



A Framework for Corporate Sustainability: The Role of Systems Thinking

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ABSTRACT

The Sustainable Development Goals, set by the United Nations in 2015 as part of the 2030 Agenda, provide a universal framework for global sustainability. Achieving these interconnected goals requires systems thinking, addressing the root causes of sustainability challenges, and moving beyond traditional, human-driven approaches. Sustainability has become a core focus for many corporations, with more proactive strategies being adopted. However, progress in corporate practices remains insufficient, as research shows ecosystems continue to decline at a rapid pace. Sustainable transformations require interdisciplinary changes across all components in a system where the business functions. It requires shifts in technologies, social behaviors, business frameworks, regulatory policies, and cultural standards that would essentially alter the core structure of the business. This study examines how systems thinking can serve as a holistic and joint concept in sustainability transformations for corporations to reach their sustainability goals, along with the challenges of incorporating systems thinking, the sustainability challenges, and the desired outcomes for businesses adopting this approach.

Keywords: Systems thinking, Corporate sustainability, Sustainable development goals, Interdisciplinary changes, Sustainability challenges

Introduction

Climate change has emerged as a key topic in today's society. Globally, we are confronted with significant environmental, social, and humanitarian issues, necessitating a strong organizational response.¹ We are now nearing, and in some cases surpassing, several planetary boundaries—critical environmental thresholds beyond which the risks of irreversible changes to Earth's systems and human well-being significantly increase.^{2–4} Furthermore, the consequences of climate change and the rapid decline in biodiversity are becoming more evident.⁵ In this critical period, society must act fast, track, and evaluate the impacts of human activities that influence our movement toward or away from these environmental thresholds.^{6,7} A substantial share of these impacts arises from corporate operations, including resource extraction, land use alterations, strain on water and biogeochemical cycles, and emissions of greenhouse gases (GHGs) and other pollutants.^{8,9} However, corporate sustainability efforts risk devolving into mere greenwashing unless businesses actively measure their progress against science-based targets, such as those outlined by the Science-Based Targets Network and the UN Sustainability Development Goals (SDGs).^{10,11}

Sustainability challenges are extraordinarily complex, encompassing a web of intricate, interconnected

problems that are deeply embedded in rapidly shifting and dynamic global processes.¹² These challenges present unprecedented hurdles because they are not isolated issues but are fundamentally systemic, affecting and being affected by social, environmental, and economic factors in an ongoing cycle of change.¹³ The current policy framework is increasingly seen as inadequate for tackling global crises like climate change, biodiversity loss, land degradation, and deforestation.¹⁴ Despite substantial attention to sustainability in science and politics, humanity continues along unsustainable development paths.¹⁵ This is partly due to sustainability science's failure to address the root causes of unsustainability¹⁶ and its reliance on an overly simplistic view of nature as a self-regulating system best left undisturbed.¹⁷ Most policies, including those for environmental protection, have been anthropocentric,¹⁴ focusing on human benefits over the intrinsic value of nature, in contrast to ecocentrism, which values all elements of the ecosystem.¹⁷ This anthropocentric perspective of businesses fosters a belief in human superiority and separation from nature, leading to the notion that humanity is not bound by planetary limits.¹⁶

Addressing these issues requires holistic, adaptive solutions that consider the wide range of interdependencies across sectors and regions. As a result, consumers and governments are expressing heightened concerns, urging companies to adopt more sustainable business practices.^{18,19}

In response to these multifaceted challenges, the United Nations introduced the 17 Sustainable Development Goals (SDGs) in 2015 as part of its 2030 Agenda.¹⁵ These goals provide a comprehensive and normative framework for understanding and addressing sustainability. The SDGs represent a globally shared vision of a sustainable society, one that is inclusive, resilient, and balanced across three key dimensions: social equity, environmental stewardship, and economic prosperity. By integrating these pillars with business practices, the SDGs offer a blueprint for fostering long-term sustainability while creating positive impacts in the current environment and society.¹¹ The SDGs demand profound transformations across all nations, yet there remains a lack of consensus on how to effectively implement them.²⁰ In this context, both our societies and economies must shift from their current unsustainable trajectories toward a sustainable and resilient future. Achieving this requires a holistic strategy that tackles all 17 SDGs simultaneously, leveraging their synergies and maximizing their benefits, while also mitigating potential trade-offs.²¹

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Sustainability in business includes three pillars: environmental, social, and economic.²² It is now crucial for companies to prioritize holistic sustainability rather than focusing solely on financial outcomes.²³ In order to overcome these challenges, companies have to adapt a systems-thinking approach tailored to the environment they operate in.

The ongoing advancement and refinement of systems thinking within the realms of policy and management²⁴ have significantly influenced the evolution of environmental policies globally. Historically, these policies tended to be narrow in focus, often operating within isolated sectors and lacking coordination, leading to instances of overlap and even conflict among different regulations. However, there has been a notable shift towards more integrated decision-making processes.²⁵⁻²⁷ This transformation reflects a growing recognition of the necessity to adopt a systems approach to effectively tackle sustainability challenges. Businesses, academics, and policymakers have increasingly embraced this perspective, acknowledging that complex environmental issues cannot be addressed in isolation but rather require a comprehensive understanding of interconnected systems.²⁸⁻³⁰ By fostering collaboration and coordination across various sectors, the aim is to create more cohesive and effective sustainable solutions for businesses that can better respond to the multifaceted nature of sustainability challenges through systems thinking. So how do we adapt systems thinking into our business practices?

Integrating Systems Thinking in Corporations

Systems thinking interprets the world as a collection of interconnected elements and components organized within specific levels that together create complex systems.³¹ These components are linked through a network of relationships, allowing them to function

cohesively.³² A system is characterized by how its elements are arranged and interconnected, which results in distinct behaviors that reflect its overall function or purpose.³³ The relationships between the system's parts can be either concrete, such as material exchanges, or abstract, like social interactions.³²

The concept of "Systems Thinking" in this context refers to a comprehensive approach to analyzing business initiatives, focusing on their internal and external impacts within the company's ecosystem. This methodology, widely used in sustainability management research,³⁴ highlights the significance of recognizing contextual boundaries when undertaking a sustainable transition.³⁵ Overlooking the broader system effects beyond company limits can lead to evaluations that fail to consider interdependencies in complex value chains, resulting in narrow and often inadequate sustainability assessments. If those involved in designing business models do not thoroughly evaluate both positive and negative potential sustainability impacts, it can lead to unintended trade-offs, causing a model to be falsely perceived as sustainable. In some cases, such incomplete assessments can even contribute to greenwashing, where companies misrepresent their environmental performance.³⁶

Systems can either be closed, where no interaction occurs with the external environment, or open, meaning the system interacts with its surroundings.³¹ An open system exists within a broader context, where both the system and its environment influence each other in a co-evolving process.³⁷ The system's components serve as the building blocks of sub-systems, and these sub-systems, in turn, contribute to a larger system. The boundaries of a system represent the limits that separate a sub-system from its wider system.³⁸ As these components are interconnected, the development of each part is influenced by the others within the network, and the growth of a sub-system depends on the evolution of other sub-systems in the larger system. Sub-systems adapt and evolve through interactions with their environments,³⁹ where changes are driven by the interplay between the features of a sub-system and the shifts in its environment.⁴⁰ This interconnected system is shown below in Figure 1, where subsystems exist within a broader system where the company A operates. The complexity of a system is defined by the number of its components, the variety among them, and the degree to which they are interconnected.³²

Challenges of Systems Thinking Application

Many professionals with technical expertise often identify themselves as systems thinkers, but the actual presence of systems thinking skills is not as widespread as these claims may suggest.⁴¹ Even individuals with advanced education and solid foundations in STEM fields often struggle to grasp the fundamental concepts of complex dynamic systems, such as feedback loops, stocks and flows, time delays, and nonlinear behavior.⁴² People frequently rely on simple, linear cause-and-effect reasoning to explain events, stopping their inquiry once they find an apparent cause.⁴³ Misunderstandings

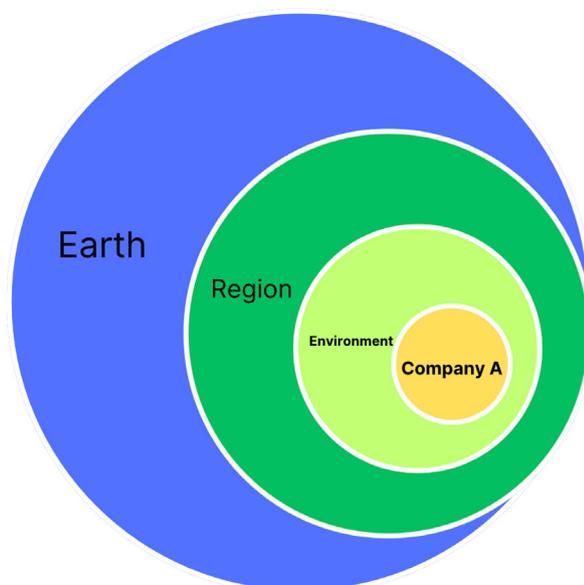


Fig 1 | Systems thinking perspective of Company A in an open system

around time delays in systems can also lead to “wait and see” attitudes that may worsen issues.^{44–46}

This suggests that businesses, which are not always trained to address sustainability issues from a systems-thinking perspective, may approach these challenges through a narrow, discipline-specific lens, resulting in strategies that lack a holistic view and are often disconnected from broader solutions. This approach aligns with the current environmental policy paradigm, which tends to focus on narrow, problem-specific solutions, neglecting broader issues such as planetary justice and global equity.¹⁴ Sectoral approaches, often developed in silos, tend to reinforce the status quo and miss opportunities for significant systemic change.¹³ Even well-intentioned preventive policies may overlook alternative impacts.⁴⁷

Systems thinking is not a ready-made tool to be applied to every complex sustainability issue. Truly understanding how systems operate requires critical, interdisciplinary thinking that integrates multiple disciplinary viewpoints, assessing their strengths and limitations. By synthesizing insights from various fields, a more comprehensive understanding of sustainability can emerge. Challenging assumptions and rethinking boundaries between disciplines can open up new ways of approaching complex problems.^{48,49} This is shown in Figure 2 of a linear and isolated perspective of company A before its sustainable transition through systems thinking towards a more non-linear and inclusive model which caters to all the actors in the field.

Systems thinking fosters interdisciplinary collaboration, creating a shared intellectual space that transcends traditional disciplinary boundaries.⁵⁰

Systems Thinking Techniques for Corporate Sustainability

The concept of interconnectedness is exemplified by the dynamics of stocks and flows within a system.⁵¹ Stocks refer to elements that can either accumulate

or diminish, such as the water in a bathtub, while flows denote the entities responsible for these changes—like a faucet that adds water or a drain that removes it.⁵² Consequently, stocks and flows create the interconnected framework typical of a system, which serves as the foundation for causal relationships and feedback loops.⁵³ For instance, a company’s inventory and the materials available in the global resource market are considered stocks. In contrast, production processes that increase inventory simultaneously reduce the availability of materials in the global market represent flows. It is crucial to differentiate between levels (“stocks or integrations”) and rates (“flows or activities”) before identifying the causal links that exist between them.⁵⁴

The sustainable business transition process is constantly developing, involving stages like idea generation, concept development, experimentation, piloting, and implementation,⁵⁵ supported by various tools. In the early phases, strategies inspire innovations such as leasing, buy-back programs, and repair services for product longevity. Tools like the Circularity Deck⁵⁶ and Circular Strategy Scanner⁵⁷ aid in these stages but often focus on general benefits rather than assessing sustainability impacts.

Some tools prompt users to think more broadly about sustainability, such as the Sustainable Value Analysis Tool⁵⁸ and the Cambridge Value Mapping Tool,⁵⁹ which help categorize value as “captured,” “destroyed,” or “opportunities.” Sustainability-focused adaptations of the business model canvas⁶⁰ add environmental and social layers or guiding questions to aid in holistic decision-making.

Tools like the Circular Value Hill⁶¹ and the Ellen MacArthur Foundation’s butterfly diagram⁶² offer rules of thumb for prioritizing strategies, though they often lack specific sustainability impact measurements.

Sustainability assessments are important during the transition process.⁶³ These assessments help foresee impacts, foster shared understanding, and support decision-making by aligning stakeholders with a common language and focusing on key sustainability challenges through a systems perspective.⁶³

Figure 3 shows three different principles of systems thinking and how they can be adapted to “Sustainable Business Management (SBM)” for transitioning towards a more sustainable business.⁶⁴

The principles are:

1. Interconnections
2. Causal relationships and feedback loops
3. System change and adaptations

Interconnections

Thinking systemically involves recognizing that systems are composed of interconnected elements, encompassing individual parts, the whole, and emergent properties.⁶⁵ For sustainable business transition, companies should be viewed as open systems with various components—employees, suppliers, and external actors—working toward common goals.^{66,67} This broader perspective allows

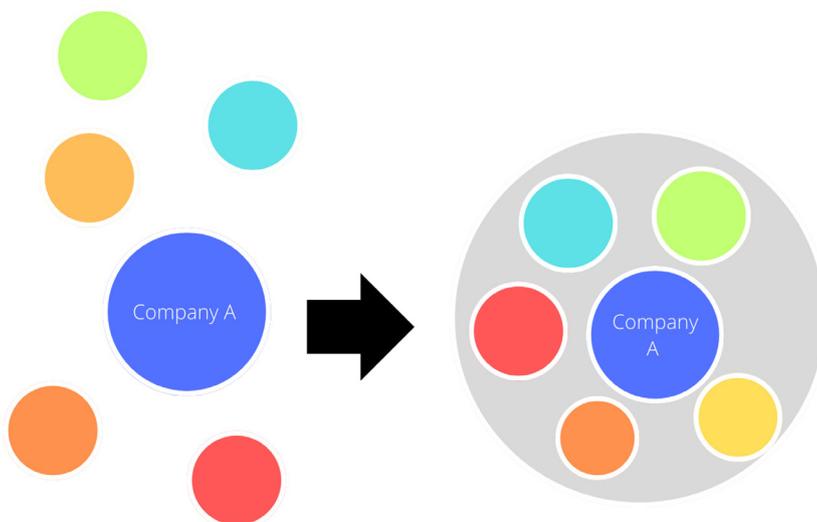


Fig 2 | Systems perspective transition for Company A

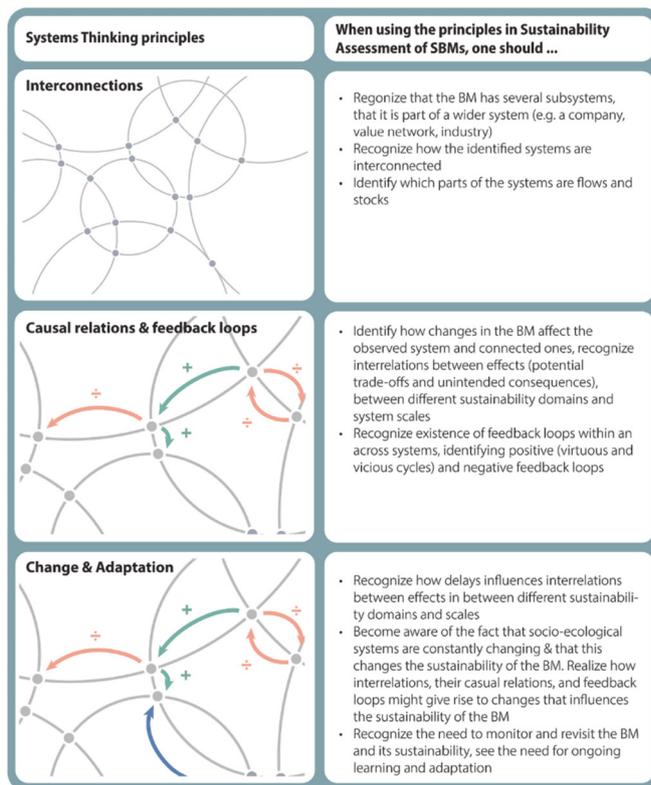


Fig 3 | Principles of systems thinking in sustainable business management⁶⁴

for a more comprehensive evaluation of sustainable business models, emphasizing the interdependence among stakeholders.

Sustainability at the business model level can only be achieved when the larger system it operates within is also sustainable.⁶⁸ Changes in both structural and cultural aspects of the socioeconomic system are necessary for firm-level sustainability.⁶⁹ For example, a business model involving employees and suppliers could integrate new customers, like a municipality purchasing biogas, thereby linking it to broader energy systems.

Causal Relationships & Feedback Loops

Identifying subsystems and their components necessitates recognizing cause-and-effect relationships within the system (Hopper and Stave, 2008). This involves understanding indirect effects and causal networks.⁷⁰ For instance, changes in materials can influence product design, while access to materials may be affected by policies or global events. There is growing concern that critical macro-level connections are often overlooked due to a management-centric approach in circular economy initiatives.^{71,72} Ignoring these connections can lead to neglecting labor practices, working conditions, and equity issues.

Understanding the relationships between a business model and its environment is essential for assessing interdependencies among stakeholders across various sustainability domains and scales. Even the most sustainable product may fail if consumption systems could be redesigned. Clarifying need and sufficiency

within consumption systems is vital for advancing sustainable business transformation.⁷³

Partners should investigate causal relationships within their systems. For example, improving manure management can benefit the local community by reducing odors, while biogas production can enhance the energy supply, decreasing reliance on fossil fuels. Identifying causal chains is critical, as closed loops create feedback.⁶⁵

Small transactions can accumulate and magnify through positive feedback.⁷³ Interactions among system components are crucial for evaluating the impacts of initiatives.⁴⁰ Increased investments in anaerobic digesters may create dependence on certain energy sources, reinforcing system rigidity and leading to undesirable feedback loops.

System Change & Adaptations

Systems thinking emphasizes recognizing patterns of change over static conditions (Senge, 1990), allowing for future developments to be anticipated.⁷⁰ Identifying feedback loops helps forecast scenarios.⁶⁵

To assess sustainability in business transitions, it is essential to evaluate models in light of surrounding system changes.⁷⁴ This assessment is crucial in the early stages of sustainable business transition and can benefit from insights from life cycle assessment modeling.

Companies must continuously revisit their sustainable business models during development and implementation to adapt to internal and external changes.⁷⁵

Numerous analytical frameworks, including multi-level perspectives and transition management, facilitate examining socio-technical transitions toward sustainability. Tools like back casting enable participatory processes to define future visions and identify necessary steps to achieve them.⁷⁶

Conclusion

System transitions often span several years, frequently extending over decades, as they encompass interconnected changes across environmental, social, and economic dimensions, along with advancements in technology. These transitions can be fraught with conflicts regarding both their direction and pace, as different stakeholders may have varying interests and perspectives on what constitutes progress.^{77,78} To successfully achieve sustainability transformation, it is essential to have a comprehensive understanding of the various factors influencing system dynamics, such as market forces, regulatory frameworks, and social norms, as well as a clear commitment to the necessary changes.⁷⁹

Identifying specific leverage points—critical areas where interventions can trigger significant change—coupled with fostering a supportive environment can greatly expedite the transition process.⁸⁰ This includes coordinated actions from various levels of government, innovations within the private sector, experimental initiatives, and advocacy from civil society organizations.⁸¹ For example, policies promoting

renewable energy can encourage innovation in green technologies, while community engagement initiatives can foster grassroots support for sustainability practices. Furthermore, emphasizing values such as openness, transparency, diversity, and equity can drive transformative changes in governmental and corporate practices, enhance public trust, and encourage greater participation in decision-making processes—these factors are considered crucial enablers of sustainability transformations.⁸² Systems thinking entails recognizing the intricate web of interrelations that contribute to complex issues, thus reshaping our understanding of our role within broader societal frameworks.⁸³ This approach focuses on identifying the underlying causes of problems, the conditions that foster unsustainable practices, and the fundamental roots of unsustainability. Unlike traditional root cause analysis, which can adopt a reductionist perspective and oversimplify complex narratives, systems thinking encourages a more nuanced exploration of interdependencies and multiple contributing factors.⁸⁴

In practice, the various interconnections within complex systems often lead to strong economic, social, and psychological incentives that can entrench society in unsustainable practices.⁸⁵ However, there lies an opportunity to influence the evolution of macro-systems in ways that promote favorable changes among actors. For example, strategies can be devised to manage demand for passengers and freight in transportation systems, potentially alleviating their adverse impacts on the environment.⁸⁶

Numerous researchers have highlighted how routine patterns of daily activities can confine individuals in unsustainable practices that are challenging to alter, even when recognized as harmful from a sustainability perspective.⁸⁷ Transforming these habitual patterns necessitates addressing the ways in which individuals derive meaning from their daily lives, taking into account lived experiences and the social and cultural contexts of their practices.⁸⁸ For instance, individuals may engage in consumer actions that align with social expectations or cultural norms, which can create a sense of identity and belonging, making it difficult to deviate from these patterns. Furthermore, individuals often encounter limits on how much they can diverge from prevailing consumerist norms, regardless of their awareness or concern for sustainability issues.⁸⁹ Many actions are heavily influenced by existing institutions and socio-material arrangements, which necessitate collective action for meaningful change.⁹⁰ Understanding the mechanisms perpetuating mass and excessive consumption is crucial before attempting to implement changes that foster transformative learning and enable institutional reforms.⁹¹

Given the complexity of these challenges, there is a clear need for developing policies that promote significant changes within the businesses. Such policies should aim to facilitate deliberate transformations that address economic growth and societal issues, such as rampant consumerism, while fostering technical and policy innovations that can overcome entrenched

practices and create incentives for more sustainable practices.⁹² Recognizing the potential of these policies to facilitate new management paradigms, which aim to radically transform production and consumption processes, is essential for building a sustainable future.⁹³ It is essential for businesses to adopt a systems perspective when addressing sustainability challenges, regardless of their complexity. By recognizing these interdependencies, businesses can strategically enhance their positive contributions to sustainability while actively working to mitigate any adverse impacts arising from their activities. This proactive engagement not only fosters long-term viability but also aligns with growing stakeholder expectations for responsible corporate practices in an increasingly interconnected world.

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