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How well are corporate sustainability goals designed? A global assessment of corporate commitments to water, ecosystems, climate, and materials and waste management

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Abstract

Amid rising global challenges, corporate sustainability commitments are under increasing scrutiny. This study offers a data-driven analysis of how companies develop sustainability goals and how these align with seven transformative criteria. We used a global dataset of 818 goals from 534 companies, evaluated through the Embedding Project's third-party Sustainability Goal Assessment framework, to assess the prevalence and quality of commitments. We compared how frequently aspects like system resilience, strategic impact or commitment transparency were included in commitments across different company types and geographically. Climate-related goals were most common and tended to receive higher scores for quality, mainly due to alignment with established reporting frameworks, but often fell short on systemic change, transparency, and implementation clarity. Ecosystem and water-related goals, though less frequent, were more likely to aim for strategic impacts and systemic change reflecting the role of multi-stakeholder coordination and strategic alignment. Commitments were scored as higher quality on average in the communication service sector compared to industrials, information technology and consumer discretionary sectors and in cases of private ownership structures. Relational network analysis revealed dependencies among criteria, highlighting that transparency's plays a central role in goal quality and the importance of actionable plans. Our findings suggest that achieving improvements in the quality of sustainability commitments requires corporate stakeholders to define measurable, time-bound sustainability goals, which extend accountability across the value chain, and integrate

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transparent reporting, and have incentives for systemic change. Policymakers can support this by standardizing terminology, creating fiscal incentives, and ensuring stable, long-term regulations that mandate transparency and full life cycle accountability.

Author summary

In this study, we explored how companies set and communicate their sustainability goals, and what this means for addressing urgent global challenges. We reviewed 818 goals from 534 companies around the world, assessing their quality and how well they support meaningful, long-term change. We found that climate-related goals were the most common and often scored well because they follow established reporting practices. However, these goals frequently lacked important elements, such as clear implementation pathways, transparency, and integration into broader strategies. Goals focused on ecosystems and water were less common, yet they often showed stronger links to high-impact practices, including collaboration across sectors and alignment with wider societal priorities. We also observed differences in goal quality depending on a company's sector and ownership structure. Our findings highlight the need to embed sustainability into core decision-making and structured reporting and to give equal attention to climate, biodiversity, and water to create more balanced and effective strategies for the future.

1. Introduction

Ecosystems and the services they provide face a range of significant challenges worldwide, from water scarcity [1] and habitat degradation [2,3] to climate change [4,5] and resource depletion [6,7]. These challenges have significant implications for businesses, which rely heavily on natural resources and ecosystem services, yet are often major contributors to environmental degradation [8,9]. For example, water scarcity affects billions globally, putting pressure on industries that depend on water for production and operations [10,11]. Ecosystem degradation, driven by deforestation, habitat loss, and biodiversity decline, threatens the services that ecosystems provide, such as carbon sequestration [12,13], water purification [14], and soil fertility [15,16]. Lastly, rising global temperatures, extreme weather events, and shifting climate patterns pose risks to ecosystems that can transfer directly to businesses and economies [17,18].

In response to nature related risks and customer demand for sustainable products and practices, companies have started to respond by setting goals to reduce their environmental impact, such as their carbon and biodiversity footprints, transition toward sustainable energy sources, and move towards a circular economy [8,19,20]. This includes improving the management of materials and waste [21], for instance through circular economy principles [22], since the oft-adopted model of production and disposal has led to over-extraction of resources, excessive waste generation, and pollution [23,21]. Waste generation, especially in sectors such as manufacturing and consumer goods, tends to contribute to environmental harm and resource inefficiency.

It is increasingly argued that corporate responsibility must extend beyond profit generation to encompass environmental stewardship, efficient resource use, and minimization of negative environmental impacts [24,25]. This shift in corporate behavior is primarily driven by three interconnected forces: stakeholder expectations, mandated policy, and economic efficiency. First, pressure from stakeholders and consumers is mounting. Investors are increasingly emphasizing environmental, social, and governance (ESG) factors [20], while consumers, particularly younger generations, are demanding corporate action on critical challenges like climate change and waste management [26–29]. Second, mandated policy plays a crucial role, with regulatory bodies imposing stricter standards for emissions, resource use, and waste, compelling companies to report and act on their environmental impacts [30,31]. Third, there is a clear economic incentive. Companies that lead in sustainability can gain competitive advantages through innovation, operational efficiency, and enhanced consumer trust as well as reducing nature-related risks for the company [8,32,33]. Conversely, businesses that fail to adapt risk regulatory penalties, financial losses, and reputational damage [34].

In response to these drivers, corporations are setting increasingly ambitious sustainability goals. Large-scale companies, for example, are now expected to lead in areas such as water conservation, ecosystem restoration, and climate change mitigation, in line with global objectives like the Kunming-Montreal global biodiversity target 15 of the UN CBD's Kunming-Montreal Global Biodiversity Framework [35–38]. However, recent publications suggest that many goals are overly ambitious and unlikely to be achieved, while engagement with Sustainable Development Goal (SDG) targets is often superficial, resulting in unmet objectives [39–43].

To explore company commitments to sustainability, this paper examines Sustainability Goal Assessment (SGAs) scores of corporate sustainability goals across four areas, critical for global sustainability efforts (Fig 1): water [10], ecosystems [37], climate [4], and materials and waste [21,45]. Overall, SGAs reflect how clearly and strategically sustainability goals are framed, focusing on design and measurability rather than future implementation or outcomes (Fig 1). SGA scores do not predict whether a goal will ultimately be achieved but serve as an initial quality control step, helping to identify goals or issue areas that may face significant barriers from the outset [39].

Here, we analyze a dataset of corporate sustainability commitments compiled by the Embedding Project, a global research initiative that supports businesses in integrating sustainability into core strategies and decision-making [46]. Using these structured third-party evaluations, we identify patterns in SGA scores and examine relationships among key assessment criteria to highlight factors, such as transparency and progress reporting, that shape SGA performance across issues. Specifically, our work provides new insights into corporate sustainability practices by testing the following hypotheses:

- Climate-related goals are the most common and have the highest SGA scores due to their alignment with global frameworks and standardized reporting protocols [39,47].
- Goals that incorporate integrated, cross-supply chain strategies tend to have higher SGA scores, as these approaches improve coordination, data accessibility, and alignment across stakeholders. The interconnected structure of such strategies reduces barriers to goal-setting and increases the likelihood of meeting SGA criteria within corporate sustainability planning [48–50].
- Ecosystem and water-related goals exhibit stronger linkages between systemic SGA criteria such as system change or strategic alignment, due to their reliance on multi-stakeholder coordination [44,49,51,52].

2. Materials and methods

The Embedding Project is a research initiative that focuses on corporate sustainability and goal setting across various sustainability issues. It provides comprehensive data that evaluates and rates corporate sustainability goals across seven

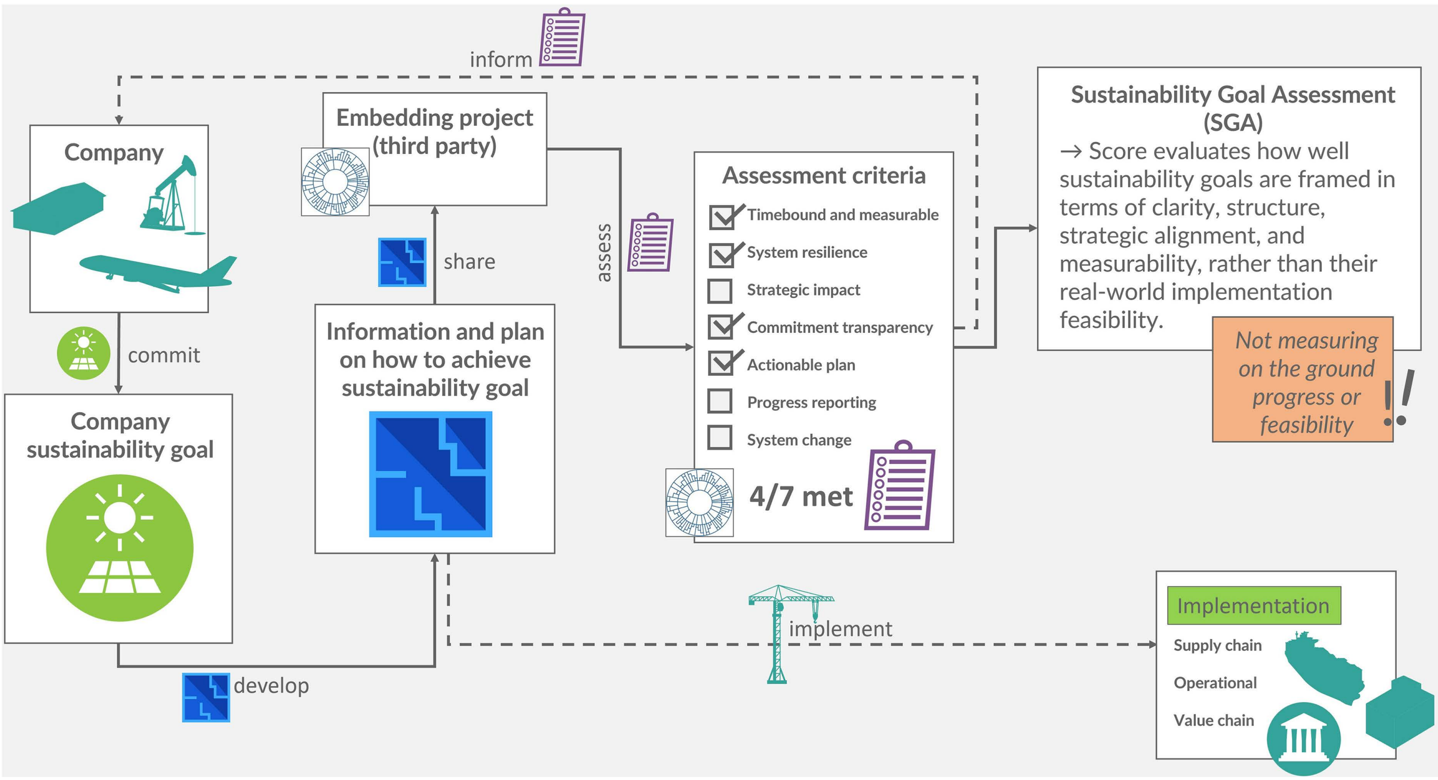

Fig 1. Sustainability Goal Assessments (SGA) of corporate sustainability goals as assessed by the Embedding Project. SGAs are assessed by the Embedding Project regarding clarity, framing, strategy alignment and measurability [44]. All symbols are freely available from uxwing and shareable for personal and commercial use.

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different criteria (S1 File). The Embedding Project evaluates goals based on whether they meet each of the seven criteria, allowing an overall SGA score for key issues such as water management, ecosystem protection, climate change mitigation, and waste management. The project aims to offer a transparent and objective analysis of corporate goals [46]. For example, a company can set the goal to achieve net zero emissions across their value chain by 2040. The Embedding Project then rates the goal based on company-provided materials and plans against the seven criteria (S1 File). The company goal could be meeting four criteria but not the other three leading to a score of 4/7 (Fig 1). Overall SGAs capture how well sustainability goals are framed in terms of clarity, structure, strategic alignment, and measurability rather than their anticipated on the ground implementation and future progress (Fig 1, S1 File).

Using the database, we extracted and sorted data for 818 goals across 534 unique companies on a global scale (August 2024), categorized by sustainability issue, company level as well as sector. These assessments are based on the pre-established SGA criteria, which allow for a structured evaluation (Table 1). We evaluated how SGA scores vary with company characteristics, including sector, Revenue Per Employee (RPE), and national sustainability policy and market context of the country, data for $n = 497$ out of 534 companies (S1 Fig). We further examined how different SGA criteria are connected by analyzing how often they are met together and how strongly they are linked. This helps identify key factors, such as transparency and progress reporting, that shape other criteria, revealing critical patterns and dependencies that influence the SGA scores (S2 Fig).

We selected predictors that may influence SGA scores based on three key categories: (1) sustainability goals and their intended application level, (2) national sustainability policy and market context, and (3) company characteristics.

Table 1. Overview and definitions of sustainability issues and corresponding Sustainability Goal Assessment (SGA) criteria used by the Embedding project to evaluate corporate goals [46].

Sustainability issue		SGA criteria
Water: Corporate goals related to water conservation, water use efficiency, and the reduction of wastewater discharge.	C1	Timebound and measurable: Is the goal timebound and is it possible to assess whether it has been met?
Ecosystems: Company efforts and contributions to protect ecosystems and biodiversity through practices such as habitat restoration, deforestation prevention, and minimizing ecosystem degradation.	C2	System resilience: Does the goal support the resilience of social and/ or environmental systems through alignment with a relevant threshold or limit?
Climate (CO_2): Corporate efforts to reduce greenhouse gas emissions, transition to renewable energy and enhance energy efficiency.	C3	Strategic impact: Does the goal influence business strategies by discussing emerging expectations, relevant risks or opportunities, and any constraints it places on future decision-making?
Material and waste: Corporate goals for reducing material use, minimizing waste generation and improving recycling and resource efficiency.	C4	Commitment transparency: Is it explained how the goal is set, including assumptions, frameworks and knowledge that informed the goal?
	C5	Actionable plan: Is a concrete plan to achieve the goal outlined, including realistic interim targets and the actions and investments required to meet them?
	C6	Progress reporting: Are there regular, transparent, and accessible updates on progress against the initial goal and interim targets?
	C7	System change: Are there plans and explanations for broader, positive systems change, such as through data and knowledge sharing, collaboration, advocacy and/ or through supporting standard setting?

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2.1 Sustainability goals and their intended application

We specifically focused on sustainability goals related to climate, water, materials and waste, and ecosystems [46,53–55].

Sustainability goals can be applied at different internal and external levels of a company (company level), broadly categorized by the Embedding [46]. Operational goals focus on internal processes, such as improving energy efficiency, reducing emissions, managing water use, and minimizing waste during production [56–58]. Value chain goals extend beyond internal operations, involving suppliers and partners to reduce environmental impact through sustainable sourcing, lower transportation emissions, and circular economy initiatives [46,50,59,60]. System-level goals address the broader context in which companies operate, including industry collaborations, policy advocacy, and participation in sustainability standards to drive systemic change beyond the company's direct control [46,61,62].

2.2 National sustainability policy and market context

Headquarters location (country) and their associated Green Future Index (GFI 2023; technologyreview.com), Sustainable Development Goal Index (SDGI 2024; sdgindex.org) and Environmental Policy Stringency Index (EPSI 2024; oecd.org) were used as proxies for national regulatory environments, policy stringency, cultural, and market conditions that may shape sustainability goals [63,64].

2.3 Company characteristics

To assess how company characteristics influence SGAs, we added three demographic variables in our analysis. Company sector (as defined by the Embedding Project), categorized by industry (S1 Table) to account for sector-specific sustainability pressures and regulatory requirements [39,59,64,65]. Company Revenue Per Employee ratio (RPE), measured as revenue (2023, Mergent online, MarketWatch, EDGAR) per employee, providing a balance between financial resources and workforce size [66]. RPE is a proxy that captures differences in capital intensity, labor structure, and financial flexibility, which may influence a company's ability to implement sustainability goals effectively [67,66].

Ownership structure, whether a company is publicly traded or privately held (public, private), can potentially influence its approach to sustainability. Publicly traded companies may face greater pressure from shareholders and regulatory bodies to demonstrate Environmental, Social und Governance (ESG) performance, while privately held firms often have more flexibility but may lack external incentives to prioritize long-term sustainability goals [68,69].

2.4 Corporate sustainability goal assessment scores

We modeled SGA scores as a function of issue, company level, sector, and other company-level indicators (RPE, GFI, EPSI, and SDGI) to understand the key drivers influencing the strength and comprehensiveness of sustainability goals across different company types (Fig 2).

We used SGA scores (range 1–7), for 497 out 534 companies, based on demographic data availability (e.g., most recent revenue). We used SGA scores as our response variable against Issue (climate, water, material and waste, ecosystems), company level (systems, value chain, operational), RPE, sector and GFI, EPSI and SDGI in a Cumulative Link Mixed Model (CLMM; ordinal package v12-4.1; non-normal residuals; Shapiro-Wilk test; [70]), using company (e.g., Google, Amazon) as a random effect [71]. *P*-values were estimated through z-statistics (at alpha <0.05) and random effect contribution [71,72]. For overall model fit and factor relevance, we compared reduced models against the full model through AICs [73,74]. Due to small sample sizes in some categories (e.g., value chain with 25 samples), cross-combination analyses were not feasible. We assessed the proportional odds assumption by performing nominal effects tests (likelihood ratio tests) for each predictor, which confirmed the model's specification was appropriate [75].

2.5 Conditional probabilities

The objective of computing conditional probabilities was to evaluate the likelihood of meeting one SGA criteria based on meeting another, providing insights into the interdependencies among different criteria (S2 Fig).

To assess the likelihood of meeting SGA criteria given that another criterion is met, we computed conditional probabilities using contingency tables across the four sustainability issues [dplyr v1.1.4; 76,77]. This allowed us to calculate the probability of meeting C4 given C3 is met, or any other pairwise combination. For each pair of criteria (C2 to C7), excluding C1 which was met in all 818 cases, we calculated $P\ (Cj|Ci) = \frac{\text{Number of companies meeting both Ci and Cj}}{\text{Number of companies meeting Ci}}$. This gives us the probability of meeting criteria Cj given that criteria Ci is met. We visualized the likelihoods as a directed network with qgraph (v1.9.5) where the edge widths represent the conditional probabilities. Conditional probabilities are not symmetric. Meeting one criterion that increases the likelihood of meeting another does not mean the reverse is true [78,76].

2.6 Network centrality

We next conducted a network centrality analysis to understand the relative importance of individual assessment criteria within the sustainability goals network, identifying key criteria that influence SGAs through their connections with others (igraph v2.0.3; [79]).

The network constructed based on co-occurrence probabilities, of assessment criteria, excluding C1 as previously mentioned, represents criteria as nodes and their likelihood of co-occurrence as edges. To characterize the importance and influence of criteria, we calculated degree, closeness, eigenvector, and betweenness centrality measures (S2 Fig). Degree centrality quantifies the direct connectivity of a node, identifying criteria that frequently co-occur with others and are prominent in the network. Closeness centrality measures the proximity of a node to all others, highlighting criteria that can efficiently connect to others and facilitate the flow of information. Eigenvector centrality evaluates a node's influence

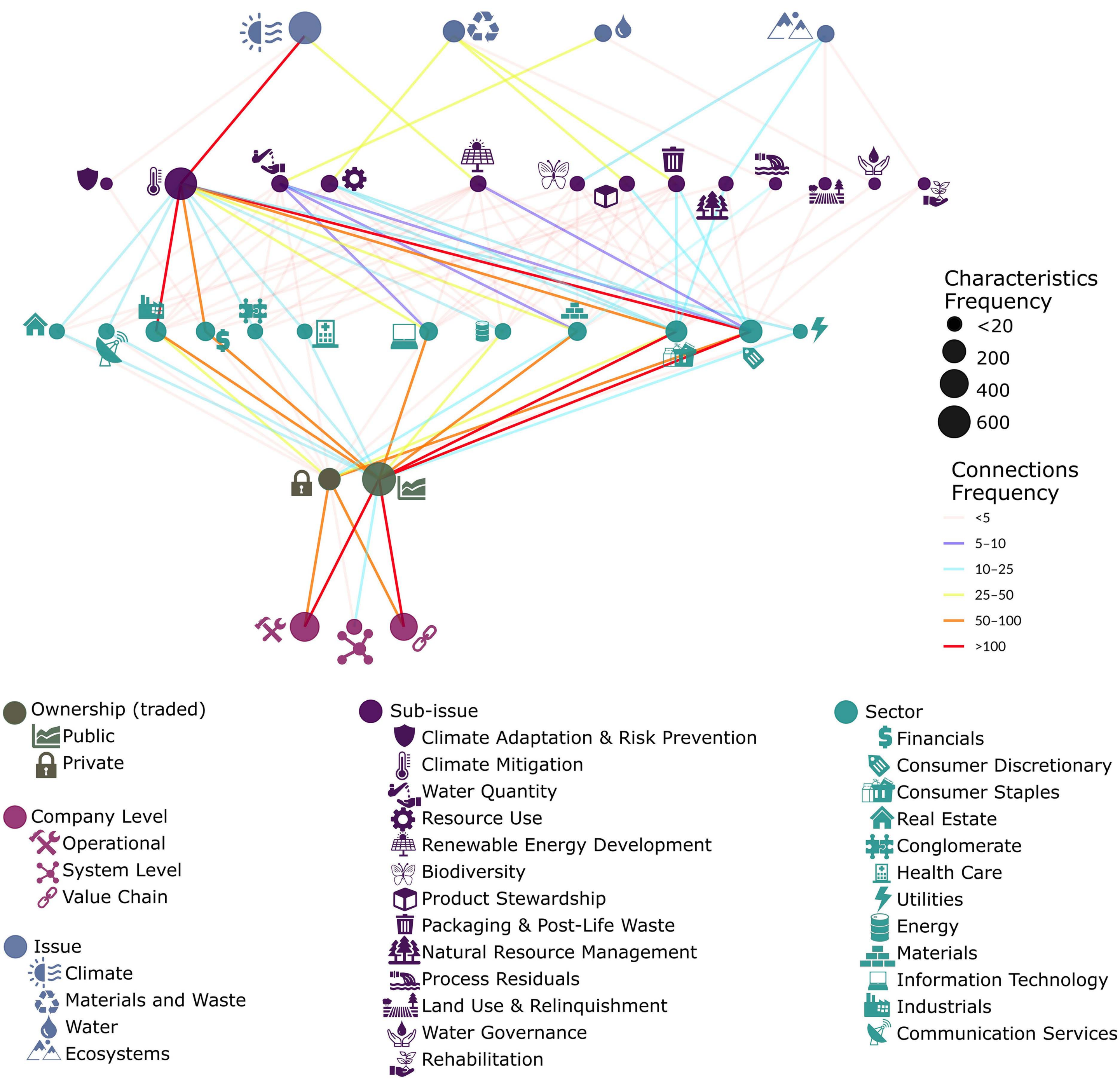

Fig 2. Network plot showing the frequency distribution of sustainability goals (n = 818) from 534 companies on a global level. Nodes connect goals to different targeted issues (climate, water, ecosystems, material and waste), sub-issues, sector, ownership and company level (S1 Table; S2 Table; [19,44]). All symbols are freely available from uxwing and shareable for personal and commercial use.

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by considering the importance of its connections. Betweenness centrality identifies nodes that act as bridges, connecting different clusters and facilitating interaction between otherwise disconnected criteria [79–81]. Together, these measures provide insights into the structural roles and relative importance of assessment criteria. All analyses were done in R [4.2.3; R Core 82; S2 File].

3. Results

Company sustainability goal distribution across 37 countries varied across issues, with 617 out of 818 goals (S2 Table) targeting mainly climate mitigation (*n* = 582 companies), followed by materials and waste with 114 goals focussing most on resource use (*n* = 47; Fig 2). Water had 45 goals centered on water quantity (*n* = 44) and 42 goals on ecosystems, predominantly aiming to address natural resource management (*n* = 18) and biodiversity (n = 19; Fig 2). Most companies were headquartered in the United States (*n* = 197), the United Kingdom (*n* = 85) and Canada (*n* = 38). Most company goals came from the Consumer discretionary (n = 188), Consumer staples (*n* = 143) and Industrials sectors (*n* = 119). The fewest company goals were classified under the Utilities (*n* = 14), Healthcare (*n* = 23), Real estate (*n* = 25) and Conglomerates (*n* = 25) sectors.

The results across regions show variation in Sustainable Development Goal Index (SDGI), Green Future Index (GFI), Environmental Policy Stringency Index (EPSI), and Revenue Per Employee (RPE) scores. Europe and Central Asia exhibited the highest SDGI score (82.2), followed by North America (75.1) and East Asia and Pacific (77.1; Fig 3). South Asia (64.8) and Sub-Saharan Africa (63.4) had lower SDGI scores. GFI values ranged from 4.3 in South Asia to 6 in Europe and Central Asia. EPSI scores were lowest in Sub-Saharan Africa (0.9) and highest in Europe and Central Asia (3.8). RPE varied across countries and regions, with most countries having revenue/ employees amounts between 400,000 and 800,000 USD (Fig 3).

3.1 Sustainability goal assessment scores

Model comparison for SGA scores across issues and company characteristics (n = 818) showed that the full model (including all explanatory variables and random effect), fit better than the reduced model(s) (no smaller AICs with >2 deviation in AIC from AIC = 2072.6; S3 Table). The random effects model revealed variance at the company level (0.82), and residuals from the model deviated from normality (Shapiro-Wilk test: W = 0.954, $p < 0.01$). The proportional odds assumption was upheld, with likelihood ratio tests yielding non-significant results (p-value range 0.10 to 0.53).

The CLMM analysis assessed the likelihood (positive or negative estimates for directionality) of goals meeting more SGA criteria based on sustainability issue, company level, RPE, sector, GFI, EPSI, SDGI and ownership. Compared to climate goals (3 ± 1.04), materials and waste goals (2.53 ± 0.86) had a significantly lower probability of meeting SGA criteria (β = -1.14, $p < 0.001$; Fig 6). Climate goals showed a lower probability of meeting SGA criteria compared to water-related goals (3.33 ± 1.09; β = 0.444, $p = 0.175$). Ecosystem-related goals (2.86 ± 1.07) also had a lower probability for meeting SGA criteria than climate goals, approaching significance (β = -0.65, $p = 0.089$; S3 Table).

Goals at the operational level had lower probabilities of meeting SGA criteria (2.78 ± 0.96) compared to those at the system (3.2; β = 1.134, $p = 0.016$) and value chain levels (3.14; β = 0.69, $p < 0.001$; Fig 4; S3 Table). RPE, GFI, SDGI and EPSI did not significantly affect SGA criteria probabilities. However, sectoral differences were observed. Compared to goals from the communication services sector (3.34 ± 1.23), goals from the consumer discretionary (2.86 ± 0.98; β = -0.866, $p = 0.05$), industrials (2.84 ± 0.95; β = -0.967, $p = 0.034$), information technology (2.82 ± 1.06; β = -0.927, $p = 0.065$), and utilities sector (2.29 ± 0.47; β = -2.062, $p = 0.005$) had lower probabilities of meeting SGA criteria (S3 Table). Publicly traded companies (2.91 ± 1) had lower probabilities (β = -0.545; $p = 0.014$) of meeting SGA criteria compared to privately held ones (3.08 ± 1.15; S3 Table; Fig 4).

3.2 Conditional probability for co-occurrence of meeting sustainability criteria

The co-occurrence analysis reveals several important patterns across the four issues (Fig 5; S4 Table), with co-occurrence pertaining to the probability of meeting a specific SGA criterion when meeting another one. A key trend is that the fulfillment of most assessment criteria (C2–C7) increases the likelihood of meeting an actionable plan (C5). However,

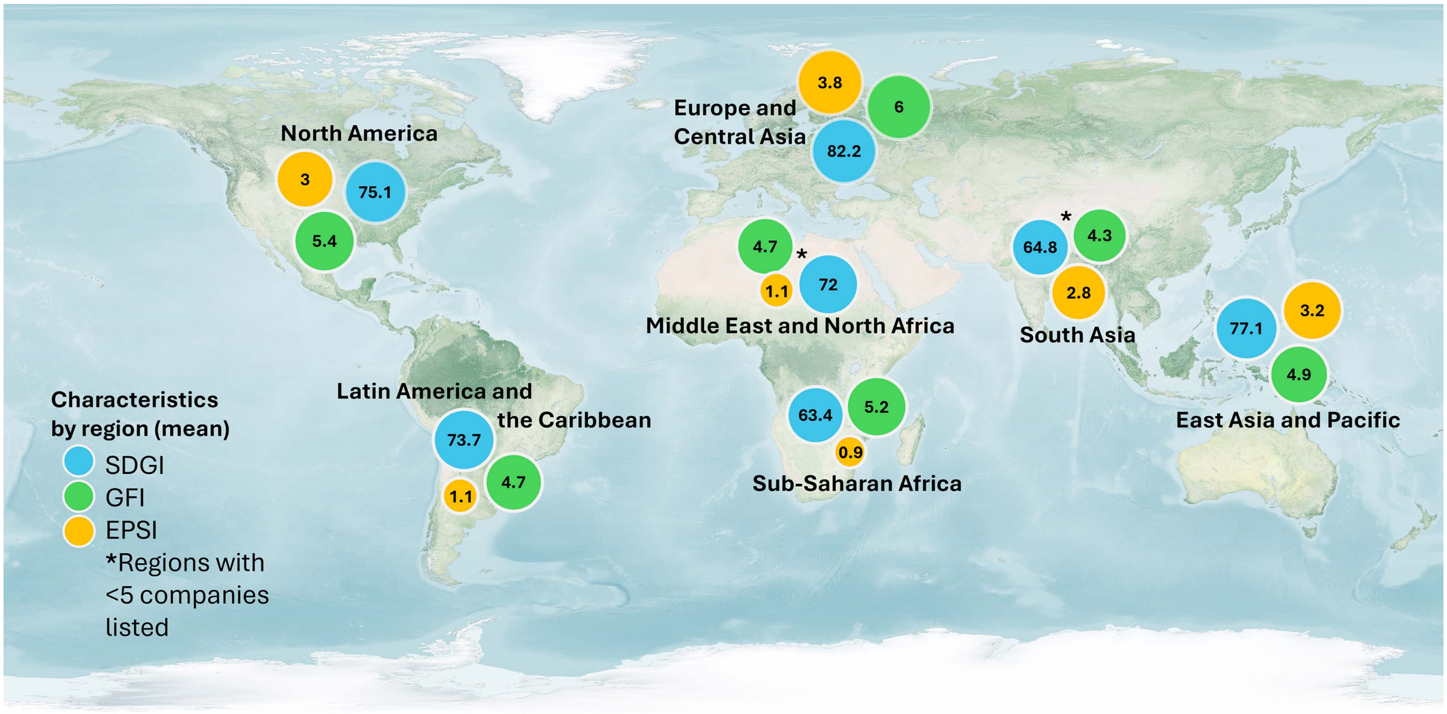

Fig 3. Map shows mean Sustainability Development Goal Index (SDGI), Green Future Index (GFI) and Environmental Policy Stringency Index (EPSI) values for 497 out of 534 companies based on where the sampled companies are headquartered. Regions are based on UN geo-scheme. (Data available from: GFI 2023; technologyreview.com, SDGI 2024; sdgindex.org, EPSI 2024; oecd.org. Made with Natural Earth. Free vector and raster map data @ naturalearthdata.com; [83]; rnaturalearth 1.1.0).

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the reverse is not true: having an actionable plan (C5) does not significantly predict the fulfillment of other SGA criteria (Fig 5). This suggests that actionable plan (C5) is more often a result of meeting other criteria, than a driver for the fulfillment of additional criteria. For instance, in the climate issue (Fig 5a), the fulfillment of progress reporting (C6) strongly increases the likelihood of meeting actionable plan (C5) (0.824), and similarly, system resilience (C2) and strategic impact (C3) also positively influenced the likelihood of meeting actionable plan (C5).

In the ecosystem (Fig 5b) and water (Fig 5d) issues, meeting the system change (C7) criterion is strongly associated with the fulfillment of strategic impact (C3) (with probabilities of 0.75 and 0.91). Progress reporting (C6) consistently appears as the least connected criterion across all issues (Fig 7). Its weaker associations with other SGA criteria suggest that while it plays a role in tracking progress, it does not significantly contribute to the fulfillment of other criteria. In climate, a unique pattern emerges where system change (C7), strategic impact (C3), and commitment transparency (C4) are often met together with system resilience (C2), with probabilities above 0.5. Overall, these results indicate that certain assessment criteria, such as commitment transparency (C4) and system change (C7), act as foundational drivers for the fulfillment of other criteria. In contrast, criteria like actionable plan (C5) and progress reporting (C6) are more often met because of additional criteria.

3.3 Network centrality

Across all issues, actionable plan (C5) consistently exhibits the highest eigenvector centrality (1.0), highlighting its central role in the network and strong connections to other criteria (Fig 6). However, C5 does not display high closeness centrality, suggesting that while it is well-integrated within the network, it is not the most directly reachable criterion from others.

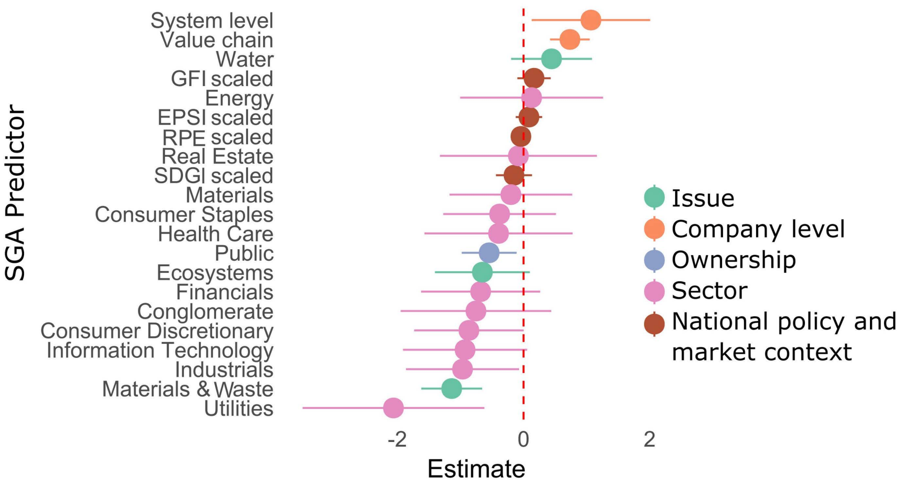

Fig 4. This plot shows the effect size of seven criteria on a Sustainability goal assessment (SGA) score. The analysis considers the presence or absence of meeting these criteria across different targeted issues (climate; water; ecosystems; material and waste), company levels (operational, system, value chain), and the national policy and market context (Sustainability Development Goal Index (SDGI), Green Future Index (GFI) and Environmental Policy Stringency Index (EPSI)). Estimates are considered significant if their confidence intervals do not cross the zero line. Full model results are available in S3 Table. 497 out of cwemandw3.

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In materials and waste (Fig 6d), strategic impact (C3) stands out with the highest betweenness centrality (4), indicating that it serves as a critical bridge between other criteria in this issue. Similarly, progress reporting (C6) shows notable betweenness centrality in both ecosystems (8c) and materials and waste (Fig 6d), reflecting its role as a connector in those networks.

For water (Fig 6b), strategic impact (C3) exhibits the highest eigenvector centrality (0.917), underscoring its influence within this issue's network, while system resilience (C2) and commitment transparency (C4) have prominent roles in terms of closeness centrality, indicating their importance in ensuring network connectivity.

In climate (Fig 6a), the uniformity in degree centrality (all nodes having 5 connections) reflects a highly interconnected network, though system change (C7) and strategic impact (C3) show slightly higher closeness values compared to others, hinting at their more immediate influence. Overall, the results emphasize the distinct dynamics of each issue's network, with some SGA criteria, like actionable plan (C5), consistently being foundational across all issues, while others, like strategic impact (C3) or progress reporting (C6), take on more pivotal roles depending on the specific context. These variations reflect the nuanced interplay of SGA criteria in supporting and framing system-wide goals.

4. Discussion

Sustainability goals across issues revealed disparities, with climate-related goals dominating the corporate landscape. Of the 818 goals analyzed, 617 were climate-related, with the majority focusing on climate mitigation (582), aiming for carbon neutrality or net-zero emissions by 2050 [57,87,88]. While climate mitigation was prioritized, areas like climate adaptation (1 goal) and renewable energy development (34 goals) were less represented, highlighting a potential gap in addressing broader resilience and energy transition challenges [87,89,90].

In contrast, goals related to ecosystems, water, and materials and waste were less frequent and more unevenly distributed. Ecosystem goals primarily targeted biodiversity and natural resource management [91–93], while goals regarding land use, relinquishment, and rehabilitation were minimal [94]. This imbalance suggests that of the few companies that focus on maintaining existing ecosystems, mainly consumer staples, even fewer direct their attention to restorative

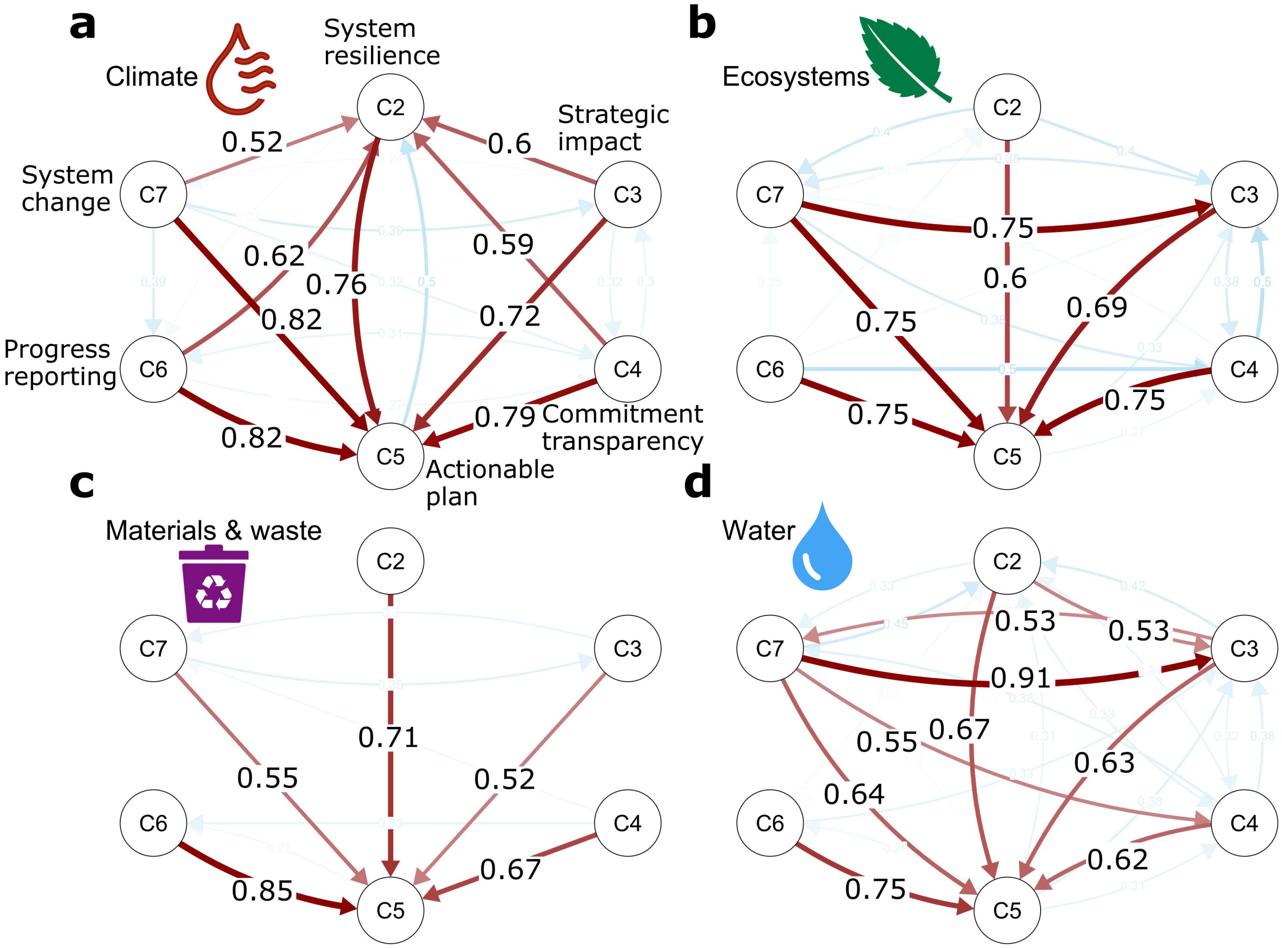

Fig 5. Conditional probability of co-occurrence of meeting a specific sustainability goal assessment criterion (C2-C7;Table 1) for sustainability goals across targeted issues (a) climate, (b) ecosystems, (c) material and waste, and (d) water. C1 excluded as it was universally met (S4 Table). Arrows indicate the direction of the relationship, while line color indicates its strength (dark red > 0.7; red 0.5-0.7; blue <0.5). All symbols are freely available from uxwing and shareable for personal and commercial use.

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practices, which are crucial for reversing degradation and reducing nature related risks [17,19,61,95]. Similarly, water goals, mainly aimed for by the materials, consumer discretionary and information technology sectors, predominantly addressed water quantity (~98%) rather than governance, pointing to a preference for operational solutions over integrated, systemic approaches which, when considering water quantity, quality and governance together have shown to be more effective and essential for sustainable future water use ([44,52,96].

Materials and waste goals were more evenly distributed, covering resource use, packaging and post-life waste, and product stewardship, predominantly in the consumer discretionary and staples sectors [22,65]. However, goals to process residuals, such as upstream waste impacts [97,98], were underrepresented (<3%). This gap could reflect the ongoing emphasis on post-consumer waste reduction and societal responsibility and environmental consciousness rather than upstream impacts, limiting the potential for a more comprehensive circular economy approach [84,99,100]. These patterns suggest that companies are often focused on operational efficiencies, but may overlook the need for broader, systemic changes in their sustainability strategies [101]. Reasons here could stem from cost implications [85], limited traceability

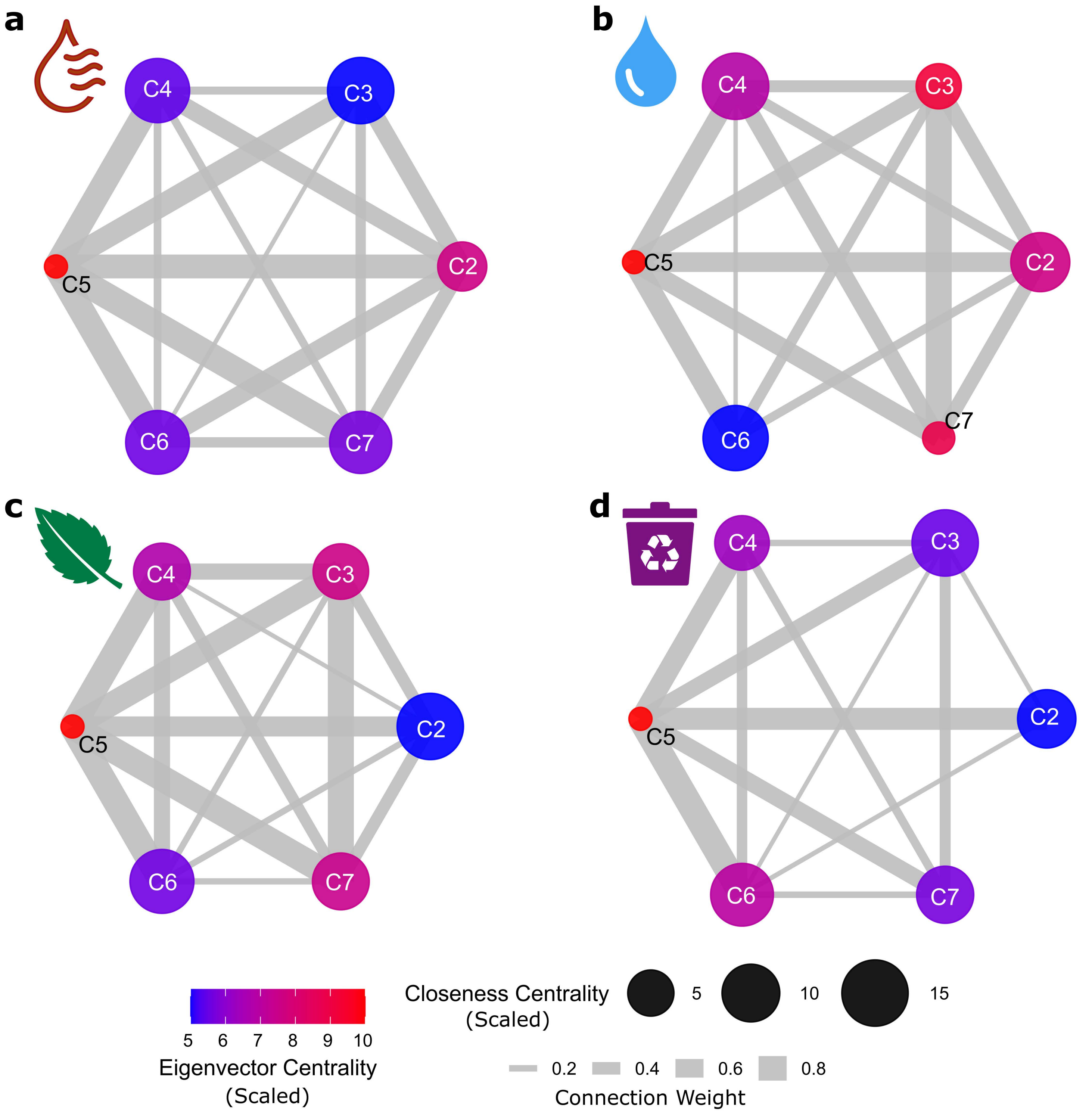

Fig 6. Network centrality analyses for assessment criteria (C2-C7; Table 1) for sustainability goals (n = 818) from 534 global companies across targeted issues (climate: a; water: b; ecosystems: c; material and waste. d). The plot displays three key metrics: closeness centrality (how efficiently a criterion connects to others), eigenvector centrality (a criterion's influence), and connection weight (the strength of the relationship). Closeness and eigenvector are scaled for plotting purposes; original values can be found in the results section and S4 Table. All symbols are freely available from uxwing and shareable for personal and commercial use.

https://doi.org/10.1371/journal.pstr.0000215.g006

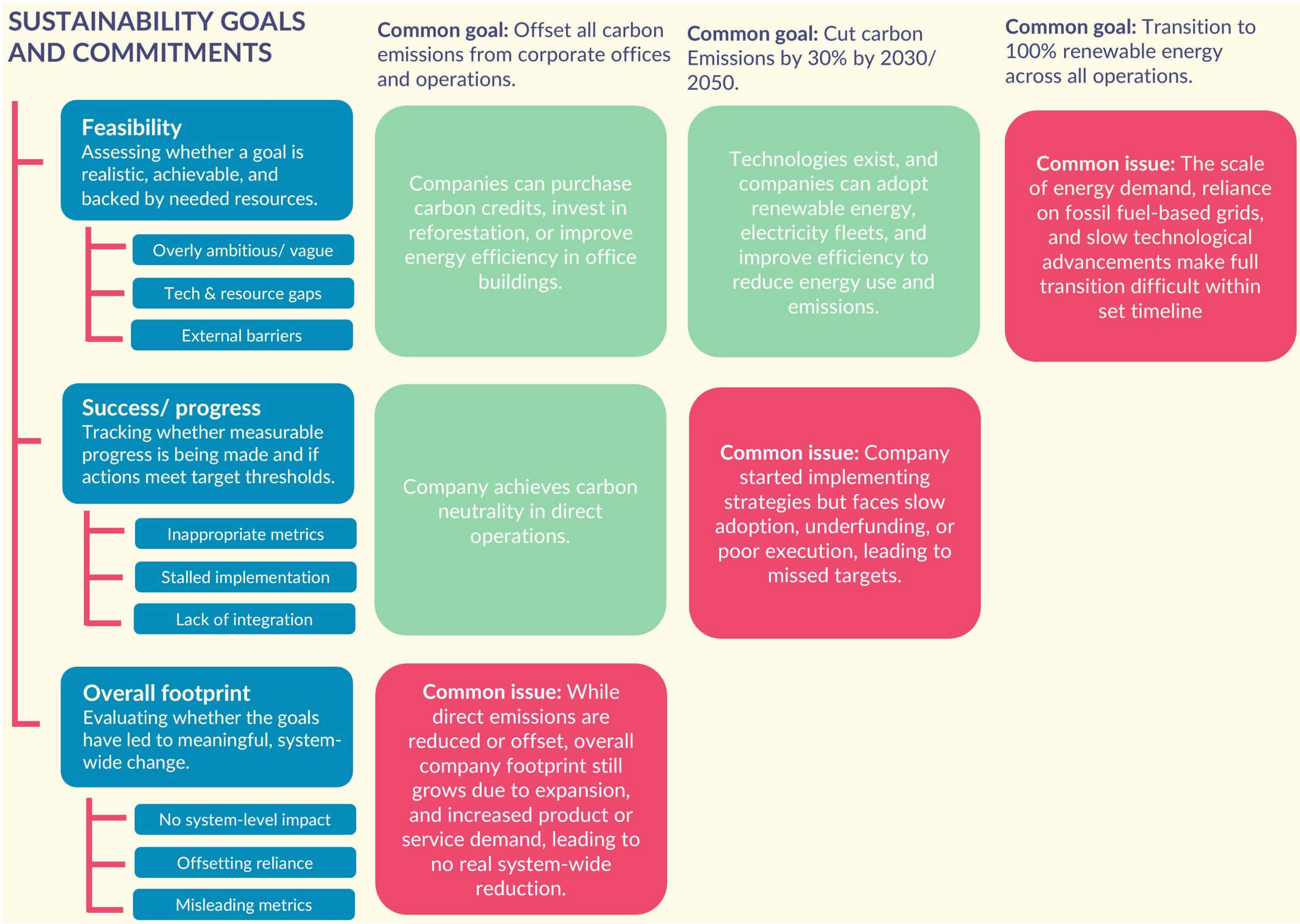

Fig 7. Corporate sustainability goals as part of the three tiers of achieving said goals (SGA scores, success/ progress, overall footprint). The flowchart illustrates potential bottlenecks where high-scoring goals may not translate into meaningful environmental outcomes (high SGA scores ≠ success ≠ overall impact effect). Based on [42,47,56,75,84–86].

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and data availability [102], lack of control in upstream processes within the supply chain [45], and established regulations around post-consumer waste like recycling [103]. Yet, this focus shifts a substantial burden to the consumer [56] while having to account for increasing complexity in post-consumer waste due to an increase in material complexity in everyday products [99] and a system that still allows for significant waste of recyclable materials post-consumer [104].

The dominance of management-oriented objectives reflects their practicality but also the need for integrated strategies that balance feasibility with transformative ambition [41,59]. While focusing narrowly on emissions reductions or resource efficiency can yield measurable results, failing to address interconnected challenges, such as water governance or ecosystem health, risks undermining broader sustainability progress [17,38,62,105].

4.1 Disparities in sustainability goal assessment scores

SGA scores varied significantly, influenced by their focus and operational complexity. Climate goals, with the majority aiming at net-zero emissions, tend to achieve higher assessment scores than those addressing materials and waste. This reflects their global prioritization [106], and alignment with corporate reporting frameworks [107,108]. Higher SGA scores for climate-related goals tend to reflect compliance-driven motivation over transformative action [109,110]. This aspect could further be supported by the fact that the assessment of climate goals is not uniform. The prevalence of net-zero targets raises concerns about achievability, especially for companies lacking actionable plans or transparent progress tracking [43,111]. For instance, the recent emphasis on nature finance mechanisms like carbon credits has been criticized as an inadequate approach to meeting net-zero targets. The carbon market is widely considered insufficient because of credit benefit overestimation and since it fails to drive systemic changes within corporate structures and supply chains [112,113].

Ecosystem goals focused on biodiversity and natural resource management frequently emphasize "net positive" outcomes, such as biodiversity conservation or sustainable forest management [92,114–116]. However, the concept of "net positive" remains loosely defined in many cases, making it appealing for marketing purposes but limiting its utility as a measurable or actionable target. This ambiguity can result in goal-setting that is more symbolic than substantive, potentially reducing the effectiveness of such goals in guiding meaningful environmental outcomes [93,117]. Similarly, water quantity goals often revolve around improving water management and returning water to communities or catchments, aligning with global priorities [44,96]. These management-focused objectives are likely perceived as more attainable than more complex or resource-intensive goals, such as ecosystem rehabilitation (e.g., implementing regenerative agricultural practices at scale; [116,118,119]) or addressing process residuals (e.g., processing and reducing mining and energy production residuals, reducing food waste, or achieving net-zero organic waste to landfills; [97,98]. On a business-level, corporations tend to be risk-adverse, making it easier for them to adopt existing, cost-effective replacements when available [120,121]. Hence, resource use sustainability goals, such as increasing the proportion of recyclable materials, often leverage existing systems and infrastructure [122,123], potentially making them relatively easier to achieve and hence to develop a tangible plan reflected in higher SGA scores, compared to waste reduction, which also often involves broader consumer behavior and logistical challenges [124,125].

Privately held companies, irrespective of sector, generally had higher SGA scores, potentially due to facing less pressure to prioritize short-term financial returns compared to publicly traded companies [126,127]. Their greater operational flexibility, monetary reserves and values-driven leadership can allow for a more in depth planning of long-term sustainability goals [91,126]. In contrast, publicly traded companies are often constrained by shareholder expectations and short-term market performance, which can limit the thoroughness or overall planning of their sustainability efforts or even lead to unrealistic ambitions to meet public expectations [41,127–129]. There also may be a tendency for companies to publicly report only on the more feasible, management-focused goals, especially if they fear reputational damage from failing to achieve more complex or high-risk targets, an example of potential greenhushing (Botea- Muntean & Constantinescu, 2023). This could be particularly true when complex goals involve factors beyond the company's control, such as environmental variability or unpredictable consumer behavior, leading to a skew in reporting toward goals where companies have more direct influence. EPSI, GFI, and SDGI scores had little to no effect on the sustainability goal assessment criteria scores, suggesting that broader country-level indicators of environmental performance and governance may not directly translate to company-level sustainability goals during the planning phase. That may especially true when companies operate across multiple countries with diverse regulatory environments. In such cases, sustainability goals may be shaped more by the need for consistency across operations or by sector norms than by the specific governance context [130,131].

4.2 Within goal relationships and dependencies

The co-occurrence patterns reveal that actionable plan (C5) was frequently an outcome, emerging from criteria such as system resilience, strategic impact, or progress reporting, rather than a primary driver. This implies that companies often treat actionable plans as reactive steps shaped by earlier assessments, knowledge intermediaries, and established frameworks rather than as proactive, integrated elements of their sustainability strategies [60,132].

Actionable plans typically follow broader strategic goals by providing the specific details necessary to implement measures aimed at meeting targets. While this sequence underscores the foundational roles of measurable goals (C1) and systemic thresholds (C2), it also introduces the risk that plans become too narrowly focused or short-term [133]. Such an approach may lack the broader strategic and systemic vision required for long-term sustainability [133,134]. Moreover, the limited connection between executing actionable plans (C5) and achieving system change (C7) constrains their ability to drive transformational outcomes, such as fostering collaborative or industry-wide shifts, which is critical for broad-scale improvements [47,62]. This disconnect is particularly concerning when feedback mechanisms like progress reporting (C6) fail to prompt necessary adjustments [135]. To enhance C5's effectiveness, it is essential to integrate it more robustly with other criteria so that plans become not only operationally actionable, but also aligned with realistic thresholds and transparent, iterative processes [47,60,61].

Progress reporting (C6) generally exhibited weak linkages with other criteria, likely reflecting chronic underinvestment and the absence of mature, standardized reporting frameworks, especially in domains like biodiversity [135–137]. As a result, reporting often functions as a discrete exercise rather than a catalyst for systemic improvement [138,139]. Nevertheless, evolving regulatory frameworks, such as those under the Global Biodiversity Framework and disclosure mechanisms like the Task Force on Climate-related Financial Disclosures (TCFD), are beginning to establish mandatory expectations and provide better monitoring resources [140,141]. Embedding reporting within a dynamic framework that both informs and strengthens other sustainability goals remains a critical yet underutilized opportunity.

System change (C7), which encompasses broader transformations achieved through collaboration, advocacy, and standard-setting, was strongly linked to strategic impact (C3) in the realms of ecosystems and water. This suggests that addressing systemic challenges, such as ecosystem degradation or water scarcity, requires companies to embed these shifts directly into their strategic planning and long-term decision making [91,92]. In practice, these linkages mean that initiatives for ecosystem rehabilitation or water sustainability, which often involve compensatory measures or stakeholder coordination, are more likely to be pursued if they align with broader business objectives [114,142]. However, the high time and resource investments required for such transformational change often limit their prevalence [143,144].

In contrast, within climate and materials and waste, the relationships among criteria were generally weaker. These sectors frequently adhere to global or national targets, focusing on measurable operational outcomes, such as reductions in carbon emissions or waste minimization [58,145]. While this focus on concrete indicators aids accountability, it can also sideline broader system-wide changes, especially when such changes are perceived as already underway or external to company operations [47,103]. In materials and waste, the role of strategic impact (C3) as a bridging element suggests that while business strategies are generally aligned with sustainability efforts, there remains a tendency to prioritize downstream outcomes over addressing upstream challenges like process residual management or implementing circular economy principles [56,84].

A distinct observation in the climate sector is the strong support that system resilience (C2) receives from both system change (C7) and strategic impact (C3). Given that most climate goals are framed around net-zero targets and defined by global thresholds, the availability of benchmarks such as carbon budgets and international agreements enables a structured and cohesive alignment [51,146]. Network analyses indicate that climate goals form highly interconnected systems, reflecting the well-established metrics and frameworks that drive their development.

Conversely, in fields like biodiversity and ecosystems, standardized thresholds and metrics are either fragmented or still evolving, which may contribute to the weaker integration of system resilience (C2) in these sectors [147,148]. The inherent complexity and context-dependency of ecosystem management underscore the need for methodologies that better adapt global thresholds to regional or local conditions [149]. A coordinated approach, such as jointly implementing the monitoring frameworks of the UN Paris Climate Agreement and the UN CBD's Kunming-Montreal Global Biodiversity Framework (through platforms like the TCFD and TNFD), could facilitate more frequent and aligned assessments of progress in both climate and biodiversity areas [137,140].

4.3 Beyond goal setting

Even when sustainability targets are robust and technically achievable on paper, companies may struggle to meet them due to insufficient investment [150], weak execution strategies [134], or organizational inertia [86]. For example, a company might commit to reducing emissions by 30% (see Fig 7), yet operational delays, resistance from supply chain partners, and conflicting financial priorities can stall progress [151]. Waste reduction initiatives at individual facilities might show localized improvement, but broader systemic barriers, such as inadequate recycling infrastructure or challenges in sourcing sustainable materials, can impede the realization of more ambitious goals like achieving zero waste [84,152].

These challenges underscore the importance of robust internal accountability systems that not only track progress but also drive meaningful advancements across all operational levels [153,154]. Effective accountability mechanisms must connect goal setting with the implementation of actionable plans to foster tangible environmental change [153,155]. Recent policy shifts, such as the scaling back of ESG requirements in the United States, further illustrate that without sustained regulatory pressure, companies may deprioritize sustainability measures [156,157]. This situation reinforces the idea that strong SGAs alone do not guarantee effective action without a supportive and stable regulatory environment [158,159].

Another concern is that companies might achieve set targets without meaningfully reducing their overall environmental footprint. Having goals that are misaligned with a company's actual impact, such as focusing on restoring habitats that a company minimally affects rather than addressing ecosystems where the impact is greatest, may limit the effectiveness of those goals in reducing the company's overall environmental footprint [35,93,160]. Another instance is when goals focus narrowly on direct operational achievements, such as attaining carbon neutrality, without addressing the impacts embedded in their supply chains or product lifecycles [145,161]. For example, while transitioning to recyclable packaging is a positive step, if companies do not invest in consumer recycling infrastructure, the environmental burden is merely shifted, and waste may persist in landfills [56,162]. Such scenarios create an illusion of progress where corporate metrics improve while broader system-wide impacts remain inadequately addressed. Instances like a company reporting lower direct emissions despite its suppliers operating with high carbon footprints, or comparing lifecycle emissions between a diesel and an electric vehicle, highlight the gap between sustainability goals and their overall outcomes [163,164].

Thus, it is critical for companies to expand their sustainability metrics beyond immediate operational outputs and to include full lifecycle and supply chain impacts. Without this comprehensive approach, there is a risk of creating a false narrative of sustainability progress. Moreover, SGA evaluations, which serve as primary quality control mechanisms, must ensure that targets are not only ambitious and measurable but also supported by sufficient technological, financial, and organizational resources [165,166]. Only by integrating broader, long-term goals that account for the entire supply chain and product lifecycle can companies ensure that their sustainability efforts are both realistic and genuinely transformative.

4.4 Study limitations

When drawing conclusions from the analyzed SGAs, it is important to consider two key limitations, both of which stem from the voluntary nature of the Embedding Project.

First, the dataset is subject to a self-selection bias. Companies that voluntarily submit their goals for assessment are likely to be more invested in sustainability than the average firm [167,168]. This is supported by the finding that all participating SGAs met the C1 criterion. Consequently, this assessment may not accurately represent the full spectrum of corporate sustainability goals, particularly those from companies in the early stages or with less-developed programs. Mandatory reporting data, potential accounting for more early stage or underdeveloped goals would likely yield different results [169].Secondly, the voluntary approach may introduce a demographic bias in the sample. The dataset may over-represent larger, multinational companies that have more resources to dedicate to sustainability evaluation. Conversely, smaller, regional, or non-English-speaking companies might be under-represented, potentially because they are less aware of the Embedding Project [167,170]. While we attempted to account for company characteristics, this potential bias could limit the generalizability of the findings. Despite these limitations, this analysis provides an insightful learning experience on SGA development. It serves as a useful resource for improving the robustness and achievability of sustainability goals, offering value beyond just the participating companies.

5. Conclusions

Based on our findings, we offer a few key lessons and potential recommended actions for both corporate stakeholders as well and policy and lawmakers towards more robust goal setting.

Recommendations for corporate stakeholders

1. Operationalize vague commitments: Terms such as "net-zero" and "net positive" should be defined with specific, quantifiable, and time-bound metrics. High-level goals must be linked to detailed, adequately resourced, and public-facing actionable plans as an integral component of the initial strategy.
2. Expand scope to the full value chain: Conduct formal materiality assessments to identify and prioritize the most significant environmental impacts (e.g., emissions, process residuals). Metrics must extend beyond direct operations to facilitate systemic change through industry collaboration and strategic investment in circular economy infrastructure in sectors and companies where appropriate or feasible.
3. Enhance internal accountability and reporting: Progress reporting should be leveraged as a dynamic mechanism for adaptive management rather than a static compliance report. Integrate sustainability achievements directly with executive compensation and performance metrics. Publicly traded firms should articulate the long-term strategic and financial benefits of sustainability initiatives to shareholders in an accessible and tangible form.

Recommendations for governing bodies and policymakers

1. Standardize terminology and mandate transparency: Develop legally binding definitions and standardized measurement methodologies for key sustainability claims to mitigate greenwashing. Mandate the disclosure of not only high-level goals but also their supporting actionable plans and progress reports. Promote and support the coordinated implementation of monitoring and reporting frameworks, such as TCFD and TNFD.
2. Incentivize systemic interventions: Use fiscal tools such as grants, fees, tax incentives or procurements, to encourage corporate investment in complex, systemic challenges (e.g., ecosystem restoration) that extend beyond low-complexity operational goals. Implement policies to assign financial responsibility for the full product lifecycle.
3. Ensure consistent and comprehensive regulatory frameworks: A stable, predictable regulatory environment is essential, though often hard to achieve in changing political settings, as fluctuating standards deter the long-term capital investment required for sustainability transitions. Implement long-term regulations, robust against political turnover, that mandate accounting for full value chain impacts to close reporting loopholes and prevent the externalization of environmental burdens.

Our analysis underlines that current corporate sustainability goals show significant disparities. Climate-related commitments are prevalent but, like goals in other sectors, often lack the robust action plans and systemic linkages needed for transformative impact. Critical areas like biodiversity and upstream waste remain underrepresented, highlighting a misalignment with global frameworks (e.g., SDGs, GBF). High assessment scores often reflect alignment with existing standards rather than proactive, comprehensive planning, pointing to a reactive, compliance-driven approach. With weak connections between actionability, reporting, and system change, companies risk falling behind evolving voluntary standards (e.g., TCFD, TNFD) and stakeholder expectations, unless they adopt more systemic, resilient, and outcomes-based strategies.

Supporting information

S1 Fig. Workflow for using Sustainability Goal Assessment (SGA) scores compiled by the Embedding Project in response to Sustainability goals, National policy and market context and Company characteristics variables. Base outline presentationgo.com. All symbols are freely available from uxwing and shareable for personal and commercial use.
(TIF)

S2 Fig. Overview of using conditional probability and network analysis for Sustainability Goal Assessment (SGA) criteria connections across water, climate, materials and waste and ecosystem issues. Base outline presentationgo.com. All symbols are freely available from uxwing and shareable for personal and commercial use.
(TIF)

S1 Table. Descriptions of company sectors based on 12 sectors assigned by the embedding project to their respective companies, as listed in the analyzed embedding project database (Embedding Project, 2024).
(DOCX)

S2 Table. Issue and sub-issue distribution across company sustainability commitments from 534 assessed companies on a global level as of August 2024 (Embedding Project, 2024).
(DOCX)

S3 Table. Cumulative Link Mixed Model (CLMM) fitted with the Laplace approximation for effect of issue, company level, revenue per employee (revenue 2023/ employees; RPE) and sector on sustainability goal assessment scores (SGAs) as well as Green Finance Index (GFI), Sustainable Development Goal Index (SDGI) and Environmental Policy Stringency Index (EPSI), all scaled, with company as random effect. Shapiro-Wilk tests for residuals assess model fit. Significant predictors are marked (* $p < 0.05$, ** $p < 0.01$). $n = 497$.
(DOCX)

S4 Table. Conditional probabilities for assessment criteria to be met and co-occur across targeted issues (Climate, Ecosystems, Material & Waste, Water) based on 818 company commitments. Network centrality measures across the four targeted issues, showing role and connectedness of each assessment criteria within issues. C1 excluded since it was always met. Eigenvector centrality: Indicates criterions influence within the network by accounting not only for its own connections but also for how well-connected its neighboring criteria are, highlighting which criteria are central in the overall co-occurrence structure. Closeness: Measures how quickly a criterion can connect with all other criteria in the network. Degree: indicates connections of each assessment criteria (5 = connected to all others; 0 = connected to none). Closeness: quantifies how close a commitment (node) is to all other commitments (nodes) in a network.
(DOCX)

S1 File. Overview of the SGA assessment approach conducted by the embedding project based on materials on sustainability goals provided by the individual companies to be reviewed (Embedding Project, 2024).
(DOCX)

S2 File. R-code used to create and plot (hierarchical) networks.
(DOCX)

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