RESEARCH ARTICLE

Navigating Complexity: The Role of Observation and Responsiveness in Agile Leadership

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Abstract

The intersection of agile leadership with the principles of complexity science is considered essential and significant for organisations in fluctuating environments. This study synthesises the traits of agile leadership with the perspectives offered by complexity science, emphasising the substantial role of adaptable strategies in unshackling organisations from emergent phenomena.

Through complexity science, this paper clarifies how organisational behaviours and outcomes arise from observing complex interrelations of fine and coarse-grained relationships between parts and explores the relational effects of such interactions within a tangled nexus. It advocates for a shift from traditional leadership approaches to a dynamic model that can navigate the inherent unpredictability of complex systems through agile practices.

Strategic adaptability and the capacity to manage and navigate complexity are central to the discourse on agile leadership. Leaders observe the nuances of complexity science to identify and respond to organisational patterns and trends. The deep engagement in observation and a nuanced understanding of the organisations' ecosystem allows for identifying and capitalising on strategic opportunities in complex and dynamic interconnections and interdependencies. The paper contends that these leaders have the foresight to effectuate minor yet impactful adjustments, enhancing organisational agility and securing transient wins in unpredictable circumstances by understanding the relational attributes of components within a system.

In conclusion, this paper proposes that integrating complexity science and agile leadership creates a method that empowers organisations to thrive amidst volatility and uncertainty; this is an essential sine qua non for seizing opportunities for discernible benefit. This paper establishes a theoretical framework that emphasises the significance of a behavioural response strategy, necessary for leaders who want to utilise agile leadership under challenging circumstances.

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Introduction

Agility in organisational contexts is increasingly examined through the lens of complexity science, which offers a comprehensive framework for understanding the dynamic behaviours that characterise adaptive enterprises. Here, agility refers to the capacity of individuals and organisations to respond swiftly and effectively to changing environments. This necessitates a dual focus: leaders must be individually agile, capable of rapidly processing information, making decisions, and adapting their strategies, while organisations, as aggregates of these individuals, must be aligned in their agility. This alignment is critical because it ensures that the collective response to environmental changes is coherent and efficient, leveraging the system's emergent properties. This paper explores this concept through the lens of the natural phenomenon observed in Bénard cells. By examining agility through different levels of analysis—individual and organisational—complex systems theory clarifies how local interactions and feedback loops contribute to the overall adaptability and resilience of the organisation. This perspective highlights leaders' need to cultivate individual agility and a supportive organisational structure that promotes synchronised, agile behaviours across all levels.

Complexity science provides insights into the complex, nonlinear interactions characterising organisational dynamics. It posits that organisational behaviours and outcomes are the products of complex interrelations among various system components (Uhl-Bien et al., 2007). This perspective is crucial for agile leaders who must understand their organisations' subtle fine-grained interactions. By applying complex principles, leaders can discern patterns and systemic behaviours that traditional approaches might overlook.

Lichtenstein et al. (2006) proposed "that leadership (as opposed to leaders) can be seen as a complex dynamic process that emerges in the interactive 'spaces between' people and ideas. That is, leadership is a dynamic that transcends the capabilities of individuals alone; it is the product of interaction, tension, and exchange rules governing changes in perceptions and understanding" (p. 2). Lichtenstein et al. (2006) labelled this as dynamic and adaptive leadership. Lichtenstein et al. (2006) conceptualised this leadership event as a distinct series of actions, the significance of which is constructed through the interactions and tangled relations among the actors involved in the execution. This perspective underscores leadership's complex, emergent nature as a dynamically co-created phenomenon by multiple stakeholders.

Here, this paper extends the discussion on Lichtenstein et al.'s (2006) complexity leadership theory (CLT) within the framework of complex systems by introducing the concept of interdependent relations in spacetime and co-relating it to Lichtenstein et al.'s (2006) 'space between'. It argues that the presence of various actors at pivotal times and spaces significantly influences the array of strategic options available to leaders (Leong, 2023). On observation, these

interdependent relations determine the resources or relationships leaders can leverage for organisational advantage. The notion of interconnectedness describes how the states of different entities become interdependent such that one cannot be entirely described without reference to the other. This paper posits that the complex interconnections within Lichtenstein et al.'s (2006) 'space between' offer a coherent framework for understanding relational dynamics. These observations and subsequent assimilative and sensemaking of the tangled relationships enhance world-making relations, thereby significantly influencing organizational outcomes. The concept of interdependent relations thus enriches the understanding of complex adaptive systems by highlighting the interconnected nature of all system components. Hence, the characteristics of a system are emergent and dependent on the complex network of interactions that determine the system's internal and external relationships (Choi et al., 2001).

Leong (2024) examined the phenomenon of phase transitions in Bénard cells, drawing an analogy to ballet-like movements. Leong (2024) elaborated on how internal and external forces can precipitate the emergence of a new order. This analysis underscores the dynamic interplay between forces and the resultant structured patterns in complex systems. Managing a complex system effectively requires observing how these interdependent relations influence system behaviour and agility. This observation is fundamentally locality-specific and requires heightened sensitivity to diverse signals, which may manifest as Lichtenstein's (2009) opportunity tensions or other differentials between the edges of order and chaos. This juncture, often referred to as Lichtenstein et al.'s (2006) 'space between' in this paper, is argued as the tangled nexus—a critical region at a time where existing structures dissolve, and new orders are forged through phase transitions. Lichtenstein et al.'s (2006) 'space between' involves "identifying and bracketing the events, episodes, and interactions of interest" (p. 5) and, from there, highlights "their relational qualities and longitudinal dynamics" (p. 5). Thus, each locale, the 'space between' relationship and resources within the organisation, may require unique responses, underscoring the importance of context-sensitive agility in management strategies.

This paper posits that organisational agility is intrinsically linked to the concepts of attractors and bifurcations, as derived from complexity science. Attractors in this context are the stable operational modes or cultural norms organisations tend toward over time. Hazy (2019) posited that structural attractors function similarly to gravitational forces in general relativity. In this analogy, the information and knowledge embedded within physical and social structures act as the 'mass', which draws human activities toward the attractor. This bias induces order by rendering relevant events more predictable.

Consequently, structural attractors influence and distort the spatial and temporal dimensions of human interactions, shaping the emergent behaviours and patterns within the system. This perspective underscores the role of embedded information and knowledge in organising and directing human activities within complex adaptive systems. These are the consistent patterns or states that provide stability and predictability to the organisation, serving as reference points or benchmarks within the organisational landscape (Strogatz, 2018). Conversely, bifurcations represent crucial junctures (or tangled nexus) in an organisation's development—points at which minor variations in the environment or internal conditions can precipitate substantial and often dramatic shifts in organisational behaviour (Eidelson, 1997). These are the moments where strategic decisions have the potential to significantly alter the organisation's trajectory, either by enhancing its adaptability or, conversely, introducing new challenges or rigidities (Strogatz, 2018).

Navigating these bifurcations effectively requires observing the underlying attractors and anticipating and reacting to the early signs of potential change. This capability is essential for leaders who wish to harness these critical moments to foster innovation and steer their organisations towards optimal outcomes. The interplay between attractors and bifurcations in organisational settings offers profound insights into the dynamics of change management and strategic decision-making. Leaders must cultivate a deep understanding of these dynamics to successfully navigate the complexities of organisational environments. Such leadership is characterised by a balance between maintaining stability through attractors and leveraging bifurcations for strategic renewal and innovation (Uhl-Bien et al., 2007).

Applied to leadership in complex systems, interdependent relations suggest that the interactions among various organisational actors are crucial for understanding how leadership dynamics evolve and decisions are made through self-organisation. In this context, leadership is not a linear or isolated activity but is deeply embedded in a network of relationships and mutual influences that transcend superficial causal relationships. In Lichtenstein et al.'s (2006) complex leadership theory, leadership is reconceptualised as a complex, nonlinear process that extends beyond the actions of an individual leader exerting influence in isolation. Instead, leadership is fundamentally interwoven within a dense fabric of relationships and mutual influences that surpass straightforward causal interactions. This perspective highlights leadership as a dynamic and collective endeavour shaped by the aggregate ‘behaviours’ and interactions of multiple organisational actors. From this standpoint, leadership emerges from the synergistic interactions within networks of individuals who collectively contribute to decision-making processes and influence organisational outcomes. This shift from a leader-centric to a network-centric view acknowledges the importance of social dynamics and shared leadership in contemporary organisational structures. It emphasises the need for leaders to facilitate and orchestrate complex interactions that drive collective action and foster an environment conducive to collaborative innovation.

The appearance of critical actors in the organisational spacetime can catalyse new opportunities, precipitate crises, or otherwise alter the strategic landscape in significant ways. Leaders must, therefore, navigate these tangled relationships and leverage them to stack up advantages in terms of resources and alliances. This research emphasises the importance of timing and positioning in leadership. Being at the right place at the right time—or ensuring that critical actors are effectively aligned—can be crucial for seizing opportunities and enhancing the organisation’s strategic position. It also underscores the need for leaders to maintain a high degree of awareness through astute observation of fine-grained interactions and adaptability, as the dynamic nature of these interdependent relations can rapidly change the strategic context.

This research builds upon Lichtenstein et al.’s (2006) CLT by integrating the concept of interdependent relations in spacetime, thereby enriching the understanding of leadership dynamics within complex systems. By examining the ‘space between’—a tangled nexus where bifurcations occur—this study examines the observer effect and its pivotal role in influencing organisational trajectories during critical junctures. This novel integration not only advances theoretical constructs within complexity science but also provides a more nuanced framework for observing and interpreting the adaptive behaviours of leadership in response to emerging challenges and opportunities. As organisations navigate increasingly complex environments, the insights derived from this approach can inform more effective leadership

strategies that are attuned to the dynamic interplays of system components.

Moving forward, a pertinent research question that arises from this study is: How does the observer effect within the tangled nexus influence the decision-making processes and strategic directions of complex organisations? Exploring this question could yield significant contributions to complexity leadership, offering deeper insights into how leaders can effectively manage and leverage the inherent uncertainties and dynamics of complex adaptive systems.

Literature Review

Agile leadership is defined by the ability to observe and interpret the deep structure of organisational dynamics and make decisions informed by these insights (Baran & Woznyj, 2021). It is vital to contextualise and redefine agility in relation to the competitive landscape in which a business operates (Weber & Tarba, 2014). This viewpoint is crucial for various reasons, both scholarly and practical.

In addition, the significance of agility is emphasised by aligning this strategy with the dynamic capabilities framework in management theory, which asserts that maintaining a competitive edge requires the capacity to reconfigure routines and resources in response to environmental changes rapidly (Teece et al., 1997). Through benchmarking agility against the most proficient rivals, organisations can discern which capabilities necessitate improvements to attain or surpass industry benchmarks; thus, they can establish a strategic advantage in exceedingly competitive markets (Yauch, 2011).

This study expands upon the investigation of CLT in complex systems conducted by Lichtenstein et al. (2006) by incorporating the notion of interdependent relations in spacetime and establishing a correlation with the ‘space between’ where critical transformations occur. Nevertheless, the discussion surrounding leadership in complex systems transcends this boundary and encompasses many alternative theories that prioritise leadership's dynamic and interactive elements. As a comprehensive framework, CLT resonates with several contemporary theories that acknowledge the complexity of leadership dynamics.

Significant contributions have been made by theories such as shared leadership (Lyndon et al., 2022; Pearce et al., 2008), which underscores the distributive nature of leadership roles among group members, collective leadership (Contractor et al., 2012; Edwards & Bolden, 2023), which focuses on the emergent properties of leadership within high-reliability organisations; and distributed leadership (Gronn, 2002; Hickey et al., 2022), which highlights the fluid and stretched distribution of leadership across individuals and contexts. Additionally, relational leadership (Cunliffe & Eriksen, 2011; Uhl-Bien, 2006) considers the social influence processes underlying leadership, while adaptive leadership (DeRue, 2011; Heifetz et al., 2009) examines the adaptations necessary within complex changing environments. Furthermore, Hazy (2006, 2021) described leadership as an emergent organisational meta-capability that evolves through interactions within the system. Hazy (2021) delved into the intersection where purposeful, individual-driven collective actions—organisational leadership—interact with collective intelligence and agency. This exploration highlights the dynamic interplay between individual initiatives within leadership roles and the broader collective capabilities that emerge from these interactions. Hazy’s (2021) analysis emphasised the synthesis of personal leadership endeavours with the shared cognitive resources

and decision-making capacities that characterise collective intelligence. This relationship underscores the critical role of organisational leadership in directing and amplifying the collective agency, leading to enhanced organisational performance and adaptability. The study further suggests that effectively harnessing collective intelligence through strategic leadership can significantly elevate an organisation's capacity to respond to complex challenges and leverage opportunities in innovative ways.

These varied theorizations underscore the complexity of leadership as not merely the exertion of influence by an individual leader but as a dynamic capability emerging from a network of interactions. Each perspective contributes to our understanding of leadership in complex systems by providing different lenses to view the multifaceted nature of leading in volatile and uncertain environments.

Understanding Complexity Leader Theory

A leadership event was defined by Lichtenstein et al. (2006) as a recognisable series of acts whose meaning is created by the relationships between the players involved in its performance. This viewpoint emphasises leadership's intricate and evolving character as a phenomenon actively shaped by various individuals.

According to CLT, leadership is a complex and ever-changing interplay of interactions and events that are not entirely explicable outside their respective social and environmental contexts. This theory deviates from conventional leadership models by emphasising the necessity of adaptability and flexibility to traverse complicated adaptive systems efficiently. Inside these systems, leadership is not simply attributed to an individual leader but rather arises from collaborative interactions among multiple organisational agents.

Lichtenstein et al. (2006) defined complexity leadership as establishing an environment that emphasises adaptability and innovation. In such circumstances, leaders adopt a less dictatorial and more facilitative role, enabling information interchange, cultivating relationships, and promoting a culture of resilience and responsiveness. Businesses facing volatile, unpredictable, complex, and ambiguous (VUCA) situations shift from a command-and-control leadership style to a more decentralised and emergent approach (Zaidi & Bellak, 2019).

In addition, complexity leadership's adaptive ability entails responding to changes and establishing circumstances for ongoing evolution and learning inside the organisation (Uhl-Bien & Marion, 2009). This involves formulating strategies that utilise the combined intelligence of the organisation, promoting experimentation, and gaining knowledge from both triumphs and mistakes. These tactics could include forming cross-functional teams, encouraging open lines of communication, and using technology to improve teamwork.

Furthermore, CLT promotes leaders' ability to identify and react to patterns and shifts in their surroundings, which calls for a deep comprehension of their organisations' internal dynamics and the outside factors that impact them. To successfully manage this simultaneous concentration, one must possess a heightened awareness and the capacity to utilise observations to steer organisational decision-making and strategy agilely. Ultimately, CLT provides a robust and comprehensive structure for comprehending leadership in contemporary organisational environments marked by swift

transformation and unpredictability.

Observing Deep Structures and Fine-Grained Interactions

Much has been discussed in the organisational literature about the concept of ‘deep structure’ (Giddens, 1984; Hinde, 1976; Schein, 1980). At the heart of managing complex systems within organisations is the leader’s ability to discern and interpret the deep structures and fine-grained interactions that signify emergent trends. This requires examining vast quantities of data to discern pertinent signals, as it entails observing the interaction among the various components of the organisation (Marion, 1999). Despite their subtlety, the future course of emergent events can be inferred from these signals.

Heracleous and Bartunek (2021) emphasised the significance of understanding deep structures—those foundational arrangements and patterns of interaction that persist beneath the surface of organisational practices, while fine-grained interactions pertain to the minute, often rapid exchanges that occur between individual components of the system. Together, these elements provide a rich tapestry of data that, when effectively decoded, can reveal emergent trends and opportunities for strategic intervention. Heracleous and Bartunek (2021) explored “the deep structures and complex temporal dimensions associated with organisational change failure that are hidden from view” (p. 209).

In addition, Heracleous and Bartunek (2021) argued that to comprehend change failure thoroughly, one must transcend surface-level assumptions regarding its causes and embrace a more profound analytical methodology. Their support for a subterranean view on change emphasised the need to investigate the complex temporal dynamics and deep structural underpinnings of organisational change processes. To provide a more nuanced comprehension of why change initiatives may fail to produce the desired results, this strategy requires a comprehensive examination of the timing and foundational elements that significantly impact the trajectory and results of change initiatives.

Effective leadership requires the capacity to perceive and analyse the diverse information flows and interactions inherent to the systems they lead as they navigate complexity. Detecting subtle signals that could signify disruptions or changes in the system's dynamics frequently requires sifting through vast amounts of data (Snowden & Boone, 2007). These signals hold significant importance as they can apprise leaders of any essential modifications or advancements that might be required to guide the organisation towards long-term viability and expansion.

The significance of the capacity to perceive and react to intricate interactions is heightened when considering complex adaptive systems (CAS). Complex adaptive systems (CAS) are distinguished by their components' ability to adapt or learn through interactions (Alaa & Fitzgerald, 2013). Effective leadership in such contexts requires the ability to anticipate and adjust to changes and exert influence over the trajectory of these adjustments in a manner consistent with the organisation's objectives (Uhl-Bien & Marion, 2009).

For leaders, this involves understanding how local interactions (fine-grained) can lead to global patterns (deep structures) and using this knowledge to facilitate desirable outcomes within the organisation. It also involves identifying and nurturing relationships central to the system’s health and vibrancy. For example, a leader might recognise a pattern where certain

types of team interactions lead to innovative outcomes and work to replicate these patterns across the organisation.

In organisational contexts, this implies that leaders' awareness and subsequent actions based on their observations can alter the system's dynamics (Ashby, 1956). As an illustration, a leader's choice to investigate the workings of a department could potentially influence the department's conduct; this could occur due to the leader's participation generating novel perspectives that result in modifications to processes or regulations or because employees modify their conduct in response to scrutiny (Cohen et al., 2017).

Ashby (1956) presented the concept of the 'law of requisite variety', which states that for a system to be effective at regulating itself, it needs to have a level of complexity (or variety) that matches the complexity of the environment it operates in. Adaptability and responsiveness are critical in complex systems, be they biological, mechanical, or social, as this law emphasises. Ashby (1956) expounded upon feedback loops and their significance in preserving systems' stability and operational efficiency. Ashby (1956) described the workings of both positive and negative feedback, emphasising that positive feedback may result in runaway situations or exponential growth, while negative feedback supports system stability through self-correcting mechanisms.

The relationships between agents in complex adaptive systems are networked and multi-dimensional. A comprehensive yet nuanced viewpoint is necessary for this, which enables one to comprehend diverse facets of system functioning—including but not limited to group dynamics, interdepartmental collaborations, and individual motivations (Kauffman, 1993).

Due to the interdependencies within these systems, modifications in one component can yield unforeseen repercussions in another, emphasising the criticality of precisely interpreting intricate interactions. Leaders must develop the capacity to anticipate the possible ripple effects of particular modifications or interventions. They should utilise their discernment to inform strategic choices that bolster the unity and capability of the system.

Finally, in the contemporary era characterised by rapidity and interconnectivity, the capacity to discern and analyse interrelationships and structures within complex systems is an indispensable aptitude for leaders. Leaders must be able to carefully examine and accurately interpret small indications that suggest changes in the dynamics of an organisation. Leaders who manage these dynamics effectively can prevent systemic failures and take advantage of emergent opportunities for innovation and growth.

Observer Effect in Complex Interactions in Complex Adaptive Systems

Understanding the 'observer effect', a phenomenon that influences what is being observed, is essential to investigating complex systems (Baclawski, 2018). Sassoli de Bianchi (2013) explored how observational interference might influence results, pointing out that analogies are becoming more and more pertinent to complexity science, especially in organisational settings.

In complexity science, the observer effect posits that the act of measurement inherently alters the state of the observed system. Zohar and Marshall (1990) further clarified this concept through their illustrative examples, providing a crucial framework for leaders to understand the significant impact their perceptions and actions can have on organizational

dynamics. Acknowledging that multiple observers, each with unique perspectives, may concurrently examine the same phenomenon highlights the critical importance of self-awareness and reflexivity in leadership roles (Bakeman & Gottman, 1997). In this context, agility becomes paramount for securing a first-mover advantage (Yang & Liu, 2012). Leaders can effectively capture perceived opportunities by swiftly adapting to environmental changes and demonstrating complex adaptive behaviours (Haeckel, 1999). Given the presence of numerous observers, the ability to quickly respond and adapt provides a significant strategic advantage, positioning leaders to capitalize on opportunities before others do. These qualities enable leaders to acknowledge and comprehend their perceived reality, influenced by their frames of reference and levels of awareness, thereby enhancing their capacity to navigate and influence complex organisational systems.

According to Zohar and Marshall (1990), the observer effect significantly impacts the physical processes being observed and our understanding of self and consciousness. They further argued that consciousness and perception are much more closely linked with the physical world than conventional scientific views would imply. According to them, our awareness as observers is an active participant that shapes our reality rather than just a passive receiver of information since observation impacts our sensemaking and world-making interpretation process, ultimately driving action and interactions with the environment. This viewpoint is important in scholarly dialogues regarding the complex nature of human systems and leadership within organisational contexts. According to Zohar and Marshall's (1990) observations, leaders are not only observers in their organisations, monitoring and reacting to external reality; instead, they play a crucial role in co-creating the organisational environment through their choices, perceptions, and behaviours. The interconnection between observation, consciousness, and tangible consequences underscores the significance of self-awareness and intentionality in leadership positions. Their discussion extends the implications of the observer effect from the complexities of fine-grained interactions to the broader context of coarse-grained interpersonal relationships and organisational behaviour. Zohar and Marshall (1990) argued that leaders' perceptions and interpretations of their environments can fundamentally transform those environments. This perspective underscores the significance of how leaders' viewpoints and sensemaking processes can dynamically influence and reshape organizational dynamics within complex systems.

Leadership within complex systems necessitates a nuanced combination of astute and prudent observational abilities. Leaders need to read nonverbal cues well and make decisions with limited information while monitoring the possible effects of their observations on the system (Marion & Uhl-Bien, 2001). Possessing this skill set is crucial for effectively navigating the uncertainties and complexities of intricate adaptive systems.

Finally, critical insights into the dual role of leaders in complex systems can be gained from the literature on the observer effect within complexity research. Leaders, in their dual roles as observers and influencers, must cultivate advanced observational abilities to comprehend and guide their organisations proficiently while avoiding any disruption to the inherent dynamics of the system. Subsequent investigations may delve into how distinct observational approaches influence organisational results and design protocols for leaders to handle their impact while interacting with complex systems effectively.

Discussion

In the dialogue surrounding complexity science and adaptive structures, this paper posits that the concept of interdependent relations transcends mere facilitation of change and articulation of ontological fundamentals; it crucially defines and moulds the relationships within a system, including aspects such as spatial and relational proximities. According to this paper, interdependent relations are the principal connective tissue (within the tangled nexus) through which an ontology's numerous subsystems integrate to create a unified entity. Furthermore, this study examines the participation of an observer with a specific intention in this particular process, indicating that the presence and purpose of the observer might impact the dynamics inside the interconnected network. This perspective is grounded in the foundational tenets of complexity science, which posit that the state of an object under observation can be altered simply by observing it.

This paper redefines Lichtenstein et al.'s (2006) complexity leadership theory. Instead of viewing complexity as a single function or trait embodied by individuals, complexity is seen as a multifaceted, dynamic process that emerges within the 'space between' relationships and resources. This interstitial 'space between' interaction and mutual influence is called the tangled nexus. Within this nexus, leadership arises from the confluence of interactions, the inherent tensions, and the governing principles that dictate the evolution of perceptions and understanding among those engaged in collective activities.

Leong (2024) examined the principles of self-organisation within complex systems and the strategic acquisition of external resources through the interpretive framework of thermodynamics, particularly emphasising the second law. Leong (2024) posited that the Second Law of Thermodynamics and the associated concept of entropy offer a metaphorical framework for understanding entrepreneurial endeavours. As defined by Kondepudi et al. (2020), self-organisation is the inherent tendency for order to emerge from situational disorder. An example, illustrated in Figure 1, is when energy is added to a fluid medium, it can cause the creation of structured formations, such as convection cells. In the same way, leaders within organisations employ self-organisation techniques to convert unstructured market volatility into successful business operations through restructuring their enterprises, utilisation of resources, and development of strategies.

Georgiev and Iannacchione (2016) asserted that energy gradients catalyse internal structuring within systems that operate far from equilibrium. This structuring facilitates energy dissipation and reduces internal entropy in line with the principle of least action. The Bénard cell is a classic example of this self-organizing principle, where creating a convection cycle decreases entropy within the system itself.

As systems evolve to possess a more significant number of internal states, their capacity to 'perceive' and 'react' to environmental stimuli—effectively transitioning between states—enhances progressively. Kondepudi (2012) defined this process as 'transitional entropy production', a form of entropy generated more than that inherent to maintaining a given state. The implication is that as a system's interactive abilities with its environment augment and as it displays more directed behaviour, there is an associated increase in transitional entropy production.

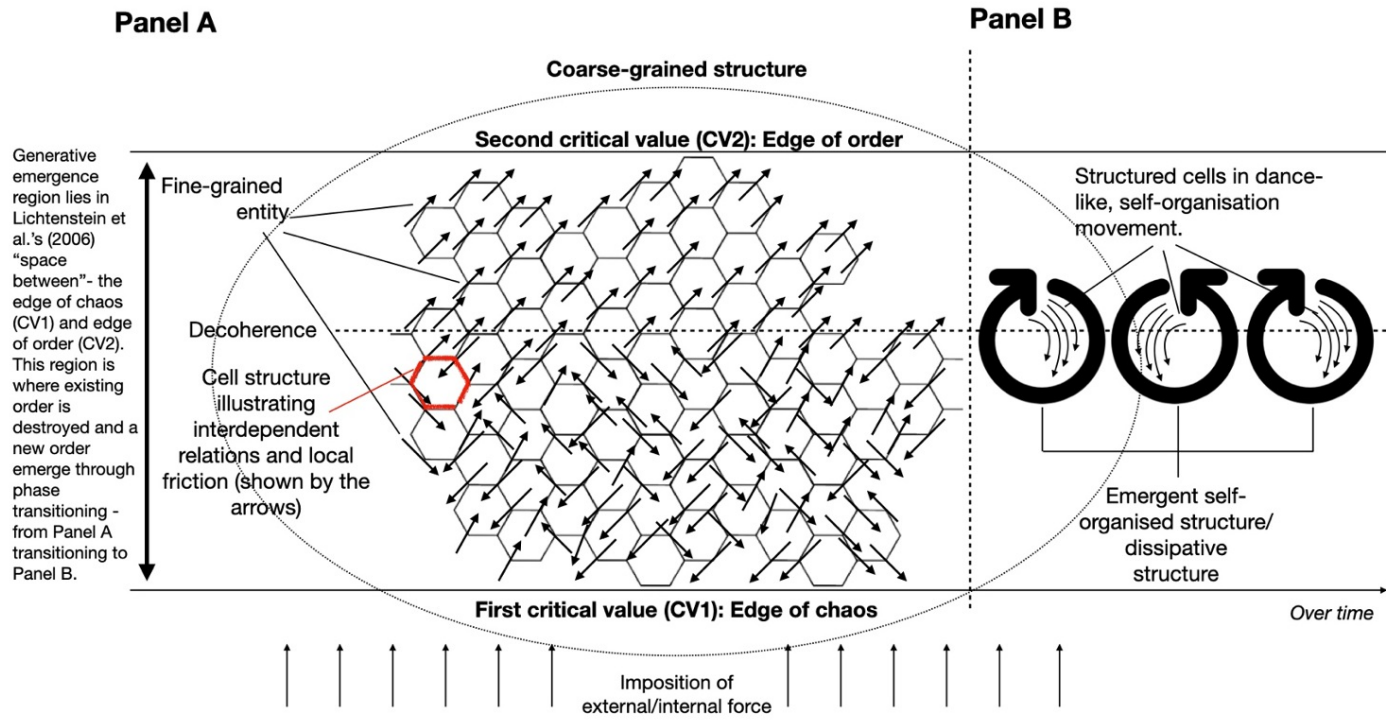

Figure 1. Re-contextualised Bénard cell in a ballet-like movement. Adapted from (Leong, 2023)

Bénard convection is a fluid dynamics phenomenon where natural convection occurs within a fluid layer subjected to a temperature gradient depicted by CV1 and CV2. The Bénard instability can be observed from this phenomenon in Panel A of Figure 1, which results from heating the fluid's lower surface and the subsequent systematic formation of convection cells called Bénard cells. This instability triggers a flow pattern that arises from the spontaneous self-organisation upon heating (Figure 1).

Panel A exemplifies the phenomenon of Bénard cells, showcasing heat's enhanced dissipation via the emergence of dissipative flow cell structures. This visual representation highlights the efficient reduction of kinetic energy diffusion within the fluid, attributed to local friction forces. The formation of these structured cells optimises the transfer of thermal energy, illustrating an essential aspect of complexity in thermodynamic systems where localised interactions significantly influence the macroscopic behaviour of the system.

Panel B provides an analogous representation within organisational contexts, paralleling the structure depicted in Panel A. This panel underscores the components, mechanisms, and emergent ordered structures characteristic of organisational systems. It illustrates the coordinated, ballet-like movement within the organisation, emphasising how individual interactions and processes collectively contribute to the system's overall dynamic and coherent behaviour. This depiction mirrors the principles of complexity science, where localised interactions and feedback loops lead to the emergence of organised and adaptive structures.

Panel A represents granular, fine-grain activity corresponding to individual leadership agility, characterized by leaders' ability to respond swiftly and adaptively to environmental signals and information. In contrast, Panel B illustrates a

coordinated, ballet-like movement resulting from the collective actions of individuals, symbolizing organisational agility. This depiction demonstrates how the synchronized efforts of multiple actors within an organization lead to adaptive behaviours that enhance the overall system's responsiveness to environmental changes. In complexity science terms, these panels highlight the distinction between the micro-level adaptability of individual leaders and the macro-level emergent properties arising from the collective dynamics of the organization.

According to McKelvey (2016), this process involves imposed tension, critical values, and emergent phase transitions that result in the formation of 'dissipative structures' as initially defined by Prigogine (1967). These structures emerge to alleviate the tension imposed by the temperature differential, undergoing a phase transition that significantly alters the fluid dynamics between critical values. Under extreme heat, the system displays dynamic, patterned circulation that creates new order—geometric arrangements of warmer and cooler zones. The phenomenon of fluid organisation into hexagonal cells or parallel rolls, characterised by ascending flows on one side and descending flows on the other, was noticed by Heylighen (2001). Dissipative structures, also known as patterns, function to disperse energy following the second law of thermodynamics, resulting in a rise in entropy and unpredictability. As a result of energy differentials-driven self-organisation and emergent behaviour, the fluid demonstrates physical intelligence in reacting to external heat and tension, resulting in a structured yet dynamic system similar to that seen in Bénard cells.

According to this theory, actors interact in these interstitial spaces ('space-between'), and leadership is a phenomenon that evolves dynamically and adaptively. According to Lichtenstein et al. (2006), these interdependent relations can be characterised as a set of actions arising from the complex interconnections among the actors involved. This observation underscores leadership's dynamic and complex character, collaboratively shaped by various stakeholders actively engaging in a collective universe of possibilities. The complex interactions within these interrelated networks are situated within a spacetime continuum that is deeply intertwined with multiple facilitating factors, such as resources or relationships, which leaders may leverage to shape favourable outcomes. The ability of leaders to recognise and utilise these enabling factors within the tangled nexus demands not only a clear and focused awareness but also Maheshwari's (2021) 'Higher Consciousness Management'[1]. Such awareness facilitates the strategic stacking of resources and relationships into configurations that yield sustainable benefits for the organisation.

Hazy (2019) explored the potential causal relationship between individual fine-grained actions and the resulting coarse-grained outcomes. To illustrate this, Hazy (2019) introduced the concept of a putative force termed 'structural attraction', which affects individual behaviour in consistent patterns across populations. According to Hazy (2019), structural attraction acts as a biasing force that shapes individuals' behaviours as they interpret and utilise information derived from the ordered structure. This concept highlights the interplay between fine-grain actions and coarse-grain outcomes within complex systems, emphasising how localized interactions can lead to emergent, large-scale organisational behaviours.

The Bénard convection phenomena, when viewed through the lens of complexity leadership theory, offers a powerful metaphor for adaptable and agile leadership because of its capacity for self-organisation and the creation of ordered yet dynamic patterns inside a fluid layer under thermal stress. Within this particular framework, leadership can be likened to the spontaneous creation of Bénard cells. Effective leaders in complex organisational environments function as adaptive

agents who recognise and respond to emergent dynamics, catalysing and guiding the formation of ‘dissipative structures’ within their teams and organisations.

This process of leadership emergence is like the dynamics described in complexity leadership theory, where leadership does not solely reside in a designated role but emerges dynamically through interactions among various actors (with localised frictions) within the system. In the same way, as Bénard cells develop and adjust to temperature variations, leaders also emerge and adapt to the variations in information, opportunities, and challenges that exist in their surroundings. Leaders may create environments that foster innovation and agility by employing insights from McKelvey (2016) and conforming to the principles of Maheshwari’s (2021) ‘Higher Consciousness Management’. This is achieved not through direct manipulation but rather by creating circumstances in which order and efficiency organically arise from the disorder of intricate difficulties, akin to the organised flow patterns observed in Bénard convection. The ability to effectively govern and shape emerging trends within organisations highlights the significance of agile leadership in effectively navigating the always-changing organisational environments.

Agility, for what purpose?

According to Attar and Abdul-Kareem (2020), agile leaders have a vital role in fostering organisational agility. These individuals accomplish this by adeptly manoeuvring through phases of transformation, whether they arise from external or internal disturbances, and by proficiently establishing foundational concepts, formulating strategic plans, and constructing frameworks that enable seamless transitions. These individuals are pivotal in directing the organisation towards enhancing agility and cultivating a leadership culture that encourages and disseminates comprehensive agility through deliberate observation.

This concept suggests that complex systems require an observer to acknowledge and engage with their complexity. Without such observers, the complexity stays unrecognised.

The approach is consistent with Simon’s (1962) hypothesis, which states that complex systems often display hierarchical structures to manage extensive data and interactions efficiently. Simon’s (1962) thesis posits that hierarchies play a crucial role in facilitating the management and interpretation of complexity. This shows that the observer’s methodology and limits do not just determine the process of seeing complexity but are also impacted by them.

Attractors and Bifurcations

In organisational dynamics, complexity often propels leaders toward ‘attractors’— which are described as sets of states (or points in phase space) toward which a system tends to evolve, regardless of the starting conditions (Strogatz, 2001). Hazy et al. (2023) described how a value sink attracts additional participants to the value sink, enabling it to persist and expand as a dynamical system attractor, potentially challenging broader norms. Within a dissipative structure, a value sink emerges, systematically draining value from the system until reaching a threshold point of chaos. This process illustrates how localised attractors stabilize and grow, influencing larger systemic behaviours up to a point and potentially disrupting

existing equilibria as they approach critical points of instability. In the context of organisational leadership, attractors symbolize stable patterns or behaviours that an organisation might default to under specific conditions. These may encompass cultural norms, strategic priorities, or operational routines that become deeply embedded over a period of time. Strogatz's (2001) investigation into complex networks offers valuable perspectives on applying attractors in comprehending extensive systems, such as networks of neurons, power stations, or even organisations. Strogatz (2001) examined the collective behaviour of a complex network of interconnected dynamical systems, highlighting its significance in analysing leadership's impact on organisational dynamics.

Organisations can be perceived as complex networks in which individual components (such as departments, teams, or technology) interact in manners that substantially impact overall conduct. The dynamics of each constituent are distinct, yet the interactions between them can give rise to emergent features that cannot be accurately predicted by analysing individual components. For instance, a leadership choice made in one department of the organisation might have far-reaching consequences across the entire framework, impacting both performance and strategic trajectory.

Attractors in leadership refer to particular leadership styles or organisational tactics that have demonstrated effectiveness and are accepted as the default approach in usual situations. These attractors offer stability and predictability, which are crucial for ensuring uninterrupted operations and accomplishing long-term objectives. Nevertheless, these structures also present a potential drawback in terms of inflexibility, impeding the organisation's ability to respond to external challenges or internal advancements swiftly.

Strogatz's (2018) analysis of how little alterations in a system's parameters can result in significant changes (bifurcations) is especially pertinent to organisational leadership. Bifurcation is a phenomenon observed in nonlinear dynamics when a minor alteration in the parameters of a system leads to an abrupt qualitative transformation in its dynamics. Organisations may encounter situations when changes in the market, technology, or internal personnel necessitate leaders to navigate through periods of instability and change, causing the system to deviate from its attractor state. Successful leadership requires the recognition of these crucial factors and the subsequent adjustment of strategies, potentially leading to the adoption of new approaches that are more suitable for the modified context. Gaining insight into the dynamics of attractors and the structure of interactions inside an organisation can assist leaders in predicting and handling changes with greater efficiency. Leaders may enhance their ability to achieve strategic objectives, manage transitions, and respond to external influences and internal dynamics by identifying and understanding the patterns that arise from these intricate interconnections. Organisations frequently operate in a non-equilibrium state, making them susceptible to fluctuations at crucial moments, fluctuating between temporary stability and non-equilibrium circumstances.

This paper asserts that leaders must adopt a ripple mindset, recognizing that all observable phenomena—despite their chaotic appearance—result from complex interactions.

Lichtenstein (2020) articulated the concept of 'generative emergence', positing that emergent phenomena transcend the mere aggregation of their constituent parts, instead representing fundamentally transformative processes that engender new organisational structures, modes of thought, and action patterns. The conceptual framework posits that interactions within a system might stimulate the emergence of new traits or behaviours that were not anticipated based solely on the

characteristics of individual constituents. This perspective challenges traditional linear models of change and instead argues for acknowledging change as a result of nonlinear interactions that can lead to sudden and significant changes in the structure and functioning of a system.

Figure 3 illustrates the intertwined processes of generative emergence and entropic decay within the conceptual model of a ‘ripple’ effect, as framed by this paper. At the centre of the illustration, a ripple begins at a point of generative emergence, effectively emphasising the attractor—a key fundamental in complexity science that denotes a state or condition toward which a system organically evolves. Figure 3 illustrates the ripple effect propagating over time, transitioning from a transiently stable structure to a gradual decay state, forming value sinks where information and values accumulate. These value sinks serve as the foundation for new attractors, anticipating the next reorganisation phase. This process exemplifies a shift towards increasing disorder and chaos through repetitive cycles. In complexity science terminologies, this phenomenon highlights the dynamic interplay between stability and decay, as localized accumulations of resources and information (value sinks) lead to the emergence of new attractors, driving the system through continuous cycles of order and disorder.

This illustrative metaphor succinctly captures the dual phenomena of the emergence of new structures and patterns within a system. It highlights the intrinsic dynamics of change and stability in complex systems, illustrating the necessity for leaders to embrace a ‘ripple’ mindset to navigate the complexities inherent in these systems adeptly; in this context, Lichtenstein’s (2020) discourse on generative emergence underscores that the recognition of new emergent phenomena from systemic interactions necessarily implies an accompanying entropic decay—echoing the laws of thermodynamics where any system’s emergence or order is balanced by a loss or dispersal of energy elsewhere. This paper reinforces the concept of a ‘ripple mentality’, where the emergence of order or novelty within a system must be viewed in tandem with concurrent processes of decay or transformation elsewhere within the system. Presenting this process as a waveform underscores complex system dynamics' nonlinear, iterative nature. It highlights the feedback loops and interactions that drive the system through repetitive cycles of creation and decay. In this context, value sinks are pivotal in concentrating resources and information, catalysing new attractors' emergence. However, as these structures reach their limits, the system experiences entropic decay, redistributing value and setting the stage for the next cycle of generative emergence. This depiction aligns with the principles of complexity science, where systems are understood to evolve through continuous, dynamic interplay between order and chaos.

This dual understanding challenges traditional paradigms and enriches organisational and systemic change dialogue by suggesting that leaders and change agents must be aware of the potential for innovation and emergence and the inherent decay and transformation accompanying these processes. Therefore, to effectively manage change, it is necessary to have a comprehensive understanding of systemic interactions’ creative and destructive potential and the fact that organisational systems are in a state far from equilibrium.

The ‘space-between’ represents the dynamic interstitial spaces occurring in the self-organising phase, amplifying actions, where agents interact and exchange information, fostering the emergence of novel ideas and adaptive behaviours. Encouraging such interactions allows for the continuous recombination of resources, creating new structures and patterns

within the system. Sensemaking involves interpreting and understanding these emergent phenomena, while world-making refers to the active construction and reconfiguration of the environment based on these insights.

Nonlinear dynamics revolves around operating significantly from equilibrium, offering a valuable framework for comprehending how organisations may effectively handle change and complexity. This approach is supported by Strogatz's (2001) investigation of intricate networks, in which he elucidated the unpredictable nature of organisational behaviour that cannot be readily anticipated based on its constituent elements. Organisational leaders in this situation must understand how plans and actions impact the entire organisational network, which can result in significant and occasionally unforeseen consequences.

In such contexts, effective leadership necessitates the ability to swiftly adapt and proactively address the consequences of these cascading impacts. This encompasses responding to current issues and proactively shaping the organisation's trajectory to leverage these dynamics for the organisation's advantage effectively. By doing this, leaders may effectively navigate their organisations through transitions and adjust to new competitors as circumstances change.

A Conceptual Framework for Intentional Observer Effects in Complex Organisational Systems

This research study presents a theoretical framework that utilises complexity science-inspired principles to analyse agile leadership in intricate organisational systems. It argues that recognising the 'intentional observer effect' is crucial in leadership and decision-making procedures. Based on the ideas of interdependent relations and the observer effect, which are rooted in complexity science, this framework proposes that leaders, in their role as observers, actively influence organisational reality by engaging with the system.

The central thesis of this study posits that the efficacy of leadership observation and its subsequent influence on organisational systems is contingent upon the leader's level of observation, assimilation, and sensemaking. The ability of leaders to effectively self-organise, identify, utilise, and rearrange the resources and relationships inside the complex network of value sinks is of utmost importance in influencing profitable results (Figure 3). This nuanced approach suggests that leadership effects are differentially impactful across various systemic levels and contexts, depending on the leader's engagement and understanding of the tangled organisational matrix.

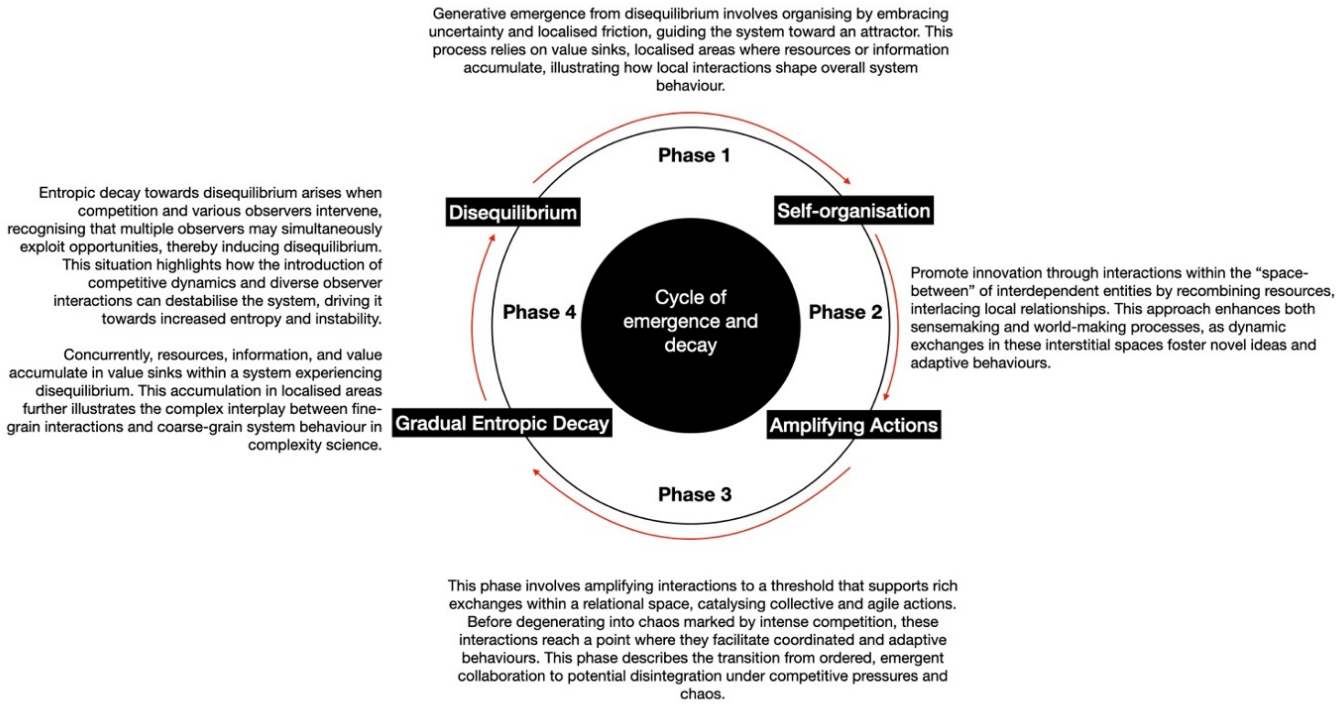

Figure 2. It illustrates the cycle of generative emergence and entropic decay adapted from (Lichtenstein, 2014) and (Hazy et al., 2023)

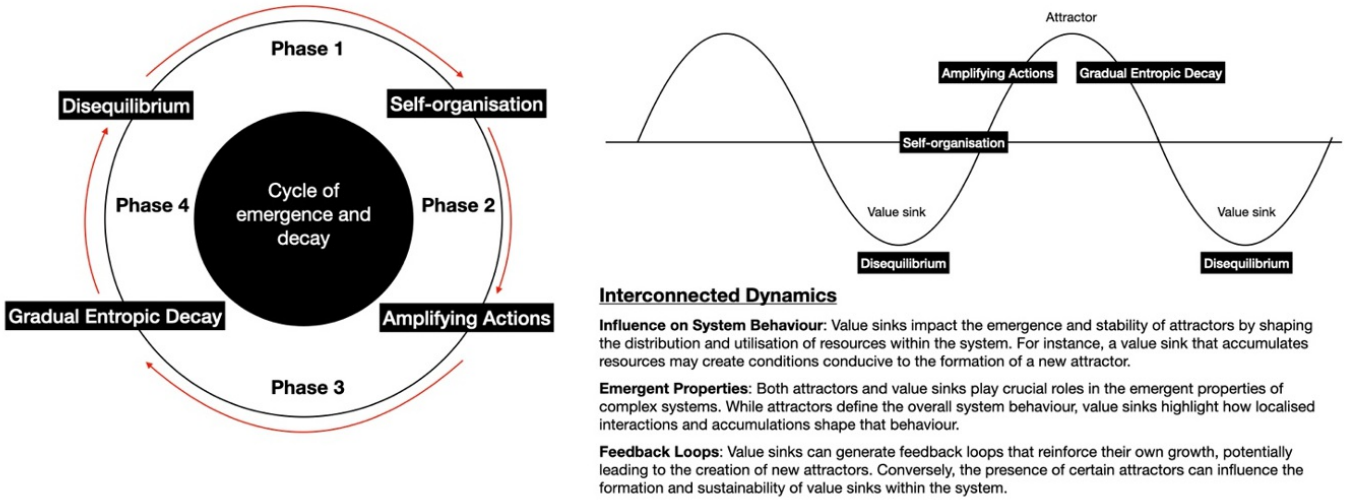

Figure 3. It illustrates the ripple effect of generative emergence and entropic decay adapted from (Lichtenstein, 2014) and (Hazy et al., 2023)

By highlighting the role of intentional observation in triggering generative emergence, the research underscores how strategic interventions by leaders can catalyse changes in subsystem configurations and functionalities. A strategically-

intentioned observer introduces a variable that significantly influences the interactions and integration of subsystems, facilitated by the leader's sensitivity to existing gradients and their proactive actions.

This exploration broadens the application of complexity science theoretical principles to organisational studies, offering a fresh perspective on leadership and decision-making in complex systems. The proposed framework emphasises the importance of leaders' awareness and strategic foresight in actively influencing organisational dynamics and outcomes. This approach provides a valuable conceptual tool for understanding leadership effectiveness in adaptive and interconnected environments, encouraging a deeper examination of the dynamic interplay between leaders and their organisational contexts.

Implications for Leadership and Organisational Strategy

Studying interdependent relations in complexity science significantly contributes to strategic organisational management and leadership discourse. Within this particular framework, interdependent relations serve a purpose beyond simply facilitating change. By exerting an influence on spatial and relational proximities, it dictates and shapes the relationships within an organisational system. Such a framework implies that leaders wield substantial influence over organisational processes' dynamics and eventual outcomes as observers and participants within this tangled nexus. This concept suggests that leaders, observers and players in this interconnected system have significant power to shape organisational processes' dynamics and ultimate results. This finding is consistent with the core tenets of complexity science, which posit that observation can alter the object's state under observation. Moreover, it enables leaders to exploit this dynamic for intentional organisational impact.

According to the suggested theoretical paradigm, leadership in complex systems emerges from the 'space between' individuals and their interactions. The emergence of leadership is not confined to a single person but comes from the dynamic combination of interactions and inherent tensions within the system. Based on the research conducted by Lichtenstein et al. (2006), this approach redefines leadership as a dynamic process that develops in the areas where different actors involved in collaborative efforts come together. The implications for organisational strategy are substantial, suggesting that effective leadership hinges on negotiating, exerting influence, and eventually aligning these relationships to develop a unified and adaptable corporate structure.

According to Leong (2024), the principles of self-organisation and entropy provide helpful insights for leaders regarding their practical relevance. Strategic organisational leadership involves the efficient use of resources and effective management of external limitations to establish a well-organised and flexible organisational environment, much like how the influx of energy results in the formation of structured patterns such as Bénard cells. This strategic skill can be compared to managing the movement of energy to minimise disorder within the system while improving operation and effectiveness.

Leaders can convert potential disruptions into structured growth and innovation by implementing methods that acknowledge and harness the innate order that emerges from seemingly chaotic situations.

The concept of intentional observer effects within complex organisational systems necessitates reevaluating leadership's role in shaping organisational dynamics. This perspective underscores the importance of leaders adopting a ripple mentality and behaving fluidly, possessing a deep understanding of complex organisational structures, to effectively harness and steer emerging characteristics and dynamics towards positive outcomes. It advocates for leaders to adopt a proactive stance, leveraging their strategic foresight and expertise to influence the design and functioning of subsystems intentionally. By doing so, leaders can adeptly navigate the inherent complexities within the organisation and guide these dynamics towards achieving long-term success in a constantly evolving business environment.

While this paper primarily builds its arguments on existing literature, it suggests avenues for future research, such as:

- Investigating how different types of interdependencies within an organisation influence its overall agility and performance.
- Examining the specific mechanisms through which leadership agility impacts organisational outcomes in various contexts.

Propositions for empirical testing include:

Proposition 1: Organizations with higher levels of leadership agility will demonstrate greater adaptability and resilience in response to environmental changes.

Proposition 2: Strong interconnectedness and feedback mechanisms within an organization will enhance its ability to achieve sustainable performance.

This discussion underscores the critical role of leadership in shaping organisational dynamics, emphasising the necessity for leaders to adopt a ripple mentality for fluid responses. Such a mentality involves influencing emergent properties and leveraging feedback loops to enhance system performance and resilience. Leaders must navigate complexity through keen observation, attuning themselves to attractors and persistently identifying value sinks. By responding with agility to these dynamic elements, leaders can effectively steer the organisation towards sustained success amidst evolving conditions. This approach aligns with complexity science principles, highlighting the importance of adaptive leadership in managing the complex interplay between local interactions and overall system behaviours.

Conclusion

The findings of this investigation on agile leadership within the context of complexity science demonstrate that the core of effective leadership lies in navigating the tangled nexus - a continuum rife with entangled interactions. Integrating agile leadership qualities with the knowledge of complexity science highlights the importance of adaptability and navigating through unexpected events in a changing organisational setting.

This study aims to recast the conventional notions of leadership by aligning them with the complex dynamism of organisational systems. Drawing on Lichtenstein et al.'s (2006) perspective, leadership is re-contextualised as a complex

phenomenon that emerges within the ‘spaces between’ or the tangled nexus between individuals and ideas through the interplay and the evolution of collective cognition and interaction. This tangled nexus is where strategic adaptability thrives, characterised by the complex exchange rules and tensions, like in the Bénard cell, that influence the organisational context. The strategic assembly of external resources (relationships and resources), as discussed by Leong (2024), can be likened to the self-organizing phenomena observed in thermodynamic systems. Metaphorically applied principles show the leadership of marshalling resources to forge order out of the chaotic market, like in the convection circulation formed by the dissipative structures. Self-organisation and dissipative structures become leadership beacons, manifesting as Lichtenstein’s (2014) generative emergence from the market’s disorder.

As organisations develop more internal states, they enhance their capacity for environmental responsiveness. As articulated by Kondepudi (2012), this increased interaction with the environment is intrinsically connected with transitional entropy production, signifying a system’s evolution towards complexity and goal-oriented behaviour.

In this context, leadership is an emergent property, dynamically sculpted by ongoing interactions within this tangled nexus. Every instance of interaction with each observation by a leader has a ripple effect on the system, potentially changing its path and impacting its future condition.

An organisation’s agility, therefore, is not a fixed attribute but rather a measure of its relative capability. An organisation’s collective competency and graded sensitivity in sensing, interpreting, and responding to the different gradients within its ecosystem characterise its dynamic reaction to external inputs.

Agility, thus, is contingent upon a leader’s ability to perceive and leverage the enabling factors within the tangled nexus, requiring a clarity of awareness that may encompass ‘Higher Consciousness Management’ as expounded by Maheshwari (2021).

This study contributes a novel perspective to organisational adaptability and strategic management discourse, advocating for agility that is not absolute but purposefully aligned with competitive advantage. An organisation’s ability to thrive in a competitive environment is shaped by its leader’s deliberate observations and response to the complex operational environment. This understanding of agility is a relative attribute that enables the organisation to flourish.

This paper presents a detailed understanding of agility as a characteristic that arises within organisations, considering the time and space they operate and the relationships and resources involved. By intentionally observing and taking action, this framework provides a comprehensive approach to navigating the complexities of business environments.

About the Author

David Leong, Ph.D., is an entrepreneurship theorist with more than two and a half decades of experience as an entrepreneur. He started his entrepreneurial ventures early, soon after graduating from the National University of Singapore in 1994 with a Bachelor of Business Administration degree. He has two PhDs – one from Charisma University and the other from the University of Canberra. He has founded at least fifteen

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Footnotes

[1] Higher Consciousness Management, as articulated by Maheshwari (2021), refers to a management paradigm rooted in the transcendental aspect of human experience that fosters spontaneous and ethically sound decision-making. This approach emphasises the cultivation of a heightened state of awareness that transcends conventional cognitive processing, enabling individuals to tap into deeper levels of consciousness that inform and guide their managerial actions. This concept suggests that management, when influenced by higher states of consciousness, becomes an act of service that extends beyond self-interest to consider the well-being of all stakeholders.

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