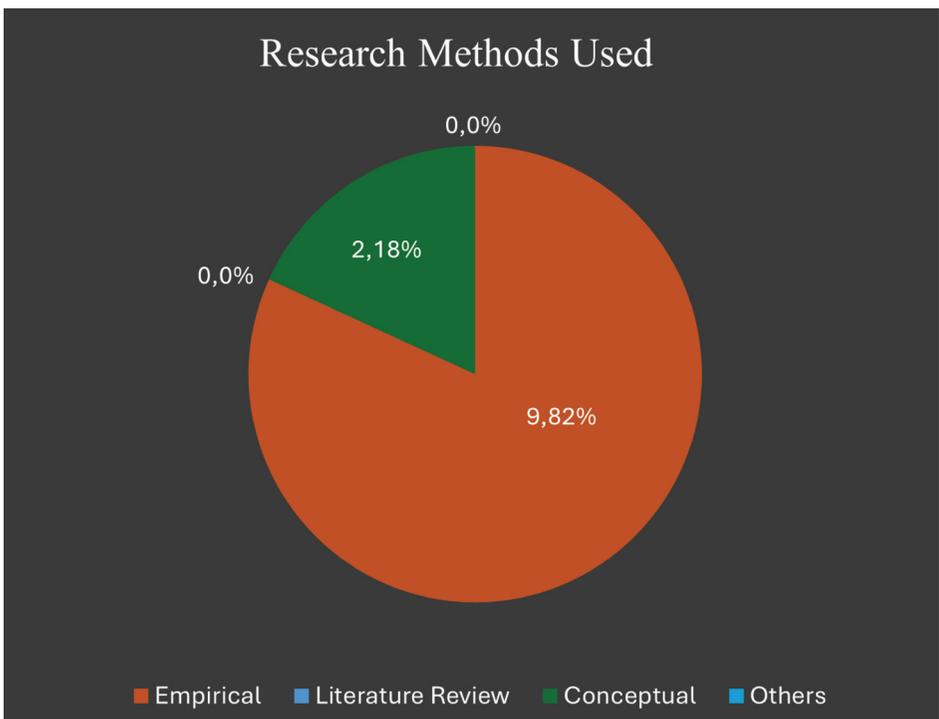


Figure 4: Methodologies of surveyed SI literature

This pattern suggests that SI research is actively operationalizing the construct through survey-based and model-testing approaches, particularly in applied contexts such as tourism and heritage management. However, despite

this empirical emphasis, the absence of review-based synthesis and limited theoretical consolidation indicates that the field remains emergent rather than mature. The concentration of empirical efforts within a relatively small body of literature further suggests that SI is still in the early stages of conceptual stabilization and cross-context validation.

2.4. Methodological Distribution of Pro-Environmental Behaviour Studies

In contrast, the methodological profile of the 49 pro-environmental behaviour (PEB) studies reflects greater diversity and structural maturity. Empirical studies account for 47% of the sample, while literature reviews comprise 25%, conceptual contributions 22%, and other approaches 6%.

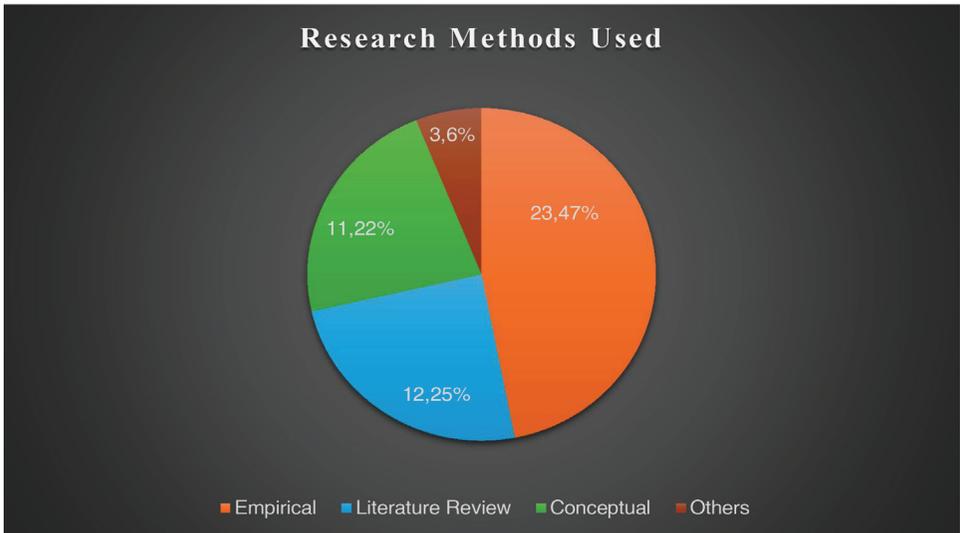


Figure 5: Methodologies of surveyed PEB literature

This balanced distribution indicates not only sustained empirical testing but also significant theoretical refinement and consolidation through review. The presence of literature reviews within the PEB corpus suggests cumulative knowledge development and reflexive synthesis, features typically associated with established research domains. Compared to the SI subset, the broader PEB literature demonstrates methodological breadth and theoretical stabilization, reinforcing the view that PEB research is structurally mature. In contrast, SI research remains developing and comparatively under-integrated.

3. CONCEPTUALIZATION OF SUSTAINABLE INTELLIGENCE

Table 1 presents the definitional landscape of Sustainable Intelligence across the reviewed studies. The definitions reveal notable conceptual variation: some scholars frame SI as an integrative organizational capability grounded in systems thinking and ethical reasoning, while others conceptualize it at the individual level as a cognitive-moral capacity that shapes sustainability-oriented judgement and action. Although recurring elements such as systems awareness, ethical orientation, long-term thinking, and integrative cognition are evident, definitional boundaries remain fluid. This variability suggests that SI has yet to achieve theoretical stabilization, reinforcing its developmental status within sustainability behaviour research (Choong-Ki Lee et al., 2021).

Table 1: Conceptual definitions of Sustainable Intelligence across reviewed studies

<i>Author</i>	<i>SI Definition</i>
(Silvestre & Fonseca, 2020)	SI as an integrative capability enabling organizations to sense, interpret, and act on sustainability challenges through systemic understanding.
(Yae Na Park et al., 2021)	Sustainability-related intelligence influencing willingness to pay and pro-sustainability orientation.
(Choong-Ki Lee et al., 2021)	SI as an individual-level capability shaping awareness, responsibility, and environmental behaviour.
(Choong-Ki Lee et al., 2022)	SI, combined with the cultural worldview, helps explain conservation-oriented actions.
(Nikhil Kewal Krishna Mehta et al., 2024)	SI is a managerial competence supporting sustainable decision-making.
(Jan Beyne et al., 2022)	Learning, leadership, values, and systems enable SI.
(Lars Moratis & Frans Melissen, 2019)	SI as awareness and understanding needed for sustainability transitions.
(V.G. Girish et al., 2023)	SI influences sustainable practices indirectly.
(Guoyi Chen et al., 2023)	Extended SI model linking cognition to sustainability outcomes.
(Yaiza López-Sánchez & Juan Ignacio Pulido-Fernández, 2015)	An individual's capacity to understand sustainability issues, integrate environmental knowledge, and apply this understanding in tourism-related decision-making.
(Jae Ho Lee et al., 2022)	Sustainable intelligence refers to an individual's ability to recognise, understand, appreciate sustainability, and act accordingly, encompassing awareness, attitudes, and understanding of sustainability.

3.1. Operationalization and Behavioural Positioning of Sustainable Intelligence

Table 2 extends the analysis by examining how Sustainable Intelligence has been operationalized across empirical contexts. The findings show that SI is most frequently applied within tourism, heritage, hospitality, and organizational

Table 2: Contextual applications, core dimensions, and behavioural focus of Sustainable Intelligence

<i>Author</i>	<i>Context</i>	<i>Core Dimensions</i>	<i>Behavioural Focus</i>
(Silvestre & Fonseca, 2020)	Corporate sustainability	Systems thinking, cognitive integration, ethical reasoning, and long-term orientation	Conceptual only. No behavioural outcome tested
(Yae Na Park et al., 2021)	Sustainable development	Cognitive understanding, future orientation, and value-based judgement	Implicit behavioural relevance (economic choice, not PEB)
(Choong-Ki Lee et al., 2021)	Destination management	Cognitive awareness, moral sensitivity, and social responsibility	Direct behavioural outcome (PEB measured)
(Choong-Ki Lee et al., 2022)	Heritage tourism	Ethical sensitivity, cultural cognition, and systems awareness	Limited behavioural application
(Mehta et al., 2024)	Farming	Strategic cognition, adaptive problem-solving, and sustainability knowledge	Implicit behavioural implications only
(Jan Beyne et al., 2022)	Organizational	Learning capability, systems thinking, and ethical orientation	No behavioural outcome
(Lars Moratis & Frans Melissen, 2019)	Sustainability	Cognitive understanding and integrative thinking	Conceptual only
(V.G. Girish et al., 2023)	Hospitality	Knowledge, attitudes, and awareness	Practice-oriented
(Guoyi Chen et al., 2023)	Wetland tourists'	Cognitive processing, ethical judgement, and strategic orientation	No direct PEB
(Yaiza López-Sánchez & Juan Ignacio PFernández, 2015)	Pro-sustainable tourists	Ethical sensitivity, long-term orientation	Implicit behavioural focus
(Jae Ho Lee et al., 2022)	Agricultural heritage tourism	Self-motivation, empathy	Direct behavioural focus (PEB measured)

sustainability settings. Core dimensions commonly include system thinking, ethical sensitivity, cognitive integration, long-term orientation, and sustainability-related knowledge. However, behavioural operationalization varies considerably. While some studies directly measure pro-environmental behaviour, others rely on intentions, attitudinal proxies, or indirect behavioural indicators. This inconsistency in behavioural validation further underscores the need for scale standardisation and for a more straightforward theoretical integration within established behavioural frameworks.

4. DISCUSSION

This study aims to position Sustainable Intelligence (SI) within the broader intellectual framework of pro-environmental behaviour (PEB) research. By combining large-scale bibliometric mapping with structured qualitative synthesis, the findings reveal a clear structural imbalance between the maturity of PEB research and the emergent status of SI.

At the macro level, a bibliometric analysis of 1,000 Web of Science records confirms that PEB research is theoretically well consolidated and firmly anchored in intention-based and norm-driven models. Constructs derived from the Theory of Planned Behaviour, moral norms, and cognitive-motivational frameworks occupy central positions within the knowledge network (V.G. Girish et al., 2022). The density and interconnection of these clusters indicate cumulative development and theoretical stabilization. Despite gradual thematic diversification toward management, consumption, and innovation, the field's dominant explanatory logic remains intention-focused.

Within this structurally mature behavioural landscape, SI does not emerge as a central or temporally prominent construct. Its absence from the dominant keyword clusters suggests that intelligence or capability-oriented perspectives have not yet been integrated into mainstream behavioural theory. This macro-level evidence substantiates the claim that SI remains conceptually peripheral within sustainability behaviour research (Choong-Ki Lee et al., 2021).

The meso level methodological analysis reinforces this observation. The broader PEB literature demonstrates methodological diversity, including empirical testing, conceptual refinement, and review-based synthesis. Such diversity reflects theoretical consolidation and the accumulation of reflexive knowledge. In contrast, SI research, although predominantly empirical, lacks

systematic review integration and exhibits limited conceptual standardization. The high proportion of empirical studies within the SI subset indicates growing efforts to operationalize the construct; however, the small corpus and the concentration of context signal an emergent rather than a stabilized research domain (V.G. Girish et al., 2022).

At the micro level, synthesis of SI definitions and operationalizations reveals conceptual variability. Some studies frame SI as an organizational capability rooted in systems thinking and ethical reasoning. In contrast, others conceptualize it as an individual-level cognitive-moral capacity that influences sustainability-oriented judgement. Recurring dimensions such as long-term orientation, ethical sensitivity, cognitive integration, and sustainability knowledge suggest underlying coherence, yet definitional boundaries remain fluid. Moreover, behavioural operationalization varies considerably. While specific studies measure direct pro-environmental behaviour, others rely on intentions or attitudinal proxies, limiting behavioural precision.

Taken together, the findings suggest that SI may function as an upstream cognitive-ethical capability that shapes how sustainability relevant information is interpreted and evaluated prior to the formation of behavioural intentions. However, its explanatory distinctiveness relative to established constructs such as environmental awareness, moral norms, and values remains unclear. Without theoretical integration into existing behavioural models, SI risks conceptual redundancy rather than substantive contribution.

5. CONCLUSION

This study provides a structured assessment of Sustainable Intelligence within the broader architecture of pro-environmental behaviour research. By integrating bibliometric mapping of 1000 PEB publications with systematic qualitative synthesis of 60 screened articles, including 11 SI-focused studies, the review offers multi-level evidence of the construct's current positioning.

The findings demonstrate that PEB research is theoretically mature, methodologically diversified, and structurally anchored in norm- and intention-based frameworks. In contrast, SI research remains emergent, empirically active but conceptually fragmented, and structurally peripheral within the dominant behavioural discourse. Although SI shows promise as an integrative sustainability capability, its theoretical embedding and behavioural validation remain limited.

By clarifying definitional variation, methodological patterns, and structural gaps, this study contributes to sustainability behaviour literature in three ways. First, it provides macro-level evidence of the theoretical architecture within which SI must be situated. Second, it systematically consolidates SI conceptualizations across contexts. Third, it outlines pathways for theoretical integration and empirical refinement.

The advancement of SI will depend on its ability to demonstrate explanatory distinctiveness and theoretical complementarity within established behavioural models. Without such integration, the construct risks remaining conceptually expansive but analytically marginal.

6. LIMITATIONS AND FUTURE DIRECTIONS

Several limitations should be acknowledged. First, although the bibliometric mapping relied on 1000 Web of Science records, the systematic review component was restricted to peer-reviewed English-language journal articles. Relevant contributions published in other languages or indexed in alternative databases may not have been captured. Second, the operationalization of SI across studies remains context-specific, and cross-sector generalizability cannot be assumed. Third, bibliometric analysis captures structural prominence but does not directly assess theoretical depth or explanatory strength.

Future research should prioritize conceptual clarification and scale standardization. Developing validated measurement instruments capable of distinguishing SI from related constructs such as environmental awareness, moral norms, or sustainability values is essential. Longitudinal and experimental designs would further strengthen behavioural validation by moving beyond self-reported intentions toward observed behavioural outcomes.

Moreover, integrative modelling approaches are needed to examine how SI interacts with established behavioural determinants within frameworks such as the Theory of Planned Behaviour or norm-activation models. Rather than positioning SI as a competing construct, future studies should explore its potential as a higher-order cognitive-ethical capability that influences attitudinal and normative processes.

Cross-cultural comparisons and multi-level analyses may also enrich understanding of SI's applicability across tourism, organizational, and community contexts. Such efforts would contribute to theoretical

consolidation and enhance the construct's legitimacy within sustainability behaviour research.

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