

Article

Teaching for Tomorrow: Closing the Sustainability Skill Gap in UK Tourism Education

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Abstract

This paper investigates how higher education institutions (HEIs) in tourism, hospitality, and events in the United Kingdom (UK) are embedding decarbonisation and sustainability competencies within their curricula. Drawing on a 28-item survey distributed to 67 universities, this study explores the relationship between explicit decarbonisation learning outcomes, Sustainable Development Goal (SDG) alignment, and the breadth of decarbonisation practices taught. Twenty-one institutions responded (31%). Results show that only 19% of programmes explicitly reference decarbonisation in their learning outcomes, yet these programmes deliver substantially broader practice coverage. While SDG-aligned programmes were more liable to include such outcomes, this association was not statistically significant. Findings here highlight the gap between representative SDG alignment and operational curriculum reform. This study recommends embedding assessment-focused decarbonisation outcomes and strengthening training supported by targeted continuing professional development. Limitations include the small, self-reported sample and cross-sectional design. Future research could adopt longitudinal and comparative approaches to help examine how specific curriculum commitments translate into applied competencies over time.

Keywords: sustainable literacy; decarbonisation skills; tourism higher education; Net-Zero transition; climate change education; United Kingdom

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1. Introduction

The United Kingdom (UK), historically recognised as a pioneer in tourism and hospitality education (Baum, 2012; Teixeira & Baum, 2001), now faces a confluence of policy and resource pressures that complicate curriculum transformation toward Net Zero. Since leaving the European Union, the UK is no longer bound by EU directives that previously structured elements of educational and environmental governance (de Sadeleer, 2020). At the same time, capped tuition fees, volatility in student enrolments, and worsening institutional finances have constrained the capacity of higher education institutions (HEIs) to invest in large-scale reform (Adams, 2024; Universities UK, 2024). Against this backdrop, the imperative to integrate sustainability into higher education remains acute (Harpe & Thomas, 2009; Slocum et al., 2019; Wilson & von der Heide, 2013), particularly as tourism graduates are expected to adapt continually to evolving industry and environmental demands (Mínguez et al., 2021). Sustainable literacy, knowledge, skills, and attitudes oriented to sustainable development,

therefore, function as a baseline graduate competency (Lugg, 2007), yet persistent deficits in provision risk undermine sectoral and national commitments.

Conceptually, sustainability in tourism is often articulated as meeting present needs without compromising those of future generations (Church et al., 2022) and is commonly operationalised through curricular attention to responsible practices spanning environmental, social, and economic dimensions (Long et al., 2014). Decarbonisation, by contrast, denotes the targeted reduction in CO₂ emissions through measures such as energy efficiency, renewable energy integration, and, where used, carbon offsetting, to shift tourism systems toward low-carbon and climate-resilient models (Scott, 2021). Climate action within the United Nations Sustainable Development Goal (SDG) 13 embeds both mitigation and adaptation, including the educational and policy functions of HEIs. The Glasgow Pact (2021) reinforces the urgency of transforming education to accelerate climate action. Yet, a persistent tension follows while sustainability is widely referenced, explicit integration of climate change and decarbonisation knowledge, skills, and assessment outcomes is uneven and often fragmented across programmes. This paper responds to that tension by examining explicit decarbonisation learning outcomes alongside broader sustainability signalling.

However, institutional behaviour further complicates this landscape. The low participation rate observed in sector studies, including this paper, suggests possible institutional inertia, competing priorities, and governance constraints that may suppress the pace of change (Eusébio et al., 2022; Universities UK, 2022). Such patterns are not uniquely British; comparable evidence from Ireland indicates similarly modest levels of sustainable literacy and curricular specificity (Conefrey et al., 2025). These signals underscore that the challenge is systemic rather than idiosyncratic, and that credible progress will require explicit curriculum architecture, appropriate staff development, and alignment between programme-level outcomes and institutional strategy.

The UK's legacy in tourism, hospitality, and events education is substantial, the first UK tourism management degree at the University of Surrey in 1966 marked a key inflection in the field's development (University of Surrey, 2025), and subsequent growth across leading institutions such as Ulster University and the University of Chester has shaped professional pathways (The Guardian, 2024). Yet without targeted reforms to address climate and sustainability imperatives, these legacy risks diminish relevance. The devolved design of UK higher education across England, Scotland, Wales, and Northern Ireland further necessitates coherent national coordination to ensure consistent engagement with the Net Zero agenda and the SDGs.

Fixed in this context, this paper probes the alignment between curricular signals and applied competence. Specifically, the authors assess programme-level SDG alignment alongside the explicit embedding of decarbonisation in learning outcomes; examine whether programmes that embed such outcomes deliver broader coverage of decarbonisation practices; and characterise the profile of practices most commonly taught across HEIs, noting where operational and systems-oriented competencies appear thin. By analysing institution-level indicators together with a multiple-response inventory of practices and a coverage count, this paper bridges from sector rhetoric to measurable curricular features and provides an empirical foundation for the results and discussion that follow. In so doing, it addresses a notable gap in the UK literature: while sustainability in tourism education is widely discussed, the operationalisation of decarbonisation, as explicit outcomes and as a coherent practice portfolio, remains under-examined despite its centrality to meeting national and global Net Zero targets.

2. Literature Review

2.1. From Sustainable Tourism Narratives to Decarbonisation Competencies

The evolution of sustainable tourism reflects a complex interplay of political, economic, and environmental influences and resists static, one-size-fits-all management (Farrell & Twining-Ward, 2005; McLoughlin & Hanrahan, 2019; Posch & Steiner, 2006; Zhang & Tavitiyaman, 2022). Emerging from broader sustainable development discourse in the 1970s, early framings often foregrounded environmental and economic dimensions while underweighting equity and participation (Arrobas et al., 2020; Hardy et al., 2002). Critiques emphasise that incrementalism is inadequate, and systemic change is required (Butler, 2019). Market logics have shaped the uptake of sustainability, yet these approaches are contested for masking power imbalances (Douglas, 2014; MacKenzie & Gannon, 2019). In this context, HEIs face not only a mandate to teach sustainability but to translate it into applied decarbonisation competencies, knowledge, skills, and dispositions operationalised in programmes and governance (Lund-Durlacher, 2015). A framework (see Figure 1) integrating knowledge, skills, and attitudes provides a useful institutional lens for embedding sustainability across curricula and operations.

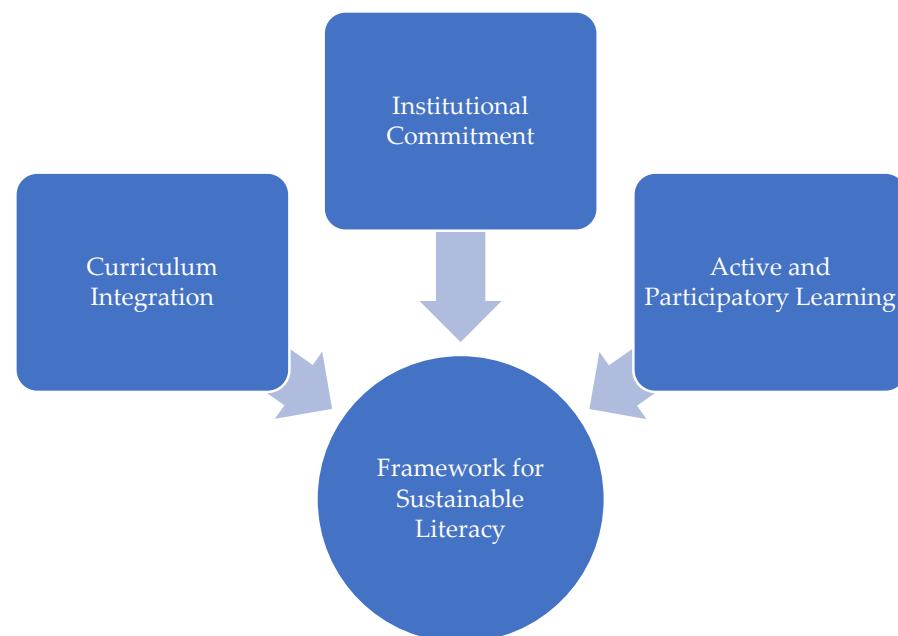


Figure 1. Framework for sustainable literacy. Source: Adapted from (Lund-Durlacher, 2015).

2.2. Formal Curriculum Signals: SDG Alignment Versus Explicit Decarbonisation Learning Outcomes

Tourism’s “smokeless industry” narrative has been challenged by evidence of substantial emissions and broader environmental costs (Ko, 2005; Sun & Higham, 2021; Tang et al., 2022). While sustainability concepts appear in some curricula (Bowen & Dallam, 2020; Septyandi & Prawira, 2022), scholars argue that climate change and decarbonisation remain under-specified in programme design (Arrobas et al., 2020; Scott & Gössling, 2022). International frameworks (TEFI, UNESCO DESD, Sulitest) offer scaffolds for signalling commitment and assessing literacy (Buckler & Creech, 2005; Melles & Paixao-Barradas, 2019; Sheldon et al., 2016), and calls for explicit integration of decarbonisation are growing (Amelung & Eijgelaar, 2021; Birendra, 2024). Yet, adoption is uneven and often confined to isolated modules rather than programme-level outcomes, limiting curricular coherence and graduate capability. The literature, therefore, distinguishes symbolic alignment (e.g., mapping to SDGs) from explicit, assessment-anchored learning outcomes that specify decar-

bonisation knowledge and skills, a distinction mirrored in our analysis of SDG alignment versus LO embedding.

2.3. Practice Portfolios and the Operationalisation of Decarbonisation

Reframing programmes around what students can do requires attention to the portfolio of practices taught, ranging from behavioural demand-side strategies (e.g., slow/low-carbon tourism, de-marketing long-haul) to organisational/technical measures (e.g., circular economy, waste/energy management, emissions accounting). The sector's growth-oriented imperatives and trade-offs (Milano et al., 2019; Qian et al., 2018) complicate the move from awareness to application. Evidence repeatedly shows heterogeneous provision and patchy depth on technical systems (measurement boundaries, data tools), which are indispensable if graduates are to plan, implement, and verify decarbonisation (Ko, 2005; Sun & Higham, 2021). Our study's focus on a multiple-response practice profile directly addresses this literature gap by identifying where emphasis currently lies and where it is thin.

2.4. Explicit and Tacit Knowledge

Competence for Net Zero depends on both explicit knowledge (policies, standards, methods) and tacit capability (contextual, experiential know-how) (Cooper, 2015, 2018). Tacit skills, emissions measurement, use of GIS, applying best practice to local constraints, translating intent into operational change (Becken & McLennan, 2017; Coles et al., 2017; Loehr & Becken, 2021; Pham et al., 2022). The literature cautions that without deliberate integration of tacit elements via experiential and applied pedagogies, explicit content risks remaining rhetorical. This dual-competence view motivates our empirical test of whether explicit LO embedding co-occurs with broader practice coverage, a key contribution relative to prior descriptive audits.

2.5. Pedagogical and Organisational Constraints on Integration

Despite policy salience, sustainability literacy remains inconsistently embedded due to crowded curricula, limited staff expertise, and perceptions of sustainability as peripheral (Décamps et al., 2017; Mínguez et al., 2021; Ruhanen & Bowles, 2020; Zizka & Varga, 2021). Transformative pedagogies, critical reflection, experiential learning, and cross-disciplinary design are recommended to couple knowledge with practice (Boyle et al., 2015; Lugg, 2007). Assessment tools can help support change, but risk tokenism if not integrated within a whole-of-programme strategy (Buissink-Smith et al., 2011; Hartono, 2020; Prada et al., 2020). Such constraints imply that faculty capability and CPD are likely levers for strengthening both explicit and tacit provision, an interpretation we revisit in the Discussion.

2.6. Synthesis and Study Focus

The literature converges on three linked concerns that shape our empirical focus: the prevalence of explicit decarbonisation in programme learning outcomes and its relationship to high-level SDG alignment; the breadth of practical decarbonisation content delivered when such outcomes are explicitly embedded; and the profile of practices emphasised across institutions, including where operational or systems-oriented competencies remain thin. To address these, the authors employ institution-level indicators, binary variables for decarbonisation in learning outcomes and SDG alignment, alongside a multiple-response inventory of practices to characterise thematic coverage and a per-institution coverage count to summarise breadth (see Conefrey et al., 2025). This design enables a direct bridge from claims in the literature to the empirical patterns reported subsequently, where cross-tabulation with exact tests evaluates prevalence/alignment (Table 2), nonparametric

comparisons test differences in breadth by learning-outcome status (Table 3), and the practices inventory delineates the distribution of taught content across the sector (Table 4).

3. Materials and Methods

Achieving a low-carbon pathway in tourism requires a skilled workforce capable of calculating emissions and optimising decarbonisation strategies (Septyandi & Prawira, 2022). This paper assesses the extent to which UK HEIs provide sustainable literacy and decarbonisation strategies to equip graduates with the competencies needed to advance the Net-Zero agenda.

The research process began with a desk-based analysis of academic literature, policy guidelines, and governmental reports to inform the development of a structured research tool. A 28-item survey was designed based on theoretical frameworks and best practices, reflecting four thematic areas (Table 1). The survey primarily featured closed-ended questions with drop-down response options, alongside select open-ended fields to capture additional insights from respondents.

Table 1. Four research themes.

Theme	Objective	Authors
Alignment of program and module learning outcomes to UN SDGs	Embedding the UNSDGs as guiding principles for enterprises' ethos and operational plans	(Conefrey & Hanrahan, 2022a, 2022b; Ferrer-Estévez & Chalmeta, 2021; Leal Filho et al., 2023; Serafini et al., 2022)
Explicit knowledge transfer and development of sustainable literacy	Overview of international reports and practices Consideration is given to transferable knowledge	(Barkathunnisha et al., 2019; Mínguez et al., 2021; Scott & Gössling, 2022; Zizka & Varga, 2021)
Tacit knowledge transfer of decarbonisation measurement and management skills	System boundaries Use of technology National and international strategies and practices Application of the decarbonisation agenda	(Arrobas et al., 2020; Conefrey & Hanrahan, 2022b; López-Bonilla & López-Bonilla, 2014; Pham et al., 2022; Ruhanen & Bowles, 2020; Septyandi & Prawira, 2022)
Further learning needs	Net-Zero objectives Sustainable literacy and decarbonisation skills need	(Chen et al., 2022; Mínguez et al., 2021; Zizka & Varga, 2021)

3.1. Survey Design and Administration

A quantitative survey approach was deemed appropriate for this study due to its ability to measure knowledge, skills, and attitudes across large populations (Dolnicar, 2018; Minor et al., 2024). Quantitative methods have been widely applied in assessing sustainability competencies in various contexts, including employment prospects and decision-making (Roohr et al., 2014), sustainable food literacy (Teng & Chih, 2022), and general sustainability knowledge (Panchal & Moschandreas, 2015).

The online survey was developed and distributed via Qualtrics between March and April 2023 to 67 UK universities (England, Northern Ireland, Scotland, and Wales) offering undergraduate (UG), postgraduate (PG), and PhD programs in Tourism, Hospitality, or Events. To enhance participation, a snowball sampling technique, as recommended by Saufi et al. (2014), was employed. Relevant department heads were asked to forward the survey to relevant Programme Directors if they felt another colleague had greater insight into program curricula and learning outcomes.

Data collection occurred between July and September 2023, with follow-up emails sent to encourage participation. Despite these efforts, the final sample consisted of 21 respondents, representing a 30% institutional response rate, comparable to similar studies in sustainability education research (Minor et al., 2024).

3.2. Sample

Questionnaires were addressed to the Head of Department for each HEI, with an explicit request that they forward the survey to a Programme Director or other colleague if they lacked detailed knowledge about program content relating to climate neutrality. This approach resulted in responses from a mix of Programme Directors and Heads of Department; however, the anonymised nature of the questionnaire meant that respondent roles were not recorded. Only one response per HEI was included, ensuring institutional-level analysis and avoiding duplication. The final sample comprised 21 HEIs (31% response rate) offering UG, PG, and PhD programs. While modest, the sample provides valuable insights into institutions actively engaged in sustainability and decarbonisation curriculum development.

3.3. Measurement

To align the analysis with the study aims and to ensure reproducibility, key variables were operationalised as follows in SPSS v30: Decarbonisation learning outcomes (AnyDecarbLO). The item asking whether the programme LO explicitly referenced decarbonisation (Yes/No/I don't know) was treated as a binary indicator (0 = No, 1 = Yes). "I don't know" and blanks were treated as missing (user-missing), so they did not inflate the "No" category. SDG alignment (SDGAligned). The item asking whether programmes were aligned with the UN SDGs (Yes/No/I don't know) was likewise coded 0/1, with "I don't know" set to missing. Decarbonisation practices (Q23). The multi-select checklist of specific decarbonisation practices was analysed in two complementary ways. As a multiple-response (MR) contrast set to produce the percentage of HEIs teaching each practice (reported as Percent of cases, using as base only those institutions with at least one valid selection); and as a per-institution coverage count (PracticeCount) computed as the number of selected practices across all Q23 items. For Yes/No items, case and spacing were standardised before dichotomisation; for Q23, the exact "ticked" value (e.g., 1 or the dataset's tick string) was used consistently in both the MR set and the Count procedure so that practice percentages and PracticeCount are internally coherent. These operational choices mirror the Results Tables 2–4, where AnyDecarbLO and SDGAligned appear as binary grouping variables, practice prevalence is presented as Percent of cases, and PracticeCount summarises the breadth of provision.

Table 2. SDG alignment $\times$ decarbonisation learning outcomes (Fisher's exact test).

SDG Alignment	LO: No (n, Row %)	LO: Yes (n, Row %)	Row Total
No	10 (90.9%)	1 (9.1%)	11
Yes	7 (70.0%)	3 (30.0%)	10
Total	17 (81.0%)	4 (19.0%)	21

Note. Fisher's exact (two-sided) $p = 0.311$; $\phi = 0.266$; odds ratio = 4.286, 95% CI [0.366, 50.197]. Two cells (50%) had expected counts < 5 ; Fisher's exact test is reported. $N = 21$.

Table 3. Practice coverage (PracticeCount) by LO status (Mann–Whitney U).

Group (Any-DecarbLO)	n	Median PracticeCount	IQR	Mann–Whitney U	Exact <i>p</i> (2-Sided)	<i>z</i>	Effect Size <i>r</i>
LO = No	17	1	6				
LO = Yes	4	19	35	9.500	0.024	−2.244	0.490

Note. Medians and IQRs from Explore; U, exact *p* and *z* from 2 independent samples (Mann–Whitney). Effect size *r* computed as $|z|/\sqrt{N} = 2.244/\sqrt{21} \approx 0.490$. *N* = 21.

Table 4. Most common decarbonisation practices taught (Percent of cases).

Practice	n (HEIs)	% of Cases
Circular economy	15	78.9
Slow tourism	7	36.8
Low-carbon tourism	7	36.8
De-market/rethink marketing efforts (i.e., long-haul destinations)	7	36.8
Reduce, reuse and recycling	6	31.6
Offer/support more sustainable trip options (for visitors and employees)	6	31.6
Adopting renewable energy sources	5	26.3
Reduce solid waste	5	26.3
Reduce food waste	5	26.3
Behavioral adaptations	5	26.3

Note. Multiple-response question; figures are the percentage of cases with a base = 19 HEIs providing any valid practice selection. Items are ordered by % (descending). Source: SPSS Multiple Response—\$Practices (dichotomy counted at value = 1).

3.4. Statistical Analysis

Analyses were conducted in SPSS v30 with two-sided $\alpha = 0.05$ and exact *p*-values where appropriate. Frequencies for key binaries (AnyDecarbLO, SDGAligned, see Appendix B) and a multiple-response frequency table for all Q23 practices are reported as Percent of cases (base = HEIs with any valid Q23 selection). This yields the ranked profile of taught practices (Table 4). The association between SDG alignment and LO inclusion was investigated. Crosstabs of SDGAligned by AnyDecarbLO with row and column percentages are presented. Fisher’s exact test (two-sided) was used due to small, expected cell counts, with ϕ (phi) as an effect size, and odds ratio with 95% CI from the Risk Estimate panel (Table 2). Group differences in practice breadth by LO status are also illustrated. Mann–Whitney U test was performed comparing PracticeCount between LO = Yes vs. LO = No, reporting U, exact *p*, and *z* (see Appendix D). Medians and interquartile ranges (IQRs) per group were obtained. The choice of Mann–Whitney analysis reflects the small sample size, and the discrete, skewed nature of coverage counts. “I don’t know” responses and blanks for Yes/No items were treated as missing; tests used all available cases on the variables involved. For the Q23 multiple-response summary, the case base is the number of institutions with at least one valid practice selection, as recommended for MR reporting; this base is stated in the table note. These conventions are reflected in the reported *N*’s and bases in Tables 2–4.

Ethical integrity was a cornerstone of this study. Participation was voluntary, and responses were fully anonymised to protect confidentiality. Ethical approval was secured from the author’s relevant Ethics Committee, ensuring compliance with established research guidelines.

4. Results

4.1. Prevalence and Alignment

Across 21 HEIs, four programmes reported embedding decarbonisation within formal learning outcomes (LOs), corresponding to 19.0% overall. Programmes reporting SDG alignment were 30.0% likely to include decarbonisation LOs versus 9.1% among non-aligned programmes (see Table 2). Although the direction favoured SDG-aligned programmes, the association was not statistically significant (Fisher's exact two-sided $p = 0.311$), with a small–moderate association ($\phi = 0.266$).

The estimated odds ratio indicated higher odds of LO inclusion under SDG alignment (OR = 4.286, 95% CI [0.366, 50.197]), but the wide interval reflects limited precision given small cell counts (two cells < 5).

4.2. Coverage of Decarbonisation Practices by LO Status

Programmes with decarbonisation LOs exhibited substantially broader practice coverage than those without (see Table 3). Median practice coverage was 19 (IQR = 35) for LO-Yes programmes ($n = 4$) versus 1 (IQR = 6) for LO-No ($n = 17$). The Mann–Whitney test was significant ($U = 9.500$, exact $p = 0.024$), with a medium–large effect ($r = 0.49$), indicating a materially higher breadth of practice teaching when decarbonisation is explicitly embedded in LOs.

4.3. Most Commonly Taught Decarbonisation Practices

Among HEIs that reported teaching at least one practice (base, $n = 19$), provision was varied but concentrated on a subset of topics (Table 4). The most prevalent was circular economy (78.9%), followed by a cluster around slow tourism (36.8%), low-carbon tourism (36.8%), and de-marketing/rethinking long-haul destinations (36.8%).

More operational behaviours were reported at moderate levels, reduce, reuse and recycling (31.6%) and offering/supporting more sustainable trip options (31.6%), with additional items (e.g., adopting renewable energy sources, reducing solid/food waste, behavioural adaptations) each at 26.3%.

Taken together, the findings from Tables 2–4 indicate that explicit curricular commitment, embedding decarbonisation in LOs, is uncommon but, when present, is strongly associated with broader coverage of practical decarbonisation content. SDG alignment shows a similar directional pattern but did not reach statistical significance in this sample, likely reflecting limited power and small expected counts. The profile of taught practices suggests emphasis on circular-economy framing, with more technical/operational measures present but less ubiquitous across institutions.

5. Discussion

This section interprets the findings in relation to the study's aims and existing scholarly literature on sustainability literacy and curriculum design within higher education. The analyses highlight three interlocking patterns.

First, the formal embedding of decarbonisation in learning outcomes (LOs) remains uncommon, present in 19% of programmes, despite widespread rhetorical commitment to sustainability in higher education. Second, where decarbonisation is embedded in LOs, practical coverage is markedly broader: programmes with decarbonisation LOs teach substantially more decarbonisation practices than those without (Mann–Whitney $U = 9.500$, exact $p = 0.024$, $r \approx 0.49$) (distributional detail in Appendix B; test statistics in Appendix C). Third, across the sector, taught practices concentrate on a subset of themes, with strong emphasis on circular-economy framing and more modest adoption of operational or systems-oriented competencies (e.g., measurement and monitoring). Collectively, these

findings sharpen the picture of a sector that acknowledges sustainability yet under-specifies the explicit and tacit competencies required for Net Zero implementation.

5.1. Formal Integration and Curricular Specificity

That only a minority of programmes explicitly reference decarbonisation in LOs suggests a persistent gap between policy discourse and curricular design. This mirrors critiques that tourism education has been slow to operationalise climate change education, with explicit mitigation outcomes still the exception rather than the rule (Conefrey & Hanrahan, 2022a, 2022b; Leal Filho et al., 2023; Scott & Gössling, 2022). In the data, SDG-aligned programmes were more likely to include decarbonisation LOs (30.0% vs. 9.1%), but this association was not statistically significant (Fisher's exact $p = 0.311$), and its imprecision (wide 95% CI) reflects small cell counts. This should be considered important because alignment statements may be necessary but insufficient as drivers of substantive curricular change without explicit LO-level commitments.

5.2. Explicit Knowledge and Tacit Capability

A central contribution of the new analysis is to empirically connect formal intent to practice breadth. Programmes that embed decarbonisation LOs deliver substantially wider coverage of practices (median 19 vs. 1 items), consistent with the view that explicit knowledge (policies, pathways, tools) and tacit capability (operational know-how) are mutually enabling rather than substitutable (Cooper, 2015; Loehr & Becken, 2021; Pham et al., 2022). In contrast, the overall pattern of provision remains fragmented: while many programmes foreground general sustainability awareness, detailed, practice-ready content (e.g., measurement boundaries, emissions accounting, systems tools) is less common, echoing concerns that tourism curricula often lack the depth and specificity needed to shift practice at scale (Barkathunnisha et al., 2019; Mínguez et al., 2021).

5.3. A Profile of Practices

The multiple-response profile places circular economy as the modal emphasis (78.9% of cases), followed by a cluster of behavioural and demand-side levers, slow tourism, low-carbon tourism, de-marketing long-haul destinations (each 36.8%), and mid-tier operational measures (see Appendix A for the full item list and percentages). Items such as adopting renewable energy, reducing solid/food waste, and behavioural adaptations appear at 26.3%. Such a distribution suggests that conceptual and behavioural frames currently outpace technical systems training, which may contribute to awareness without the application pattern noted above. Strengthening coverage of tools that anchor practice, e.g., carbon measurement, energy management systems, GIS-enabled planning, would help translate sustainability intent into evidence-based action (Barkathunnisha et al., 2019; Mínguez et al., 2021).

5.4. Interpreting the SDG Alignment Signal

The non-significant association between SDG alignment and LO inclusion must be read cautiously. Directionally, alignment appears constructive, but small expected counts reduce power and widen confidence intervals (see Appendix C for medians/IQRs and Appendix D for Mann–Whitney details). Substantively, the result is consistent with a view that symbolic alignment (e.g., mapping to the SDGs) may not, by itself, guarantee curricular specificity (i.e., explicit decarbonisation outcomes and applied skills). Thus, embedding decarbonisation at the LO level seems more tightly coupled to practice breadth in our data, underscoring the importance of assessment-anchored outcomes rather than high-level signalling (Conefrey & Hanrahan, 2022a, 2022b; Leal Filho et al., 2023; Scott & Gössling, 2022).

5.5. Staff Capability and CPD

The pattern of results is also similar to capacity constraints on the teaching side, where programmes do not embed decarbonisation explicitly, and practice coverage narrows. Prior work underscores the role of faculty expertise and CPD in shaping curriculum quality (Chen et al., 2022; Zizka & Varga, 2021). Findings presented in this paper reinforce the argument for targeted professional development in climate policy, emissions modelling, and destination-level decarbonisation planning, so that explicit knowledge can be taught alongside the tacit, operational skills graduates need.

6. Conclusions and Implications

This study examined how UK HEIs in tourism, hospitality, and events embed decarbonisation and sustainability competencies. The results show that explicit embedding of decarbonisation within programme learning outcomes remains rare (19%), yet when present, such programmes deliver substantially broader practice coverage than those without. These findings confirm that explicit, assessment-anchored learning outcomes are more effective drivers of applied decarbonisation teaching than symbolic SDG alignment alone (Conefrey & Hanrahan, 2022a, 2022b; Leal Filho et al., 2023; Scott & Gössling, 2022).

For UK HEIs, three actions are recommended. First, embed explicit, measurable decarbonisation learning outcomes at the programme level, ensuring constructive alignment between learning objectives, assessment, and teaching activities (see Biggs et al., 2022). Second, strengthen the portfolio of practices by including technical systems and tools such as emissions accounting, energy and waste management, and GIS-based planning alongside behavioural and circular-economy framing (Barkathunnisha et al., 2019; Mínguez et al., 2021). Third, invest in targeted continuing professional development (CPD) and communities of practice so staff can teach both explicit knowledge (policy, methods, standards) and tacit competencies (applied, context-sensitive problem-solving), thereby converting intent into graduate readiness (Cooper, 2015; Loehr & Becken, 2021; Pham et al., 2022).

Aligning with international critiques (Leal Filho et al., 2023; Scott & Gössling, 2022), these steps support comprehensive, skills-based reform linking policy and science literacy to hands-on operational training, backed by CPD for educators (Barkathunnisha et al., 2019; Chen et al., 2022; Conefrey & Hanrahan, 2022a, 2022b; Cooper, 2015; Loehr & Becken, 2021; Mínguez et al., 2021; Pham et al., 2022; Zizka & Varga, 2021). The next subsections outline the broader theoretical and practical implications, as well as the study's limitations and future research directions.

6.1. Practical and Theoretical Implications

Theoretically, this study advances curriculum-design literature by empirically demonstrating that explicit decarbonisation LOs are associated with broader practice coverage, reinforcing constructive alignment theory (Biggs et al., 2022) within the context of Net Zero education. It extends the concept of sustainability literacy by distinguishing symbolic SDG alignment from operational, assessment-anchored integration, illustrating that institutional signalling alone does not ensure applied competence (Leal Filho et al., 2023; Scott & Gössling, 2022).

Practically, the results provide an analytical framework for HEIs to audit and reform tourism curricula. Embedding explicit decarbonisation LOs (see Appendix E), strengthening technical systems coverage (e.g., emissions accounting, energy and waste management tools), and investing in targeted CPD initiatives can help enhance graduate readiness for climate-transition roles (Barkathunnisha et al., 2019; Chen et al., 2022; Zizka & Varga, 2021). These findings also provide policymakers and accreditation bodies with evidence-based

leverage points to help align institutional strategies and staff development with national decarbonisation goals (Conefrey & Hanrahan, 2022b; Loehr & Becken, 2021; Pham et al., 2022).

6.2. Limitations and Future Research Suggestions

While the paper offers new empirical insights, several limitations should be acknowledged. The cross-sectional, self-reported data limit causal inference and may introduce reporting bias. The modest institutional sample (N = 21) constrains statistical power and generalisability, and the binary coding of variables simplifies complex degrees of integration. These methodological limitations are consistent with earlier studies on sustainability education in higher education (Décamps et al., 2017; Ruhanen & Bowles, 2020; Zizka & Varga, 2021).

Future research should adopt mixed-methods and longitudinal approaches to examine how explicit LO integration evolves and influences graduate capability over time. Comparative, multi-country studies could test whether these patterns hold across diverse policy and cultural contexts (Eusébio et al., 2022; Conefrey et al., 2025). Qualitative approaches could further explore faculty decision-making, institutional barriers, and the organisational dynamics of curriculum reform (Boyle et al., 2015; Cooper, 2018; Lugg, 2007).

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Appendix A

Table A1. Full decarbonisation practices taught (multiple response, Percent of cases).

\$Practices Frequencies	Responses		Percent of Cases
	N	Percent	
Circular Economy	15	9.0%	78.9%
Slow tourism	7	4.2%	36.8%
Low-carbon tourism	7	4.2%	36.8%
De market/rethink marketing efforts (i.e., long-haul destinations)	7	4.2%	36.8%

Table A1. Cont.

Practices Frequencies				
	Responses		Percent of Cases	
	N	Percent		
Offer/support more sustainable trip options (for visitors and employees)	6	3.6%	31.6%	
Adopting renewable energy sources	5	3.0%	26.3%	
Reduce solid waste	5	3.0%	26.3%	
Reduce food waste	5	3.0%	26.3%	
Behavioural adaptations	5	3.0%	26.3%	
Roles and responsibilities of a sustainability officer/sustainability manager	4	2.4%	21.1%	
Reduce energy usage	4	2.4%	21.1%	
Reduce fossil fuel consumption	4	2.4%	21.1%	
More fuel-efficient/electric transportation	4	2.4%	21.1%	
Low-carbon menu options	2	1.2%	10.5%	
Local product sourcing	4	2.4%	21.1%	
Eliminate unnecessary plastics	2	1.2%	10.5%	
Encourage investing in the conservation of biodiversity	3	1.8%	15.8%	
Customer Relationship Management systems (CRMs)	4	2.4%	21.1%	
Providing guidance and training to operational staff	3	1.8%	15.8%	
Reducing emissions	3	1.8%	15.8%	
Adopting electricity, heating and cooling efficiencies	3	1.8%	15.8%	
On/Off checklists for all equipment	3	1.8%	15.8%	
Consulting with energy providers about how to reduce costs and consumption	1	0.6%	5.3%	
Optimising ground fleet	1	0.6%	5.3%	
Reduce, reuse and recycling	6	3.6%	31.6%	
Encourage investing in technology-based solutions (direct air capture, enhanced weathering, bio digester)	2	1.2%	10.5%	
Identifying system boundaries	1	0.6%	5.3%	
Data collection and distribution	2	1.2%	10.5%	
Water management systems	5	3.0%	26.3%	
Urban/building improvements	3	1.8%	15.8%	
Establishing Tourism Satellite Accounts	2	1.2%	10.5%	
Eliminating lights and make the most of natural light wherever possible	2	1.2%	10.5%	
Strict policy of turning off all equipment when not in use	3	1.8%	15.8%	
Low-carbon transport (bike/walk)	4	2.4%	21.1%	
Measuring and monitoring emissions	2	1.2%	10.5%	
Introduce free water station for refilling bottles	1	0.6%	5.3%	
Digital carbon footprint management systems	2	1.2%	10.5%	

Table A1. Cont.

Practices Frequencies			
	Responses		Percent of Cases
	N	Percent	
Energy management systems	3	1.8%	15.8%
GIS (Geographic Information Systems) mapping	2	1.2%	10.5%
Sustainability Performance Measurement	2	1.2%	10.5%
Sustainable cloud computing, IT and Software	2	1.2%	10.5%
Other initiatives (please explain)	2	1.2%	10.5%
Observe how staff use energy appliances and equipment, and consider where changes in behavior could lead to significant savings	3	1.8%	15.8%
Reduce water waste	4	2.4%	21.1%
Integrate reusable items	3	1.8%	15.8%
Compensating emissions (offsetting/carbon credits)	4	2.4%	21.1%
Total	167	100.0%	878.9%

Note. Dichotomy group tabulated at value 1. Multiple-response question; Percent of cases; base = 19 HEIs with any valid Q23 response; counted value = 1.

Appendix B

Table A2. Descriptive statistics for practice coverage (PracticeCount) by LO status.

Group (AnyDecarbLO)	n	Median	IQR	Min	Max	Mean	SD
LO = No	17	1.00	6	0	20	4.82	6.830
LO = Yes	4	19.00	35	2	45	21.25	18.209

Note. Values taken from SPSS Explore, Descriptives for PracticeCount by AnyDecarbLO (Case Processing Summary confirms group ns: 17 and 4). N = 21.

Appendix C

Table A3. Descriptive statistics for practice coverage (PracticeCount) by SDG alignment (Explore).

Group (SDGAligned)	n	Median	IQR	Min	Max	Mean	SD
SDG = No	11	1.00	4	0	20	4.45	6.890
SDG = Yes	10	5.50	19	1	45	11.80	14.367

Note. Values taken from SPSS Explore, Descriptives for PracticeCount by SDGAligned (Case Processing Summary confirms group ns: 11 and 10). N = 21.

Appendix D

Table A4. Mann–Whitney U test for practice coverage by SDG alignment.

Statistic	Value
U	34.000
z	−1.512
Exact Sig. (2-sided)	0.152
N (total)	21
n (SDG = No)	11

Table A4. Cont.

Statistic	Value
n (SDG = Yes)	10
(Optional) Effect size r =	z

Note. Ranks and test statistics from 2 Independent Samples (Mann–Whitney); r computed from z and N.

Appendix E

Table A5. Crosstabulation of alignment with the UNSDG? Programme(s) LO focus on decarbonisation.

		Do Any of Your Programme(s) Learning Outcomes Focus on Decarbonisation?		Total	
		No	Yes		
Have you aligned your programme(s) with the United Nations Sustainable Development Goals?	No	Count	10	1	11
		% within Have you aligned your programme(s) with the United Nations Sustainable Development Goals?	90.9%	9.1%	100.0%
		% within Do any of your programme(s) learning outcomes focus on decarbonisation?	58.8%	25.0%	52.4%
	Yes	Count	7	3	10
		% within Have you aligned your programme(s) with the United Nations Sustainable Development Goals?	70.0%	30.0%	100.0%
		% within Do any of your programme(s) learning outcomes focus on decarbonisation?	41.2%	75.0%	47.6%
Total		Count	17	4	21
		% within Have you aligned your programme(s) with the United Nations Sustainable Development Goals?	81.0%	19.0%	100.0%
		% within Do any of your programme(s) learning outcomes focus on decarbonisation?	100.0%	100.0%	100.0%

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