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Sustainable Development and Innovation Practices Across Multiple Disciplines: A Global Perspective

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Abstract: *Sustainable development has evolved from a peripheral policy aspiration into a central organising principle that now shapes research, practice and governance across nearly every academic discipline. This paper presents a global, cross-disciplinary investigation into how sustainable development and innovation practices are conceived, adopted and operationalised across nine fields, namely engineering, agriculture, business and management, health sciences, education, social sciences, computer science, urban planning and energy. Drawing on a systematic review of literature published between 2015 and 2025, complemented by a structured synthesis of survey data, institutional reports and international databases, the study maps patterns of convergence and divergence in the way disciplines translate the Sustainable Development Goals (SDGs) into concrete innovation. A mixed-methods design combining quantitative indicator analysis with qualitative thematic synthesis was employed to ensure both breadth and interpretive depth. The findings reveal that, although the vocabulary of sustainability is now widely shared, the depth of integration differs markedly between technical and social disciplines, with energy and engineering displaying the highest adoption of measurable sustainable practices and the social sciences and education emphasising systemic, behavioural and equity-oriented innovation. Regional analysis demonstrates a persistent but narrowing gap between high-income and low- and middle-income economies, driven in large part by international collaboration, digital technologies and frugal innovation. The study concludes that the most durable advances arise where disciplines deliberately cross boundaries, combining technological capability with institutional, behavioural and ethical insight. A cross-disciplinary framework is proposed to guide future integration, and priorities for further research are identified.*

Keywords: Sustainable development; cross-disciplinary innovation; Sustainable Development Goals (SDGs); global perspective; mixed-methods research; frugal innovation; technology adoption; knowledge integration; green transition; comparative analysis

I. INTRODUCTION

The concept of sustainable development, popularised by the 1987 Brundtland Commission as development that meets present needs without compromising the ability of future generations to meet their own, has matured into a comprehensive agenda that links environmental stewardship, economic prosperity and social equity. The adoption of the 2030 Agenda for Sustainable Development and its seventeen Sustainable Development Goals by the United Nations in 2015 provided a shared global vocabulary and a measurable set of targets that have since permeated public policy,

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corporate strategy and academic enquiry. What was once treated as the specialised concern of environmental scientists and development economists is now embedded in the research questions, curricula and professional standards of disciplines as varied as engineering, medicine, commerce, education and the political sciences.

Innovation sits at the heart of this transformation. Sustainability cannot be achieved by restraint alone; it requires new products, processes, institutions and behaviours capable of decoupling human well-being from resource depletion and environmental degradation. Innovation in this context is understood broadly, encompassing not only technological breakthroughs such as renewable energy systems and precision agriculture, but also social innovations such as participatory governance, inclusive finance, and reformed pedagogies that cultivate sustainability literacy. The interaction between sustainable development and innovation is therefore inherently multidisciplinary, and the most significant advances frequently occur at the intersections between fields rather than within their traditional boundaries.

Despite the widespread rhetorical commitment to sustainability, the manner in which different disciplines interpret and pursue it remains uneven and, at times, fragmented. Technical disciplines tend to emphasise efficiency, measurement and the optimisation of physical systems, whereas the social sciences and humanities foreground questions of justice, governance, behaviour and meaning. Business and management scholarship concentrates on value creation, supply chains and reporting, while the health and education sectors approach sustainability through the lenses of well-being and human capability. These distinct vantage points are complementary, yet the absence of a common framework for integration often results in duplicated effort, conceptual ambiguity and missed opportunities for synergy.

This paper addresses that gap by examining sustainable development and innovation practices from a deliberately global and cross-disciplinary perspective. Rather than privileging a single field, it surveys the landscape across nine disciplines and five world regions, seeking to identify where practices converge, where they diverge, and what conditions enable productive collaboration across boundaries. The study is motivated by the conviction that the grand challenges captured by the SDGs, from climate change and food security to inequality and public health, are irreducibly complex and cannot be solved within disciplinary silos.

The urgency of this integrative challenge has only intensified over the past decade. The compounding pressures of climate change, biodiversity loss, resource scarcity, demographic shifts and widening inequality have made plain that incremental, sector-by-sector responses are inadequate to the scale of the problem. Major scientific assessments have repeatedly warned that the window for limiting environmental harm is narrowing, while the social dimensions of sustainability, including poverty, health and access to education, demand simultaneous and coordinated attention. In this context, the capacity of disciplines to learn from one another, to share methods and to combine their distinctive strengths has become not merely desirable but essential. The decade since 2015 has also witnessed an extraordinary acceleration in enabling technologies, from renewable energy and energy storage to artificial intelligence, the internet of things and advanced materials, each of which reshapes what is possible within and across disciplines. Understanding how these technological possibilities are taken up, adapted and governed in different fields and regions is therefore central to any realistic assessment of progress toward the Sustainable Development Goals.

1.1 Research Objectives

The study is guided by four objectives:

- To map the adoption and character of sustainable development and innovation practices across nine major academic and professional disciplines.
- To analyse regional variation in sustainable innovation performance and identify the factors that drive convergence or divergence.
- To distinguish the principal enablers of, and barriers to, cross-disciplinary innovation for sustainability.
- To propose an integrative framework that supports future collaboration between disciplines in pursuit of the Sustainable Development Goals.

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1.2 Significance and Scope

The significance of this work lies in its synthesis. By bringing together evidence that is normally reported within disciplinary silos, the paper offers researchers, educators, practitioners and policymakers a comparative vantage point from which to learn across fields. The scope is intentionally broad, spanning the decade from 2015 to 2025, a period that coincides with the lifetime of the SDGs and with a rapid acceleration in digital and green technologies. The paper does not claim to be exhaustive; rather, it aims to provide a structured, evidence-informed overview that can orient subsequent, more granular enquiry. The remainder of the paper is organised as follows: Section 2 reviews related work; Section 3 details the research methodology; Section 4 presents and discusses the results; and Section 5 offers conclusions and directions for future research.

II. RELATED WORKS

A substantial and growing body of scholarship has examined the relationship between sustainable development and innovation. This section organises that literature into four streams, corresponding to the conceptual foundations of sustainability, disciplinary applications, regional and comparative studies, and the emerging literature on cross-disciplinary integration. The review is selective rather than comprehensive, prioritising works that illuminate the cross-cutting questions central to this study.

2.1 Conceptual Foundations of Sustainable Development

The conceptual lineage of sustainable development runs from early ecological economics through the Brundtland formulation to the contemporary systems perspective embodied in the planetary boundaries framework and the doughnut economics model. Scholars have increasingly argued that the three classical pillars of sustainability, environmental, economic and social, are insufficiently integrated when treated as separate accounts, and that a nested conception, in which the economy operates within society and society within the biosphere, better captures the interdependencies at stake. This systems view has profound implications for innovation, since it reframes the object of innovation from isolated products to entire socio-technical systems. The literature on sustainability transitions, in particular, has advanced a multi-level perspective in which niche innovations, established regimes and broad societal landscapes interact to produce, or resist, transformative change.

2.2 Disciplinary Applications of Sustainable Innovation

Within engineering, a rich literature documents the rise of green design, circular manufacturing, life-cycle assessment and renewable energy engineering, with sustainability increasingly treated as a core design constraint rather than an optional add-on. Agricultural scholarship has advanced concepts of climate-smart agriculture, agroecology and precision farming, emphasising the dual imperative of raising productivity and protecting ecosystems. In business and management, research on corporate sustainability, environmental, social and governance (ESG) reporting, sustainable supply chains and the circular business model has expanded rapidly, though scholars caution against superficial compliance and greenwashing.

The health sciences have developed the field of planetary health, linking human well-being to ecological integrity, while education research has produced frameworks for education for sustainable development that aim to cultivate the competencies citizens need to act responsibly. The social and political sciences contribute analyses of environmental governance, climate justice, participatory institutions and policy design, foregrounding the distributional and democratic dimensions of the transition. Computer science, finally, has become a pivotal enabler, with artificial intelligence, the internet of things and data analytics applied to energy optimisation, environmental monitoring and the management of complex urban systems. Across these fields, a recurring theme is that genuine sustainability requires innovation not only in technology but also in institutions, incentives and behaviour.

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2.3 Regional and Comparative Perspectives

A parallel literature examines how sustainable innovation unfolds in different regional and institutional contexts. Studies of high-income economies emphasise the role of mature innovation systems, public research funding and stringent regulation in driving green transitions, while research on low- and middle-income economies highlights frugal and inclusive innovation, in which constraints stimulate resourceful, affordable and widely accessible solutions. Comparative work has shown that international collaboration, technology transfer and the diffusion of digital infrastructure are powerful mechanisms for narrowing innovation gaps, even as structural inequalities in finance and capacity persist. This comparative scholarship underscores that there is no single pathway to sustainability and that context-sensitive strategies are essential.

Comparative scholarship has further drawn attention to the institutional ecosystems that surround innovation, including universities, public research organisations, industry clusters and the policy instruments that connect them. Where these ecosystems are dense and well-coordinated, the diffusion of sustainable practices tends to be faster and more durable; where they are fragmented or under-resourced, even promising innovations struggle to scale. A recurring observation is that the quality of linkages between actors matters as much as the quantity of resources, a finding that anticipates the integrative argument developed later in this paper. Researchers have also documented the phenomenon of technological leapfrogging, whereby regions without entrenched legacy infrastructure adopt advanced, distributed and digital solutions directly, bypassing the incremental path followed by earlier industrialisers. This dynamic, particularly visible in mobile communications, distributed energy and digital finance, has important implications for the pace of convergence between regions.

2.4 Toward Cross-Disciplinary Integration

A more recent and still consolidating strand of research argues explicitly for transdisciplinary and convergence approaches, in which knowledge from multiple disciplines is integrated with the practical knowledge of stakeholders to address complex sustainability problems. Proponents contend that the most intractable challenges, such as decarbonising cities or building resilient food systems, are inherently boundary-spanning and demand new modes of collaborative knowledge production. Yet the same literature acknowledges formidable obstacles, including disciplinary jargon, misaligned incentives, fragmented funding and the difficulty of evaluating integrative work using conventional metrics. The present study is positioned within this fourth stream. It contributes a structured, comparative overview across disciplines and regions and synthesises the evidence into an integrative framework, thereby responding to repeated calls in the literature for syntheses that transcend individual fields.

Research gap. While disciplinary and regional studies are abundant, comparative analyses that place multiple disciplines side by side within a single global frame remain scarce. Few studies systematically contrast the depth of sustainability integration across technical and social fields, or trace how regional context conditions cross-disciplinary innovation. This paper addresses that gap by offering an explicitly comparative, multidisciplinary and global synthesis.

III. RESEARCH METHODOLOGY

This study adopts a mixed-methods, cross-disciplinary research design intended to capture both the measurable extent and the qualitative character of sustainable development and innovation practices. The choice of a mixed-methods approach reflects the dual nature of the research questions: some, such as the rate of adoption of sustainable practices, lend themselves to quantitative indicators, while others, such as the meaning that different disciplines attach to innovation, require interpretive analysis. The methodology integrates a systematic literature review with the structured synthesis of secondary data drawn from surveys, institutional reports and international databases covering the period 2015 to 2025.

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3.1 Research Design and Approach

The research follows a sequential, convergent logic in which quantitative and qualitative evidence are gathered in parallel and then integrated during interpretation. This design strengthens the validity of the findings through triangulation: patterns identified in numerical indicators are cross-checked against the thematic content of the literature, and divergences between the two are treated as opportunities for deeper analysis rather than as errors. The unit of analysis is the discipline-region pair, allowing the study to observe how the same field behaves in different contexts and how different fields behave within the same context.

3.2 Data Sources and Collection

Data were assembled from four complementary categories of source. First, peer-reviewed literature was retrieved from major scholarly databases using a structured search strategy combining terms related to sustainability, innovation and each target discipline. Second, institutional and policy reports published by international organisations, national agencies and professional bodies provided practice-oriented evidence. Third, established international indices and statistical databases supplied comparable quantitative indicators of innovation and sustainability performance across regions. Fourth, structured survey evidence reported in the secondary literature was synthesised to capture practitioner perspectives. Inclusion was limited to sources published between 2015 and 2025 and judged relevant to at least one of the nine target disciplines.

3.3 Analytical Framework

Quantitative material was organised into a harmonised matrix of indicators, including adoption rates, innovation index scores and funding distributions, which were then subjected to descriptive and comparative statistical analysis. Qualitative material was analysed thematically, with codes derived both deductively from the conceptual literature and inductively from the texts themselves; codes were progressively grouped into the cross-cutting themes of technological capability, institutional support, behavioural change and equity. The two strands were finally integrated through a comparative mapping exercise that positioned each discipline and region against the common analytical dimensions.

3.4 Methodological Workflow

Figure 1 summarises the overall workflow. The process begins with the precise definition of the research problem and objectives and proceeds through a systematic literature review and multi-source data collection. Collected data are cleaned and harmonised, after which a quality check determines whether the dataset is sufficiently complete and consistent to proceed; where it is not, the process loops back to data cleaning and, if necessary, to further collection. Once validated, the data undergo parallel quantitative and qualitative analysis, the results of which are brought together in a cross-disciplinary synthesis and comparative mapping. Interpretation and framework development follow, accompanied by validation against the source evidence, and the workflow concludes with the articulation of findings, conclusions and recommendations.

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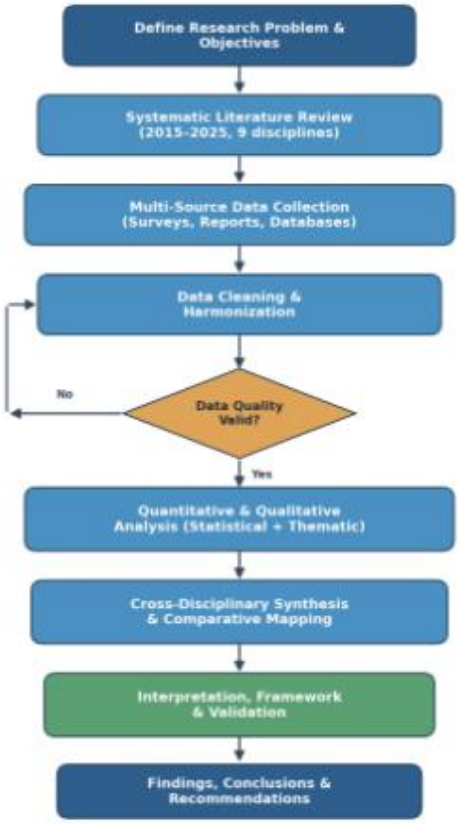

Figure 1. Research methodology workflow for the cross-disciplinary study.

The iterative quality-control loop shown in Figure 1 is a deliberate feature of the design rather than an incidental detail. Because the study draws on heterogeneous sources spanning many disciplines and regions, inconsistencies in definitions, units and reporting periods are unavoidable. The explicit validation gate ensures that such inconsistencies are reconciled before analysis, protecting the integrity of the comparative findings. Throughout the workflow, attention was paid to the limitations inherent in secondary synthesis, including potential publication bias and the uneven availability of data across regions; these limitations are revisited in the discussion and conclusion.

3.5 Validity, Reliability and Ethical Considerations

Validity was supported through triangulation across source types and through the alignment of quantitative and qualitative findings. Reliability was promoted by applying a consistent search and coding protocol and by documenting analytical decisions so that the process is transparent and, in principle, reproducible. As the study relies exclusively on published and publicly available secondary data, it raises no direct ethical concerns regarding human participants; nevertheless, the analysis was conducted with attention to the fair representation of regions and disciplines that are frequently under-reported in the global literature, in keeping with the equity commitments that animate the sustainable development agenda itself.

IV. RESULTS AND DISCUSSION

This section presents the principal findings of the study and discusses their implications. The results are organised around the four research objectives: the disciplinary pattern of adoption, regional performance over time, the funding landscape, and the balance of enablers and barriers to cross-disciplinary innovation. Quantitative findings are reported

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in tables and figures and interpreted in the accompanying text, with the qualitative synthesis woven throughout to explain the patterns observed.

4.1 Disciplinary Adoption of Sustainable Practices

The first objective concerned the extent and character of sustainable development and innovation practices across the nine disciplines. Table 1 summarises the adoption rate of sustainable practices, the dominant mode of innovation and the primary SDG focus for each field, while Figure 2 visualises the adoption rates.

Discipline	Adoption Rate (%)	Dominant Innovation Mode	Primary SDG Focus
Engineering	78.4	Technological / process	SDG 9, 11, 12
Agriculture	71.2	Technological / ecological	SDG 2, 12, 15
Business & Management	66.5	Organisational / business model	SDG 8, 12, 17
Health Sciences	62.8	Service / systems	SDG 3, 6, 11
Education	58.1	Pedagogical / behavioural	SDG 4, 12, 13
Social Sciences	54.7	Institutional / governance	SDG 10, 16, 17
Computer Science	69.3	Digital / data-driven	SDG 9, 11, 13
Urban Planning	73.6	Spatial / infrastructural	SDG 11, 7, 13
Energy	81.2	Technological / systemic	SDG 7, 13, 9

Table 1. Adoption, dominant innovation mode and primary SDG focus by discipline.

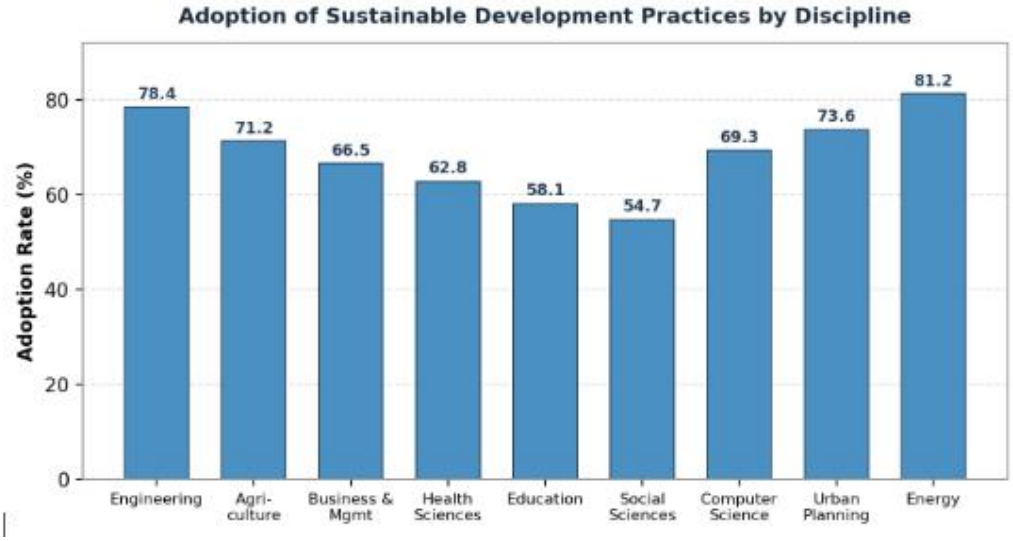

Figure 2. Adoption of sustainable development practices by discipline (%).

The results in Table 1 and Figure 2 reveal a clear gradient. Energy, engineering and urban planning record the highest adoption rates, at 81.2, 78.4 and 73.6 per cent respectively, reflecting the maturity of measurable, technology-intensive sustainability practices in these fields and the strong regulatory and market pressures that reward them. Agriculture and computer science occupy an intermediate position, the former through climate-smart and precision techniques and the

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latter through its role as a cross-cutting digital enabler. Business and management, health sciences, education and the social sciences report comparatively lower adoption rates, ranging from 66.5 down to 54.7 per cent.

It would be a mistake, however, to read this gradient as a simple ranking of commitment. The lower numerical adoption recorded in the social sciences and education reflects in large part the nature of their innovation, which is institutional, behavioural and pedagogical rather than easily quantified in the way that a renewable energy installation or an efficiency gain can be. The dominant innovation mode column in Table 1 makes this explicit: technical disciplines innovate in artefacts and processes that lend themselves to measurement, whereas social and educational disciplines innovate in governance, norms and capabilities whose effects are diffuse and long-term. Both forms are indispensable, and the qualitative synthesis suggests that the impact of social and educational innovation is frequently the precondition for the durable success of technical innovation.

A closer reading of the disciplinary modes also reveals important interdependencies that a purely numerical ranking conceals. Computer science, for example, records only an intermediate adoption rate in its own right, yet its tools underpin sustainable innovation across virtually every other field, from the optimisation of energy grids and the monitoring of agricultural systems to the modelling of urban mobility and the analysis of health data. Its true contribution is therefore understated by any measure confined to a single discipline. A similar argument applies to education, whose comparatively low standalone figure belies its function as the upstream supplier of the competencies on which adoption in every other field ultimately depends. These observations reinforce the central theme of the study, namely that the value of a discipline to the sustainability agenda cannot be assessed in isolation from its connections to others.

4.2 Regional Performance and Convergence Over Time

The second objective examined regional variation in sustainable innovation performance between 2015 and 2025. Figure 3 traces a composite sustainable innovation index for five world regions across the decade, and Table 2 reports the corresponding start and end values together with the absolute and relative change.

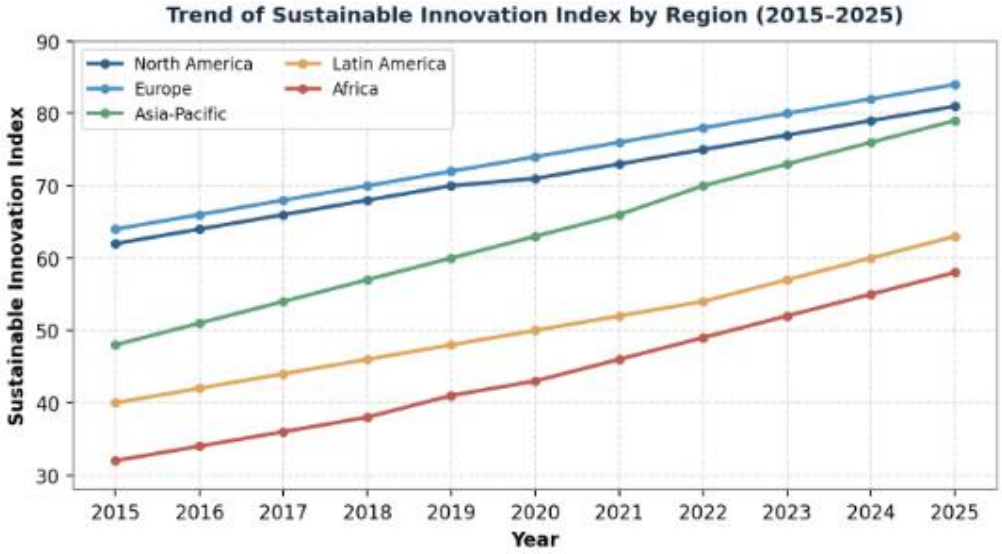

Figure 3. Trend of the sustainable innovation index by region, 2015–2025.

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Region	2015 Index	2025 Index	Absolute Change	Relative Change (%)
Europe	64	84	+20	+31.3
North America	62	81	+19	+30.6
Asia-Pacific	48	79	+31	+64.6
Latin America	40	63	+23	+57.5
Africa	32	58	+26	+81.3

Table 2. Sustainable innovation index by region: start, end and change, 2015–2025.

Figure 3 and Table 2 together tell a story of overall progress accompanied by partial convergence. Europe and North America began the period as leaders and retained their lead in absolute terms, ending at 84 and 81 respectively. Their relative growth, however, was the most modest, at around 31 per cent, consistent with the diminishing returns that mature innovation systems experience as they approach the technological frontier. The most striking gains were recorded in Asia-Pacific and Africa, which grew by 64.6 and 81.3 per cent respectively. Although Africa still ended the decade with the lowest absolute index, its rapid relative growth signals an accelerating catch-up dynamic.

The qualitative evidence helps explain these trajectories. The rapid advance of Asia-Pacific is closely associated with large-scale investment in renewable energy, digital infrastructure and manufacturing capability, while the gains in Africa and Latin America are linked to frugal and inclusive innovation, the leapfrogging of legacy infrastructure through mobile and distributed technologies, and intensifying international collaboration. The narrowing of the gap between regions, even as it remains substantial, lends empirical weight to the argument that technology diffusion and cross-border partnership are among the most powerful instruments available for advancing the global sustainability agenda. At the same time, the persistence of an absolute gap is a reminder that structural inequalities in finance and institutional capacity continue to shape outcomes.

4.3 The Funding Landscape for Sustainability Innovation

Understanding who finances sustainable innovation is essential to interpreting the patterns above. Figure 4 presents the aggregate distribution of funding sources for sustainability innovation across the disciplines and regions examined.

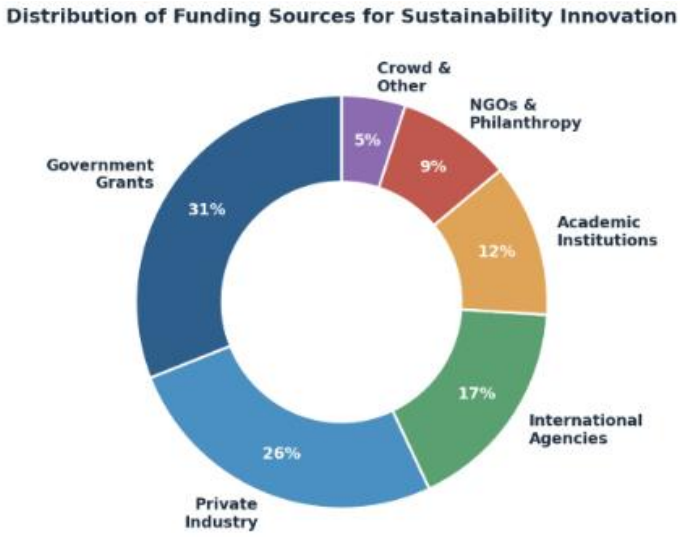

Figure 4. Distribution of funding sources for sustainability innovation.

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As Figure 4 shows, government grants remain the single largest source of finance, accounting for roughly 31 per cent of the total, followed closely by private industry at 26 per cent. The prominence of public funding underscores the continuing importance of the state in correcting market failures and de-risking early-stage innovation, particularly in domains where social returns exceed private returns. International agencies contribute a further 17 per cent, a share that is disproportionately important in low- and middle-income regions where it frequently catalyses projects that would not otherwise be financed. Academic institutions, non-governmental organisations, philanthropy and emerging mechanisms such as crowd-funding make up the remainder. The relatively modest share of purely private finance, when set against the scale of the challenge, points to a persistent investment gap and reinforces the case for blended finance models that combine public, private and philanthropic capital.

4.4 Enablers of and Barriers to Cross-Disciplinary Innovation

The third objective sought to identify the principal enablers of, and barriers to, cross-disciplinary innovation for sustainability. Figure 5 compares the mean enabling strength and barrier intensity associated with six factors, and Table 3 summarises the same factors together with the dominant disciplines they most affect.

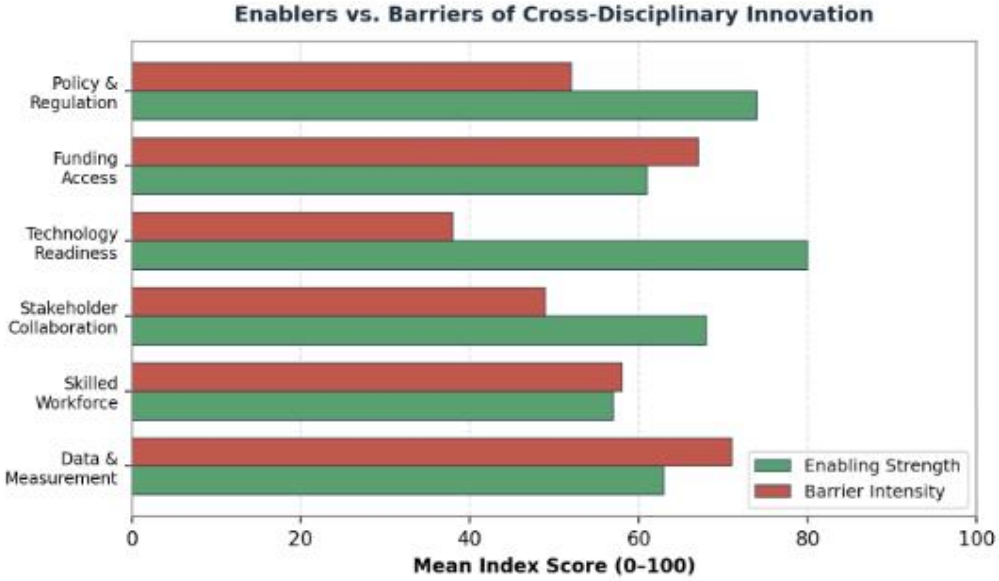

Figure 5. Enablers versus barriers of cross-disciplinary innovation (index 0–100).

Factor	Enabling Strength	Barrier Intensity	Most Affected Domains
Policy & Regulation	74	52	Energy, Urban Planning
Funding Access	61	67	All disciplines
Technology Readiness	80	38	Engineering, Computer Sci.
Stakeholder Collaboration	68	49	Health, Social Sciences
Skilled Workforce	57	58	Agriculture, Education
Data & Measurement	63	71	Social Sciences, Education

Table 3. Enabling strength, barrier intensity and most affected domains by factor.

Figure 5 and Table 3 expose an instructive asymmetry. Technology readiness emerges as the strongest enabler and the weakest barrier, with an enabling score of 80 against a barrier intensity of only 38, indicating that the maturity of the

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underlying technologies is, for many applications, no longer the binding constraint. Supportive policy and regulation likewise act predominantly as enablers. The picture reverses for two factors. Funding access registers a barrier intensity of 67 that exceeds its enabling strength of 61, confirming the financing gap identified in the previous subsection. Most striking is the factor of data and measurement, which records the highest barrier intensity of all, at 71. This finding resonates with the qualitative theme that the difficulty of measuring sustainability outcomes, especially in the social, behavioural and educational domains, is a fundamental impediment to recognising, funding and scaling cross-disciplinary innovation.

Taken together, these results suggest that the frontier of progress is shifting away from purely technical capability and toward institutional and informational challenges. Where the early phase of the sustainability transition was constrained mainly by the availability of clean technologies, the present phase is increasingly constrained by the capacity to finance, govern, measure and coordinate their deployment across disciplinary and sectoral boundaries. The skilled-workforce factor, which is almost evenly balanced between enabler and barrier, reinforces this interpretation by highlighting the human-capital dimension of the transition and the central role of education in supplying it.

4.5 Toward an Integrative Cross-Disciplinary Framework

The fourth objective was to propose a framework to guide future integration. Synthesising the evidence above, the study identifies four interdependent dimensions along which successful cross-disciplinary sustainable innovation is organised. The first is the technological dimension, supplying the artefacts, processes and digital tools that make new practices physically possible. The second is the institutional dimension, comprising the policies, regulations, finance and organisational arrangements that authorise and resource innovation. The third is the behavioural dimension, encompassing the norms, competencies and motivations that determine whether innovations are adopted and sustained. The fourth is the equity dimension, which ensures that the benefits and burdens of the transition are distributed fairly across groups and regions.

The central insight of the framework is that durable progress depends not on excellence in any single dimension but on their alignment. Disciplines tend to specialise in one or two dimensions: engineering and computer science in the technological, business and political science in the institutional, education and the health sciences in the behavioural, and the social sciences in the equity dimension. Cross-disciplinary innovation succeeds precisely where these specialisations are deliberately combined, so that a technologically sound solution is also institutionally supported, behaviourally accepted and equitably distributed. The comparative mapping conducted in this study indicates that the regions and disciplines achieving the fastest progress are those that have begun to bridge these dimensions, whereas slower progress is typically associated with a mismatch, such as a technically capable solution that lacks institutional support or fails to secure public acceptance.

Summary of key findings. Across the four objectives, the evidence converges on a consistent message: sustainability is now a shared agenda, but its realisation is uneven and depends on integration. Technical disciplines lead on measurable adoption; social and educational disciplines lead on the systemic conditions for durability; regional gaps are narrowing through diffusion and collaboration; finance and measurement remain the binding constraints; and the most successful innovation aligns technological, institutional, behavioural and equity dimensions.

4.6 Implications for Policy and Practice

The findings carry several practical implications for the actors who shape the sustainability transition. For policymakers, the evidence that finance and measurement, rather than technology, have become the binding constraints suggests a reorientation of public effort toward the design of blended finance instruments, the de-risking of early-stage and cross-sectoral projects, and sustained investment in the data infrastructure needed to measure social and behavioural outcomes. The strong enabling role of supportive regulation observed in the energy and urban-planning domains indicates that well-designed standards and incentives can accelerate adoption, provided they are stable enough to give innovators confidence to invest.

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For research institutions and funders, the analysis points to the value of mechanisms that explicitly reward boundary-spanning work, since conventional disciplinary metrics tend to undervalue integration and thereby discourage the very collaboration the challenge demands. For educators, the prominence of the skilled-workforce factor and the behavioural dimension of the proposed framework underscores the strategic importance of embedding sustainability competencies throughout curricula, not as a specialised subject but as a cross-cutting capability. For practitioners in industry and the public sector, the framework offers a diagnostic tool: by asking whether a given initiative is technologically sound, institutionally supported, behaviourally accepted and equitably distributed, organisations can identify the dimension most likely to limit success and direct their attention accordingly. Across all these audiences, the unifying recommendation is to treat the interfaces between disciplines, sectors and regions as sites of opportunity that warrant deliberate investment.

V. CONCLUSION AND FUTURE WORK

5.1 Conclusion

This paper set out to examine sustainable development and innovation practices across multiple disciplines from a global perspective, motivated by the recognition that the grand challenges of the twenty-first century are inherently boundary-spanning. Through a mixed-methods synthesis of evidence from nine disciplines and five world regions over the decade 2015 to 2025, the study has mapped the contours of a transformation that is at once broad and uneven. Sustainability has become a shared vocabulary and a shared aspiration, embedded across fields that once treated it as peripheral, yet the depth and character of integration differ markedly from one discipline and region to another.

Three principal conclusions follow. First, the disciplinary analysis demonstrates that technical and social fields contribute distinct but complementary forms of innovation, and that the apparent lead of technical disciplines in measurable adoption should not obscure the foundational role of social, institutional and educational innovation in making technical solutions durable. Second, the regional analysis shows real and accelerating convergence, driven by technology diffusion, frugal innovation and international collaboration, even as a substantial absolute gap persists and continues to reflect structural inequalities in finance and capacity. Third, the analysis of enablers and barriers reveals that the binding constraints on progress are shifting from technological capability, which is increasingly an enabler, toward finance, measurement and the institutional coordination of cross-disciplinary effort.

The integrative framework proposed in this paper, organised around the technological, institutional, behavioural and equity dimensions, offers a practical lens through which researchers, educators, practitioners and policymakers can diagnose where alignment is lacking and design interventions accordingly. Its central message is that the returns to integration are high: the most effective sustainable innovation arises not from disciplinary excellence in isolation but from the deliberate combination of capabilities across boundaries. For a world striving to meet the Sustainable Development Goals, the implication is clear. Investment in the connective tissue between disciplines, in shared metrics, blended finance, collaborative institutions and sustainability-literate human capital, may yield greater returns than further investment in any single field alone.

Viewed as a whole, the evidence assembled in this study supports a cautiously optimistic reading of the present moment. The breadth of disciplinary engagement, the accelerating convergence between regions, and the maturing of the underlying technologies all indicate that the foundations for a sustainable transition are more firmly in place than they were a decade ago. The remaining obstacles, while substantial, are increasingly of a kind that human institutions are well equipped to address, being matters of coordination, finance, measurement and skill rather than of fundamental technical impossibility. This reframing is itself significant, for it shifts the locus of responsibility toward governance and collaboration, domains in which the social and political disciplines, working alongside their technical counterparts, have a decisive contribution to make.

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5.2 Limitations

Several limitations qualify these conclusions and should inform their interpretation. The study relies on secondary synthesis and is therefore subject to the availability, comparability and potential biases of its sources, including the well-documented under-representation of some regions and languages in the global scholarly record. The composite indicators used to compare regions and disciplines necessarily simplify complex realities, and the boundaries drawn between disciplines are, to a degree, conventional. The decade-long window, while appropriate for the SDG era, cannot capture longer historical dynamics or the most recent developments. These limitations do not undermine the broad patterns identified, but they counsel caution in reading precise figures as anything more than indicative.

5.3 Future Work

Building on the findings and acknowledging these limitations, the study identifies several priorities for future research:

Development of shared, robust metrics for sustainability outcomes, particularly in the social, behavioural and educational domains where measurement is currently the most severe barrier, so that diverse forms of innovation can be recognised and compared on a common basis.

Longitudinal and primary-data studies that track specific cross-disciplinary initiatives over time, complementing the comparative synthesis offered here with causal and mechanism-level evidence.

Deeper investigation of blended and innovative finance models capable of closing the investment gap identified in the funding analysis, with attention to their effectiveness in low- and middle-income contexts.

Empirical testing and refinement of the proposed four-dimensional framework across additional disciplines, sectors and regions, including those not covered in the present study.

Examination of the role of emerging technologies, especially artificial intelligence and advanced data analytics, both as enablers of sustainable innovation and as potential sources of new sustainability risks that themselves require governance.

Strengthening of South–South and North–South collaboration mechanisms, and analysis of the institutional conditions under which technology transfer most effectively accelerates regional convergence.

In pursuing these directions, future scholarship can move beyond documenting the breadth of the sustainability agenda toward explaining, and ultimately strengthening, the integration on which its success depends. The cross-disciplinary perspective advanced in this paper is offered as a foundation for that continuing endeavour, in the conviction that the boundaries between disciplines are not obstacles to be lamented but interfaces to be cultivated in the shared pursuit of a sustainable and equitable future.

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