



Section of the conference: Management

Sekcja konferencji: Kierownictwo

How to cite: Ordoñez-Iturralde, D. (2025). Biomimetic management: what natural ecosystems can teach management. *World Conference on Emerging Science, Innovation and Policy 2025*. Futurity Research Publishing.
<https://doi.org/10.5281/zenodo.15844773>

Biomimetic Management: What Natural Ecosystems Can Teach Management

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Accepted: June 16, 2025 | **Published:** July 8, 2025 | **Language:** English

Abstract: This study explores how the principles of natural ecosystems can be applied to organizational design and management to foster more sustainable, resilient, and adaptive models. Through a qualitative theoretical review, principles such as decentralization, diversity, feedback, and regeneration are identified and connected to key dimensions of management. The findings indicate that biomimetic management offers strategic advantages over traditional models, although it also faces structural and cultural barriers. The study concludes that this approach represents a viable and necessary framework for redesigning organizations in alignment with the planet's ecological and social boundaries.

Keywords: organizational biomimicry, sustainability, resilience, self-organization, decentralization, systems thinking, regenerative innovation, ecological management.



Introduction

In the context of ecological crises, growing inequality, and the saturation of traditional management models, contemporary organizations face the challenge of transforming themselves to be not only efficient but also sustainable, resilient, and adaptable. Within this emerging scenario, biomimicry—the practice of learning from nature’s organizational principles to solve human problems—offers a promising framework for reimagining management through an ecosystemic lens.

Modern management has historically relied on mechanistic, hierarchical, and linear models. However, these models show significant limitations when confronted with complex and uncertain environments. In contrast, nature, through millions of years of evolution, has developed highly efficient, collaborative, and regenerative systems. Organizational biomimicry posits that companies can redesign their structures and processes by drawing inspiration from these natural dynamics to generate sustainable and innovative solutions (Olaizola et al., 2020).

Authors such as Celep et al. (2017) have proposed that the principles of biomimicry can be applied to key areas such as leadership, innovation, organizational structure, and strategic planning, thereby fostering more flexible, harmonious, and self-regulating organizations. Similarly, Lipholt (2019) argued that biomimicry not only helps address technical challenges but also enables a holistic vision of sustainable innovation by connecting the efficiency of living systems with organizational strategies.

From this perspective, the biomimetic approach encourages us to view organizations not as machines, but as living systems that interact with their environment, evolve, and coexist with other systems. This logic, more aligned with systems thinking and ecological perspectives, may be key to addressing the challenges of the 21st century.

Research Objective and Research Questions

The primary aim of this study is to explore how the functional principles of natural ecosystems can be adapted to organizational design and management, with the goal of fostering administrative models that are more sustainable, resilient, and adaptive in the face of contemporary complexity.

This approach seeks to overcome the limitations of the traditional mechanistic paradigm by proposing a form of management that mimics living systems, promoting decentralized, collaborative, resource-efficient organizational structures oriented toward continuous learning. Biomimetic management is thus positioned as an innovative path for aligning business logic with the principles of sustainable development and systems thinking.

Based on this foundation, four research questions are proposed to define the scope of the study and guide the theoretical analysis toward a critical and applied understanding of biomimicry’s potential as an alternative management model:

1. What key principles of natural ecosystems can be translated into the field of organizational management?



2. What strategic advantages can biomimetic management offer compared to traditional management models?
3. What barriers do organizations face when attempting to implement nature-inspired approaches?
4. How can biomimetic logic be integrated into organizational culture and decision-making processes?

Methodology

This study adopts a qualitative, theoretical-analytical approach, based on a documentary and bibliographic review of relevant scientific literature on the application of biomimicry to management and organizational design.

The use of a theoretical review is particularly appropriate for emerging and multidisciplinary fields such as organizational biomimicry, as it allows for the exploration of evolving concepts and the integration of perspectives from various domains of knowledge. Scholars such as Celep et al. (2017) and Olaizola et al. (2020) have employed similar approaches to identify connections between natural principles and management structures, establishing conceptual models and propositions that serve as foundations for new practical applications.

The analysis was structured around the functional principles of ecosystems—diversity, decentralization, adaptability, and symbiosis—and their correspondence with key dimensions of contemporary management, such as leadership, organizational structure, innovation, and sustainability.

Results

Biomimetic management is grounded in the observation of the principles that govern natural ecosystems, which have proven to be sustainable, adaptive, and efficient over millions of years of evolution. The literature reviewed made it possible to identify a series of key principles applicable to organizational design.

Decentralization and autonomy: Just as ecosystems operate without central control, organizations can benefit from decentralized structures that foster greater adaptability and local autonomy (Lipholt, 2019; Olaizola et al., 2020; Toor & Kaur, 2017).

Functional diversity and resilience: Biodiversity ensures the stability of natural systems. Similarly, organizations that encourage multidisciplinary teams and diverse perspectives strengthen their capacity to respond to crises (Ilieva et al., 2022; Nkandu & Alibaba, 2018).

Continuous feedback: Ecosystems adjust their behavior based on environmental signals. Likewise, organizations can implement ongoing feedback systems to improve processes and decision-making (Linder & Huang, 2022; Reap et al., 2005).

Circular economy and energy efficiency: Inspired by nature's closed-loop systems, organizations can redesign their processes to reduce waste, optimize resource use, and regenerate their surrounding environment (Movva & Velpula, 2020; Oguntona & Aigbavboa, 2017).



Self-organization and emergent learning: As seen in swarms or colonies, organizations can organize themselves dynamically through simple rules that promote collective intelligence (Celep et al., 2017; Guerreiro, 2011).

Evolutionary adaptation to change: In nature, the species that survive are those capable of adapting quickly. Biomimetic management fosters agile organizational cultures with a long-term vision (McInerney & Niewiarowski, 2022; Mejía-Villa et al., 2023).

Connection with the environment: Nature is deeply interwoven with its surroundings. Organizations, too, must align more systemically with their communities, ecosystems, and social networks (Ashwath et al., 2021; Rao, 2014).

Reduction of rigid hierarchies: Inspired by natural networks such as mycelium or neural systems, organizational models can evolve toward more horizontal and collaborative structures (Mead, 2017; Olaizola et al., 2020).

Conditions conducive to life: The ethical core of biomimicry is to generate solutions that support life—both human and natural. This includes healthy working conditions, emotional well-being, and respect for planetary boundaries (Ilieva et al., 2022; Linder & Huang, 2022).

Regenerative innovation: Beyond minimizing harm, biomimicry proposes solutions that restore and regenerate social and ecological systems, positioning organizations as active agents of positive transformation (Klein, 2009; Mead, 2017).

The theoretical findings allow these principles to be grouped into a functional relationship between ecosystem behavior and their potential applications to the organizational domain. The following table presents a synthesis of this correspondence, illustrating the strategic benefits of each natural principle for designing more sustainable, resilient, and adaptive organizations [Table 1].

Table 1

Correspondence between ecosystem principles and organizational dimensions

Natural principle	Ecological description	Application in Management
Decentralization	Coordination without central control	Horizontal structures and autonomous decision-making networks
Functional diversity	Biodiversity as a mechanism of stability	Multidisciplinary teams and inclusion of diverse perspectives
Continuous feedback	System self-regulation based on environmental signals	Feedback systems for continuous improvement
Circular economy	Closed cycles of matter and energy	Process redesign to eliminate waste
Self-organization	Structures that emerge spontaneously through simple rules	Collective intelligence and distributed leadership
Evolutionary adaptability	Gradual changes in response to environmental pressure	Change management and agile organizational culture
Connectivity	Interdependence with other systems	Strategic alliances and collaborative



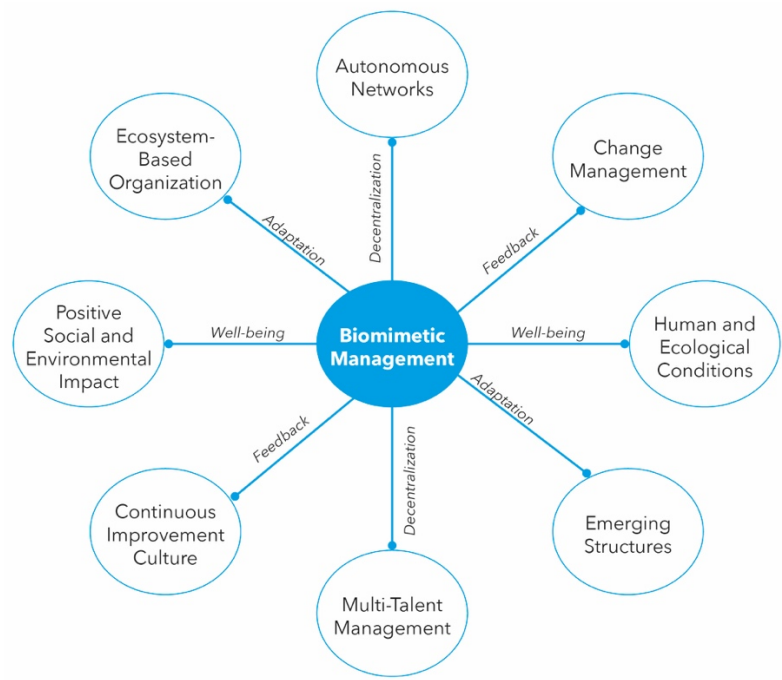
		and the environment	work
Conditions conducive to life	Resource optimization without depletion		Healthy work environments, well-being, and internal sustainability
Regenerative innovation	Regeneration of the natural and social environment		Projects with positive impact on community and ecosystems

Source: Compiled by the author based on the theoretical review.

To complement the above, the following diagram presents a model that summarizes the logic of the biomimetic approach to management—from its natural inspiration to its practical expression in the organizational sphere—illustrating how natural principles are linked to the fundamental elements of an organization [Figure 1].

Figure 1

Biomimetic Management Model: From Nature to the Organization



Discussion

The findings support the assertion that biomimetic management constitutes an emerging approach with considerable potential to transform traditional organizational models. Its foundation in principles derived from ecosystems—such as *decentralization*, *adaptability*, and *regeneration*—represents a paradigmatic shift from the dominant hierarchical and mechanistic logic.

The principle of *decentralization* has been recognized as key to enhancing organizational resilience, as it enables more agile and autonomous responses to uncertain environments (Lipholt, 2019; Olaizola et al., 2020). Like natural networks, organizations can develop non-linear structures based on dynamic interconnections, which foster collaboration, localized efficiency,



and self-organization.

Likewise, *functional diversity* in natural ecosystems—which ensures stability in the face of disturbances—translates in the organizational context into multidisciplinary teams and inclusive work environments. Studies such as those by Ilieva et al. (2022) and Mejía-Villa et al. (2023) confirm that a diversity of perspectives generates more creative and sustainable solutions.

One of the most significant contributions of this approach lies in its capacity to introduce *regenerative* rather than merely sustainable dynamics. That is, the goal is not only to minimize negative impacts but to create organizations that actively restore their natural and social environments. In this regard, research by Silva et al. (2024) and Pugalenthil et al. (2024) highlights how the incorporation of biomimetic principles into industrial process design and organizational structures can lead to production and management models with a net positive impact.

Nevertheless, the lack of specialized training, the cultural rigidity of many organizations, and the absence of clear policies remain recurrent obstacles to the implementation of such approaches (Jones et al., 2024; Oguntona & Aigbavboa, 2019). Additionally, many biomimetic practices remain confined to symbolic or aesthetic dimensions, without fully integrating into decision-making or governance processes (Reap et al., 2005).

In contrast, experience in fields such as architecture and urban planning demonstrates that when a *holistic vision* of biomimicry is adopted—one that goes beyond form imitation to replicate functions and relationships—the results can be both disruptive and innovative (Guerreiro, 2011; Prakash & Sharma, 2017).

Finally, integrating this approach into organizational culture requires not only structural changes, but also a redefinition of leadership and managerial education. Mejía-Villa et al. (2023) argue that cultivating leaders with systems thinking, creativity, and ecological awareness is a necessary condition for the transition toward truly biomimetic organizations.

Conclusions

The findings of this study allow us to conclude that biomimetic management constitutes an innovative, relevant, and necessary approach for redesigning 21st-century organizations through a systemic, resilient, and regenerative lens. By emulating ecological principles such as decentralization, functional diversity, self-organization, feedback, and circular economy, it becomes possible to transform organizational structures, processes, and cultures in alignment with the planet's ecological and social boundaries.

This approach not only offers tangible strategic benefits—greater adaptability, operational efficiency, and more collaborative structures—but also introduces a new ethical framework centered on the regeneration of natural and social environments. In this way, biomimetic management moves beyond an inspiring metaphor to become an empirical and operational foundation for designing organizations that learn from life to sustain life.

However, its implementation faces significant barriers, including the structural rigidity of many



organizations, the lack of specialized training, and the scarcity of applied models that can serve as references. Overcoming these challenges requires rethinking managerial education, promoting institutional redesign processes, and developing public policies that support management models more deeply integrated with the logic of the planet.

For future research, we propose the development of empirical studies that measure the real impact of this approach across various organizational sectors, as well as the construction of methodological tools to facilitate its systematic application. It is also relevant to explore its convergence with other emerging paradigms, such as regenerative economics, distributed governance, and ecosystemic leadership.

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