Requisite Resilience:

Towards a Definition

Emmanuel Muller [1,2,3], Marion Neukam [2], Lise Martins-Nourry [1,2], Mats-Benjamin Gnamm [1], Ksenija Djuricic [1,4], Didier Raffin [1,5], Thierry Burger-Helmchen [2,6]

[1] KIAF, University of Applied Sciences Kehl (Germany)
[2] BETA, University of Strasbourg (France)
[3] Fraunhofer ISI, Karlsruhe (Germany)
[4] EM Strasbourg, HuManiS, University of Strasbourg (France)
[5] Faculty of Psychology, University of Strasbourg (France)
[6] Faculty of Economics and Management, University of Strasbourg (France)

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Abstract: This paper introduces and defines the concept of *Requisite Resilience* as a way to better understand how systems and organizations can respond effectively to crises. Building on Ashby's Law of Requisite Variety, and extending the work of Boisot and McKelvey, the concept focuses not on managing complexity for its own sake but on maintaining functionality in the face of disruptive events. *Requisite Resilience* refers to the capacity of a system to balance internal variety with external disturbances, by mobilizing appropriate responses across multiple levels and actors. The paper positions resilience as a meta-capability, distinct from but related to existing notions of complexity and adaptability. A conceptual framework is proposed, highlighting the risks of both under- and over-resilience when internal configurations are misaligned with environmental challenges. While the concept remains in an early stage of development, this contribution seeks to open the field to further theoretical refinement, empirical testing, and managerial application. Future research directions include clarifying the links between resilience and systems, exploring the role of resources in resilience-building, deriving practical implications for managers, and assessing how contextual factors such as culture and organizational size shape resilience configurations.

Outline

1. Crisis and resilience in organizations and systems

Crises are an inherent part of all systems whether biological, institutional or societal. While some crises can be anticipated and mitigated, others are inevitable, requiring an effective response when they occur. The felt increasing frequency and severity of disruptions suggest that crises are becoming a repetitive but not specifically predictable feature of contemporary life. Extreme weather events, threats to critical infrastructure, large-scale migration movements, pandemics, energy grid failures, and the repercussions of conflicts are no longer hypothetical scenarios but tangible risks. Moreover, it is likely that new, unforeseen threats will continue to emerge (Borel, 1943; Roussie *et al.*, 2024).

At both the macro and micro levels, crises in international business can take various forms, ranging from global disruptions to internal organizational challenges. On a broader scale, companies must navigate risks such as global supply chain breakdowns, financial market instability, cyberattacks, and sudden regulatory shifts. Geopolitical tensions, trade wars, and shifting economic policies can abruptly alter market conditions, forcing firms to adapt rapidly. Systemic crises, like the 2008 financial collapse or the 2025 US Tax and Trade War, have demonstrated how interconnected markets amplify vulnerabilities, while unforeseen events, such as pandemics, expose weaknesses in production networks, workforce management, and strategic planning.

At the firm level, as businesses expand into new regions and embrace technological innovation, they must also confront ethical dilemmas, data privacy concerns, and the environmental consequences of their operations, all of which demand a higher degree of organizational adaptability and strategic foresight. At a more operational level, crises emerge within firms, disrupting internal processes, teams, and decision-making structures. Leadership transitions or executive misconduct can create instability, affecting both employee morale and investor confidence. Tensions between regional subsidiaries and headquarters may arise due to cultural differences, conflicting strategic priorities, or resource competition, leading to inefficiencies and misalignment. Additionally, sudden disruptions in key partnerships, such as the loss of a critical supplier or the failure of a joint venture, can jeopardize production schedules and market expansion efforts. Cybersecurity breaches, internal fraud, or compliance failures with international regulations can further damage a firm's financial stability and reputation.

While these crises differ in **scale**, they are **interconnected**, as external shocks often exacerbate internal vulnerabilities, requiring organizations to develop resilience across multiple levels.

Crises differ also in **nature** and **impact**, depending, among other factors, on the characteristics of the systems in which they occur. As a result, the resilience expected from the system as a whole may not be exactly the same as that required of the organizations operating within it (highlighting the multifaceted nature of the concept of resilience). Therefore, some systems demand structural robustness, others necessitate agile and adaptive responses at the

organizational level. However, as a starting point, resilience can be broadly defined as the ability to anticipate, absorb, and adapt to disruptions while maintaining essential functions.

Resilience is a multifaceted concept that has been explored across various disciplines, leading to diverse definitions and interpretations. In the context of organizational studies, resilience is often viewed as a dynamic capability that enables organizations to anticipate, prepare for, respond to, and adapt to incremental change and sudden disruptions in order to survive and prosper (Burnard *et al.*, 2018; Burnard and Bhamra, 2011). Duchek (2020) conceptualizes organizational resilience as a meta-capability comprising three successive stages: (1) anticipation, (2) coping, and (3) adaptation. This framework emphasizes the importance of not only responding to crises but also proactively preparing for potential threats and learning from past experiences to enhance future responses. Hillmann and Guenther (2021) further elaborate on this by highlighting resilience as a valuable construct for management research, underscoring its role in enabling organizations to survive and thrive amidst adversity or turbulence. They argue that resilience encompasses the capacity to absorb stress, recover critical functionality, and emerge stronger from crises. In a broader psychological context, Southwick *et al.* (2014) define resilience as a stable trajectory of healthy functioning after a highly adverse event. This perspective focuses on the individual's ability to maintain or regain mental health despite experiencing significant stress or trauma.

Given this evolving landscape of crises, strengthening resilience at both individual and organizational levels has become a necessity. This paper proposes a reconceptualization of resilience, mainly at an organizational level, introducing the concept of ***Requisite Resilience***. This perspective seeks to bridge existing gaps between the complexity-system literature and the burgeoning resilience works in economics and management.

This concept may enhance our understanding of how crises involving multiple layers and actors can be analyzed and addressed in practice. Given the diversity of crises and the variety of resilience definitions, there is a need for an approach that integrates both systemic and organizational responses.

The structure of the paper is as follows. The next section examines the academic literature on resilience, emphasizing its complexity, multidimensional nature, and the fragmentation of existing theories, which poses challenges for implementation. The discussion then shifts to corporate-level crises, applying Ashby's Law of Requisite Variety to explore how organizations can develop resilience strategies in response to dynamic environments. Based on these insights, a definition and a conceptual representation of *Requisite Resilience* are proposed. The paper concludes by outlining future research directions and potential applications of this framework.

2. Resilience: A multilayer cake

2.1 Some more definitions

Resilience remains a widely debated concept, with no single agreed-upon definition across academic disciplines. Even within the realm of economics and management sciences, resilience is understood in different ways and applied to various contexts (Olekalns *et al.*, 2020; Raetze *et al.*, 2021). While flexibility and agility emphasize adaptability under normal conditions, resilience is fundamentally about how systems or organizations respond to crises, manage disruptions, and potentially emerge stronger after the event (see Table 1).

	Lean	Agile	Resilience
Definition	Value creation through continuous improvement	Rapid response to a change in the company's business environment	Ability to absorb a shock (covid, major innovation of a competitor, etc.)
Objectives	Elimination of waste, simplification of processes	Consumer satisfaction, new configurations, products or services	Return to a desired previous situation in short-term (competitive situation...) + eventual long-term modification
Timing	Constant activity	Mainly in reaction to...	Anticipation
Result	Lower costs (price/profit impact)	Strategic Change + Innovation	Organizational Change + Innovation

Table 1: Broad definition of lean, agile and resilience (source: Burger-Helmchen *et al.* (2019))

The idea of resilience can be examined from different perspectives depending on the level of analysis. At the broadest scale, resilience relates to entire economies, industries, and geopolitical systems. Global financial crises, regulatory transformations, and climate-related disasters force countries, regions, and economic sectors to restructure and develop new strategies for stability. Cities and local economies also face resilience challenges as they respond to supply chain disruptions or local weather catastrophes.

At the corporate level, resilience is tied to a firm's ability to maintain stability and competitiveness amid disruptions. Large organizations must navigate geopolitical risks, technological advances, and financial volatility while ensuring operational continuity. Some scholars emphasize resilience as the ability to maintain performance despite external shocks, with organizations reorganizing internal structures to absorb disturbances (Han *et al.*, 2025; Oliveira *et al.*, 2025). Others view it as an ongoing process through which firms achieve favourable outcomes despite uncertainty (Vasi *et al.*, 2024). Additionally, research highlights the role of leadership, strategic decision-making, and workforce capabilities in fostering resilience at the firm level (Lengnick-Hall *et al.*, 2011).

Resilience is also crucial within companies at both operational and individual levels. Leadership changes, tensions between subsidiaries and headquarters, or the breakdown of key partnerships can destabilize activities. Internal risks such as cybersecurity breaches, regulatory failures, or financial mismanagement demand swift responses. Some definitions emphasize the rapid mobilization of resources and recovery of core functions (Hillmann and Guenther, 2021), while others see resilience as a broader capability to anticipate, respond, and adapt (Duchek, 2020).

A useful way to approach resilience is by considering its different dimensions, which together shape how an organization or system can withstand and adapt to disruptions. First, resilience involves anticipating risks before they materialize, allowing for proactive preparation and risk mitigation. This is particularly relevant for firms operating in volatile environments where external factors, such as new regulations, trade restrictions, or technological shifts, can disrupt business strategies. Second, resilience includes the capacity to absorb shocks and restore stability after a crisis, ensuring that disruptions do not cause lasting damage. In corporate strategy, this may involve adapting supply chain models, adjusting financial planning, or implementing contingency measures. Finally, resilience is also about long-term adaptation, where organizations not only recover but use crises as catalysts for transformation. Companies that integrate new technologies or develop more agile business models in response to disruption illustrate how resilience is not just about survival but about strategic renewal.

By bringing these perspectives together, this paper aims to define the concept of requisite resilience, providing a framework that considers the multiple levels at which resilience is relevant and how organizations can strengthen their ability to manage complex crises.

Box 2.1: Understanding Levels, Layers, and Dimensions in Organizational Studies

In organizational research, the concepts of levels, layers, and dimensions are frequently used to analyse complex systems. While these terms are sometimes used interchangeably, they carry distinct meanings and implications depending on the theoretical framework applied.

Levels refer to structured, hierarchical stages of analysis, ranging from the very macro (e.g., global economy, industries, and national policies) to the very micro (e.g., individual employees or specific business units). Within organizations, levels often align with formal decision-making structures (CEO, middle management, operational managers). However, the way these levels are organized depends on the company's strategy and cultural context. For instance, firms following an M-form structure have distinct strategic business units, while more centralized firms operate under a single corporate authority (Chandler, 1962).

Layers, in contrast, often emerge as a result of more organic and less structured processes. They represent different aspects of a system that may overlap or evolve over time, rather than being explicitly predefined like levels, hence the feeling that layers are pilled rather than purposefully designed. For example, in a multinational corporation, informal networks of influence or knowledge-sharing may create layers of decision-making that do not correspond directly to formal hierarchical levels. Similarly, in strategic management, firms operate in

multiple layers of competitive environments (industry dynamics, technological ecosystems…), which may not align neatly with traditional levels of analysis (Burger-Helmchen *et al.*, 2019).

Dimensions provide a different analytical perspective. Rather than representing hierarchy or structure, dimensions are categories used to analyze an object based on a set of characteristics. For example, in organizational resilience studies, resilience can be examined across dimensions such as (financial robustness, technological adaptability, leadership effectiveness). Similarly, in corporate strategy, firms are often analyzed across dimensions such as (market positioning, innovation capability, supply chain resilience) (Burger-Helmchen *et al.*, 2019).

The trend in recent management research is increasingly toward multi-level analysis to capture the complexity of organizational and strategic dynamics. For instance, studies on ambidexterity now extensively incorporate multi-level approaches, examining how firms balance exploitation and exploration across (corporate, business unit, individual) levels (Birkinshaw and Gupta, 2013). Similarly, research on microfoundations or dynamic capabilities seeks to bridge firm-level strategic responses with individual-level behaviors, emphasizing the interaction between (top management decisions, organizational routines, employee competencies) (Eisenhardt *et al.*, 2010). These perspectives reflect a broader movement toward integrating different analytical levels, reinforcing the need to distinguish between levels, layers, and dimensions while recognizing their interdependence.

In this work, we will speak interchangeably of levels and layers. Even if this may seem confusing at first, distinguishing between the two can be difficult in some applications, where intimate knowledge is required to understand how they have come into existence and whether they are path-dependent etc. Without this specific information, we prefer to use them interchangeably.

2.2 A complex systems view on resilience

Complexity theory builds on the study of subsystems, extending the systemic approach to account for the interdependencies and feedback loops that shape organizations and their environments. It examines the relationships between different components, the cause-and-effect dynamics between individuals and structures, and the time delays in responses, all of which create reciprocal influence mechanisms that must be understood and managed (Heraud *et al.*, 2019). Complexity arises from the numerous feedback loops that connect elements within a system (a concept sometimes visualized as a "*plate of spaghetti*" when representing large systems).

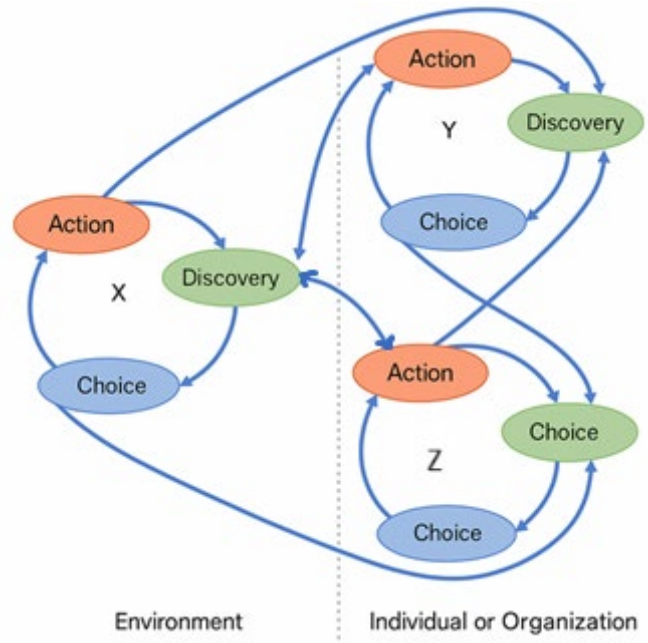

Figure 1 : A typical system approach, source: Burger-Helmchen *et al.*, (2019)

For instance, in Figure 1, consider a system with three entities: X, Y, and Z. From the perspective of X, the environment consists of Y and Z. X must interpret the actions of Y and Z and decide how to respond. However, X's response will, in turn, influence Y and Z, prompting them to react and adjust accordingly. This cycle of actions and feedback can continue indefinitely, creating a web of interdependent interactions. Complex systems are composed of numerous such interactions, many of which are not fully identified, nor necessarily planned, by those within the system or are related to sub-systems.

A defining feature of complex systems is that they are nonlinear, small changes in one part of the system can have disproportionate and sometimes unpredictable consequences elsewhere. Unlike deterministic systems, where inputs and outputs are directly linked in a predictable fashion, complexity implies that similar initial conditions can lead to vastly different outcomes due to emergent properties and unforeseen interactions. This unpredictability is further amplified by adaptive behaviour, as entities within the system learn from past events, modify their strategies, and influence others in return.

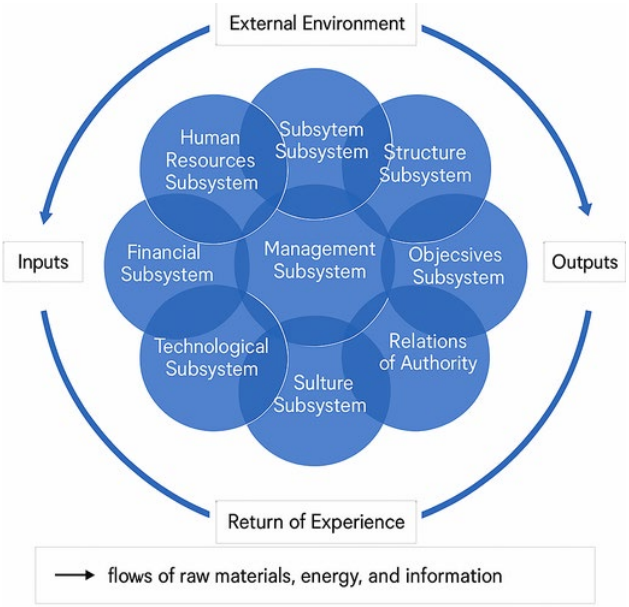

Figure 2 : A typical corporate sub-system decomposition, source: Burger-Helmchen *et al.*, (2019)

In such systems (an even more if they are open systems), complexity is heightened by the fact that external conditions are in constant flux. Political, technological, environmental, and social changes reshape the boundaries of what is possible, requiring continuous adaptation. Unlike closed systems, where external factors play a minimal role, open systems remain in constant interaction with their surroundings, making them inherently dynamic. The growing body of research in complexity studies seeks to better understand how such systems maintain equilibrium, evolve, or undergo structural transformations over time.

Another important notion linked to complexity is self-organization, the spontaneous emergence of order from interactions among system components, without centralized control. Self-organization can be observed in biological ecosystems, economic markets, and social institutions, where patterns emerge from the bottom up rather than being imposed from above. It is a key reason why complex systems are often resistant to rigid, top-down interventions and instead require mechanisms that allow flexibility and adaptability.

Understanding complexity challenges linear and reductionist approaches that attempt to isolate single causes for observed phenomena. Instead, it encourages a holistic perspective, acknowledging that systems must be analysed as wholes rather than as collections of independent parts. But the “manager” needs to recognize the importance of each part, each actor. Whether examining global supply chains, financial markets, environmental systems, or social structures, complexity thinking offers a way to better comprehend the uncertainties and interdependencies that define modern systems.

Understanding complexity has significant managerial implications. In human resource management, for example, organizations may prioritize hiring employees with strong adaptability and broad skill sets to better navigate unpredictable changes (Robertson *et al.*,

2015; Rodríguez-Sánchez *et al.*, 2021). In corporate strategy and production management, firms may focus on building ecosystems and establishing resilient relationships with suppliers to ensure flexibility and responsiveness to external shocks (Heraud *et al.*, 2019). Since interactions within complex systems are nonlinear, outcomes become harder to forecast, reinforcing the need for adaptive management strategies.

The complexity of systems is not only defined by their nonlinear interactions and adaptive behaviours but also by the multiple levels at which these interactions take place. In open systems, different actors operate at various levels, ranging from global institutions and national governments to firms, teams, and individuals, each responding to and influencing the environment in their own way. Some interactions emerge spontaneously, driven by self-organization and decentralized decision-making, while others result from deliberate coordination and structured governance. The coexistence of these dynamics generates a high degree of variety, as different entities interpret, react to, and shape the system based on their unique constraints, resources, and objectives[1].

This variety in actors, decision-making processes, and external pressures contributes to the overall complexity of the system, requiring appropriate mechanisms to manage and respond to it effectively. The greater the diversity of challenges, uncertainties, and influences within a system, the greater the need for adaptive responses capable of addressing them. This brings us to the principle of requisite variety formulated by Ashby (1956), which establishes that in order to maintain control and stability, a system must possess at least as much variety in its internal configurations and responses as exists in its external environment. Without this balance, the system is unable to regulate itself effectively, making it vulnerable to disturbances.

In section 3, we explore Ashby's Law of Requisite Variety in greater depth, examining how different configurations of response mechanisms can be aligned with the diversity of challenges that systems face. This discussion provides the foundation for understanding how organizations, institutions, and broader socio-economic systems can enhance their ability to cope with uncertainty, maintain functionality, and adapt over time.

3. Only Variety Can Absorb Variety: From Systems to Adapted Responses

As complexity grows within systems, whether they be organizations, markets, or broader socio-economic structures, so too does the variety of challenges they must navigate. This variety is shaped by multiple actors operating across different levels, from global institutions to individual decision-makers, each responding to and influencing their environment. Some of these responses emerge spontaneously, driven by self-organization, while others result from deliberate governance and strategic planning. The interaction of these elements generates a

[1] An additional layer of complexity arises when solutions applied at different levels move in divergent or even contradictory directions. For instance, during an earthquake in Mexico, while local populations sought to self-organize and enter the ruins to rescue people, the military intervened to block access and expel them. This led to delays in providing aid, as efforts were diverted into conflicts rather than collaboration (Solnit, 2010)

dynamic and unpredictable environment, requiring systems to develop internal mechanisms capable of responding effectively to external complexity.

This necessity is captured by W. Ross Ashby's *Law of Requisite Variety*, which posits that for a system to maintain control and stability, its internal variety must at least match the variety present in its external environment. Without this balance, systems become overwhelmed by complexity, unable to regulate disturbances effectively. The implications of this principle extend far beyond its original cybernetic[2] context, finding applications in organizational design, strategic management, public policy, and crisis response.

Building on Ashby's work, later scholars such as Max Boisot and Bill McKelvey expanded the concept, suggesting that only complexity can effectively counter complexity. This idea is particularly relevant when examining how firms, institutions, and governance structures configure their decision-making processes, operational flexibility, and strategic adaptations to cope with uncertain and volatile environments. They introduced the concept of the Ashby Space[3], a framework that illustrates how different levels of variety both in stimuli and responses, determine whether a system remains stable, adapts, or fails under pressure (Boisot and McKelvey, 2011).

A critical challenge in applying the law of requisite variety is striking the right balance. If an organization, institution, or system lacks sufficient internal complexity, it will struggle to cope with external shocks. Conversely, if internal complexity exceeds what is necessary, inefficiencies and decision paralysis may arise. This balancing act is particularly visible in multinational corporations, where firms must adapt to diverse regulatory environments, cultural differences, and economic fluctuations while maintaining cohesion across their global operations. Similarly, in intercultural teams, a well-managed diversity of perspectives enhances problem-solving capacity, but if misaligned, it can lead to miscommunication and inefficiencies.

This section explores how the law of requisite variety applies to managing complexity across different levels of decision-making and adaptation. The discussion begins with an overview of Ashby's principle, followed by an examination of how various systems, ranging from businesses to policy frameworks, configure their internal variety to respond effectively to external complexity. Through this, we lay the groundwork for understanding how requisite variety serves as a foundation for resilience and adaptive stability in an increasingly unpredictable world.

3.1 The Law of Requisite Variety

[2] Cybernetics was defined by Wiener (1948) roughly it is the science of control and communication between the living and machine worlds.

[3] This work draws heavily on the contributions of Boisot and McKelvey. However, their focus was on complexity rather than resilience, emphasizing the cognitive aspects of individuals, which is not the core of our approach.

Variety, as defined by Ashby, refers to the number of distinguishable states a system can take. The more possible states a system can recognize and respond to, the greater its ability to regulate itself in response to disturbances. If a system lacks sufficient internal variety, it becomes vulnerable to instability, unable to manage external complexity, and at risk of failure. Conversely, if a system has excessive variety beyond what is necessary, inefficiencies, misalignment, and decision paralysis can arise.

Ashby illustrated this principle using a simple analogy: a fencer facing an opponent with multiple attack strategies must have at least as many defensive manoeuvres available in order to parry effectively. If the fencer only has a limited set of responses, they will eventually face an attack they cannot counter, leading to defeat. The same logic applies to any complex system, whether it is an organization navigating market volatility, a government responding to economic shifts, or a team managing intercultural collaboration.

The variety faced by corporations or politicians like city mayors' manifests in the numerous states they must navigate to remain effective in their roles. A multinational corporation, for instance, must respond to fluctuating market conditions, shifting consumer preferences, regulatory changes across jurisdictions, technological disruptions, supply chain vulnerabilities, and geopolitical risks. These factors introduce a wide range of scenarios, some requiring minor operational adjustments, others necessitating full-scale strategic shifts. If a corporation lacks sufficient internal variety in its decision-making structures, workforce expertise, or technological adaptability, it risks being unable to respond effectively, leading to financial losses, market erosion, or operational breakdowns. At the same time, too much variety in decision-making structures can also generate contradictory choices and coordination failures, which may undermine resilience if not properly managed. To mitigate these risks while still enhancing adaptability, firms often develop flexible decision-making frameworks, diverse leadership teams, decentralized operational models, and digital transformation strategies to increase their internal variety and match external complexity (Teo *et al.*, 2017).

Similarly, a city mayor operates within a dynamic and often unpredictable environment where external variety emerges from economic trends, demographic shifts, infrastructure demands, environmental crises, and social tensions. Mayors must manage both long-term urban planning and immediate crisis responses, dealing with challenges such as natural disasters, public health emergencies, and political unrest while ensuring stable public services. A governance structure lacking the requisite variety will be unable to anticipate or react to these pressures, resulting in inefficiencies, inadequate public policies, or loss of public trust. To enhance their adaptive capacity, cities implement smart governance systems, multi-stakeholder decision-making processes, digital infrastructure for real-time urban management, and cross-sector partnerships to better absorb and process environmental complexity.

Both corporations and city governments must find a balance between centralization and decentralization to effectively manage variety. A corporation that imposes the same rigid strategy across all subsidiaries may fail to address specific local challenges, leading to inefficiencies or non-compliance, whereas excessive autonomy without coordination risks fragmentation and strategic misalignment. Likewise, a city with overly centralized decision-

making may struggle with slow responses in emergencies, while excessive decentralization can lead to inconsistency in service delivery. While Ashby's analogy with sport emphasizes the role of a single decision-maker to ensure coherence, organizational and governance settings often require a more distributed approach, which increases responsiveness but also demands mechanisms of coordination to avoid contradictory actions. The challenge is therefore to design organizational and governance configurations that ensure a sufficient level of internal variety to match external diversity, allowing for both stability and adaptation in complex environments.

The principle has been extended and adapted by scholars such as Max Boisot and Bill McKelvey, who reframed it as "only complexity can counter complexity." (Boisot and McKelvey, 2011). Their concept of the Ashby Space illustrates the relationship between the variety of stimuli a system encounters and the variety of responses it can generate. They argue that systems must operate within a range where response variety is at least equal to environmental variety. If external complexity surpasses internal capabilities, the system will fail to adapt. If internal complexity significantly exceeds external demands, resources are wasted, and decision-making becomes inefficient.

The law of requisite variety also applies to public governance and policy-making. Governments operating in dynamic, multi-stakeholder environments must develop institutions that can process diverse forms of information, anticipate emerging issues, and implement responses that match the complexity of societal challenges. A highly bureaucratic system with rigid processes may struggle to respond to rapid economic or technological changes, while an overly flexible system may lack the structure needed for coherent long-term planning. The concept of requisite variety helps explain why some governance structures are more resilient than others in the face of crises.

The next sections will explore how different systems, businesses, institutions, and governance frameworks, configure their internal variety to align with external complexity. This discussion will highlight the mechanisms used to regulate variety and ensure adaptive and effective responses to change. Understanding how requisite variety is applied in different contexts provides a foundation for thinking about resilience and strategic flexibility in an increasingly unpredictable world.

Box 3.1: Ross Ashby, works and legacy

W. Ross Ashby (1903-1972) was a British psychiatrist and one of the pioneers of cybernetics, a field that emerged in the mid-20th century to study systems, feedback loops, and self-regulation in both machines and living organisms. His most influential contribution, the Law of Requisite Variety, was introduced in *An Introduction to Cybernetics* (1956). This principle states that a system can effectively regulate another system, or its environment, only if it possesses at least as much variety in its internal responses as the variety present in its external challenges. In essence, complexity must be met with equivalent complexity for a system to maintain control and stability.

Ashby's work was developed during a period of intellectual expansion in systems thinking and decision sciences, and it shares conceptual parallels with the ideas of Herbert A. Simon (1916-2001), an economist and cognitive psychologist known for his theories on bounded rationality and decision-making in complex environments. While Ashby focused on the structural and regulatory aspects of systems, Simon explored how individuals and organizations make decisions under conditions of limited information and cognitive constraints (Simon, 1945, 1969). Both scholars contributed to the understanding of adaptive systems, Ashby through the necessity of internal variety to match external complexity and Simon through the practical limits of human decision-making in managing such complexity.

Over time, W. Ross Ashby's Law of Requisite Variety has significantly influenced various domains, including corporate strategy, international business, and innovation management. His insights have been widely applied beyond cybernetics, particularly in organizational theory, strategic management, and governance. In corporate strategy, his principle is reflected in organizational flexibility, risk management, and adaptive business models, where firms must structure themselves to respond effectively to market volatility, technological disruptions, and regulatory changes. Notable works have built upon Ashby's principles to examine their relevance in different organizational contexts. Ghoshal and Nohria (1989) explored the application of Ashby's Law in managing relationships between corporate headquarters and divisions within multinational corporations, arguing that performance is enhanced when there is a fit between environmental variety and organizational structure. On a different topic, Bartel-Radic and Lesca (2011) questioned the relevance of Ashby's Law in the context of intercultural teams and extreme teaming, analysing how these teams adapt to environmental complexity. Another well-known example is Boisot and McKelvey (2011), who revisited Ashby's Law to discuss its implications for managing complexity in organizational environments. Similarly, in public administration and policymaking, requisite variety informs how institutions must adapt to social and economic complexity, balancing centralized control with decentralized flexibility to address diverse challenges. Across these fields, Ashby's work continues to serve as a foundation for understanding how organizations and decision-makers must align their internal configurations with external uncertainties to maintain stability and effectiveness in an increasingly unpredictable world.

3.2 Variety in Complex Systems and Multi-Level Interactions

Complex systems are characterized by the interaction of multiple actors operating at different levels, each responding to environmental complexity in their own way (and not all actors are known before the crisis occurs). These interactions may be structured or spontaneous, creating a dynamic landscape where variety continuously emerges. In such environments, decision-making processes must account for the fact that no single actor has complete control over outcomes. Instead, organizations, institutions, and individuals must constantly adjust their strategies to match the complexity of their surroundings. **Resilience is born out of this constant adjustment.**

- At a macro level, global institutions, national governments, and industries face external variety stemming from economic fluctuations, geopolitical shifts, regulatory transformations, and technological change. For example, multinational corporations must

navigate trade barriers, currency fluctuations, and shifting market demands, all of which require tailored responses in different regions. The external complexity they encounter is amplified by the fact that different markets, political systems, and cultural expectations generate distinct pressures that must be managed simultaneously (Ghemawat, 2011).

- At the meso level, firms, cities, and public institutions encounter variety through interactions with stakeholders, competitive dynamics, and evolving societal expectations. A multinational corporation must coordinate across subsidiaries that operate under different legal and economic conditions. Similarly, city governments must manage urban development, infrastructure demands, and social policy, adapting to economic cycles and demographic changes. In both cases, organizations must integrate diverse perspectives and balance competing demands to ensure stability and effectiveness (Ghemawat, 2018).
- At the micro level, decision-makers within organizations, whether corporate executives, middle managers, or municipal officials, face complexity in their immediate operational environments. They must process information from multiple sources, assess risks, and develop responses that align with both internal priorities and external conditions. For instance, a corporate strategy team may need to decide whether to standardize or localize business practices across different markets, balancing efficiency with responsiveness. A city administrator, on the other hand, may need to adapt local policies to address emerging community concerns while maintaining alignment with national regulations (Ghemawat, 2007; Neukam and Bollinger, 2022).

These different levels of complexity interact with one another, creating an environment where variety is constantly generated and redistributed. The variety present in the external environment does not remain static; it evolves as different actors respond to changing conditions. Organizations, therefore, must continuously reassess their internal structures and decision-making processes to ensure they have the necessary variety to absorb and regulate external complexity.

The coexistence of structured and spontaneous responses within complex systems further complicates the challenge. Some mechanisms are deliberately designed to manage complexity, such as corporate governance frameworks, strategic planning processes, and regulatory policies. Others emerge organically, as seen in the evolution of informal networks, shifting market dynamics, or grassroots political movements. In multinational corporations, this balance is reflected in the tension between centralized decision-making and local responsiveness. A firm that imposes uniform policies across all subsidiaries may struggle to adapt to local challenges, while excessive autonomy can lead to inefficiencies and fragmentation. Similarly, in urban governance, city administrations must balance top-down policy directives with decentralized, community-driven initiatives that respond to localized needs (Seker, 2024).

The next section will explore how different systems configure their internal variety to manage these complexities effectively. Understanding how organizations, institutions, and governance structures align their decision-making frameworks with external variety is essential for ensuring adaptive and resilient responses in an increasingly uncertain world.

3.3 Configurations of Requisite Variety in Response to Uncertainty

Uncertainty is a defining characteristic of complex systems, affecting organizations, institutions, and individuals across multiple levels. As external complexity increases, systems must develop internal mechanisms that match this variety to maintain stability and effectiveness. However, the ability to regulate uncertainty is not confined to a single level of analysis. Organizations, teams, and individuals interact dynamically, creating interdependencies that shape how resilience is developed and maintained.

The framework proposed by Raetze *et al.* (2021) (Figure 3) highlights how resilience operates at multiple levels within an organization, showing how individual, team, and organizational resilience are interconnected. Their model outlines how antecedents (such as resources, competencies, and leadership) shape resilience, which in turn influences outcomes (such as performance, creativity, and well-being). However, while this intra-organizational perspective provides valuable insights into how resilience is structured within firms, it does not fully capture the external pressures that extend beyond organizational boundaries.

Beyond the firm level, external uncertainty arises from geopolitical shifts, technological disruptions, market volatility, and social and environmental changes. These external forces do not act in isolation; rather, they interact with organizational and individual dynamics in unpredictable ways. A multinational corporation, for example, must simultaneously manage internal coordination among its subsidiaries and adapt to external regulations, market conditions, and technological advancements. Likewise, public institutions and municipal governments must align their internal governance structures with changing economic conditions, demographic trends, and policy constraints. The complexity of these interactions suggests that resilience cannot be understood solely within fixed organizational boundaries.

To address this challenge, the concept of *Requisite Resilience* extends beyond intra-organizational resilience by acknowledging the need for adaptive capacity across multiple levels. Unlike fragmented resilience strategies that focus on isolated components, such as an individual's ability to cope with stress, a firm's crisis management plan, or a government's emergency response, *Requisite Resilience* is concerned with how these elements interact in a systemic and multi-actor environment. It requires configurations that integrate individual, team, and organizational resilience while remaining responsive to broader systemic pressures.

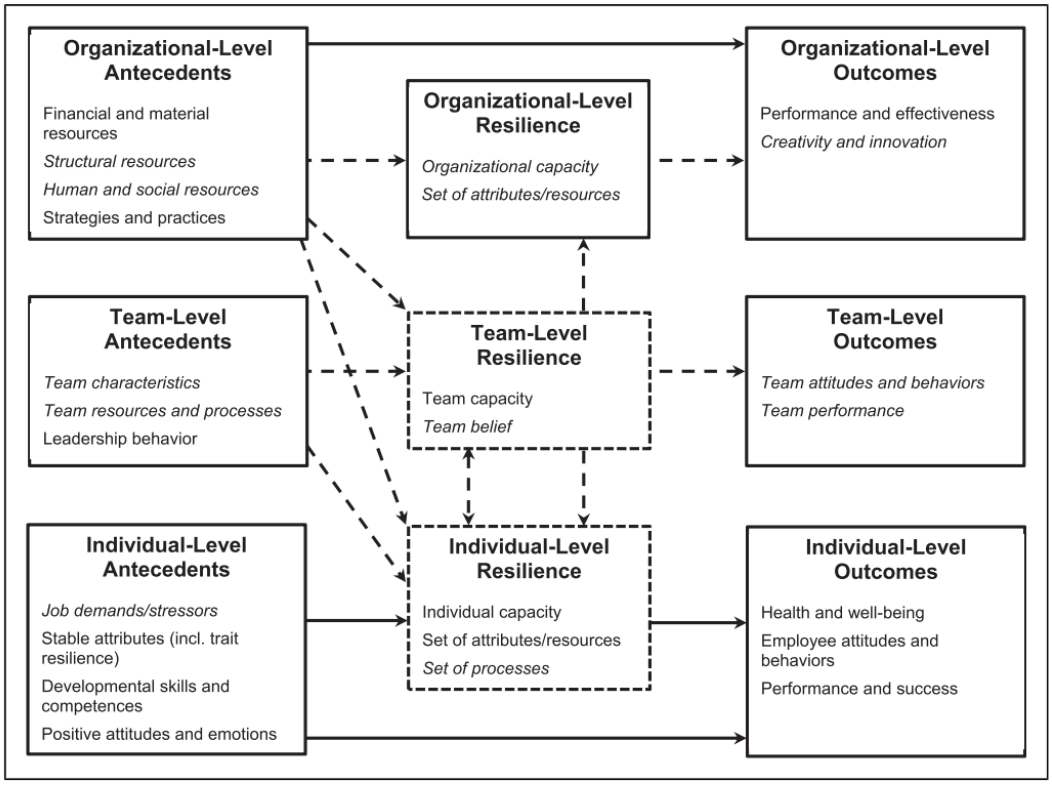

Figure 3: A multilevel framework for organizing research on resilience in organizations (source: Raetze *et al.* (2021))

Requisite Resilience can be conceptualized through three key principles:

1. It requires the integration of multiple levels of response, ensuring that resilience is not limited to a single domain but distributed across interconnected systems;
2. It emerges from an effective multi-actor governance approach, where organizations, governments, and other stakeholders coordinate their responses to external uncertainty; and
3. It should be viewed as a meta-capability, enabling continuous adaptation and learning rather than being a static trait.

Those principles have be developed by Muller *et al.* (2024). This document shares several foundational definitions and objectives with that work introducing *Deep Resilience*.

This broader understanding of resilience allows us to bridge the gap between intra-organizational perspectives and the realities of external complexity. As uncertainty increases, the need for *Requisite Resilience* becomes more apparent, leading us to the next section, which explores its conceptual foundations and practical implications.

4. The Ashby space

As uncertainty grows in complex systems, organizations, institutions, and individuals must develop mechanisms that align their internal variety with external challenges. This section builds upon Ashby's Law of Requisite Variety and its extensions by Boisot and McKelvey to explore how requisite variety can be conceptualized in a broader framework of resilience.

4.1 Variety and different regimes

Ashby's work on requisite variety provides a foundational understanding of how systems regulate themselves in response to environmental complexity. In his original formulation, variety refers to the number of distinguishable states a system can take. To maintain control and stability, a system must possess at least as much variety in its internal responses as exists in the external environment. If the external variety surpasses the internal capacity to regulate it, the system risks instability and failure.

Boisot and McKelvey expanded upon Ashby's principle by introducing the concept of the Ashby Space (Figure 4), which graphically represents the relationship between a system's variety of responses and the variety of stimuli it encounters. In this model:

- The horizontal axis represents the variety of responses available to a system.
- The vertical axis represents the variety of stimuli from the environment.
- The 45-degree diagonal line represents the threshold of requisite variety, where response variety matches environmental complexity.

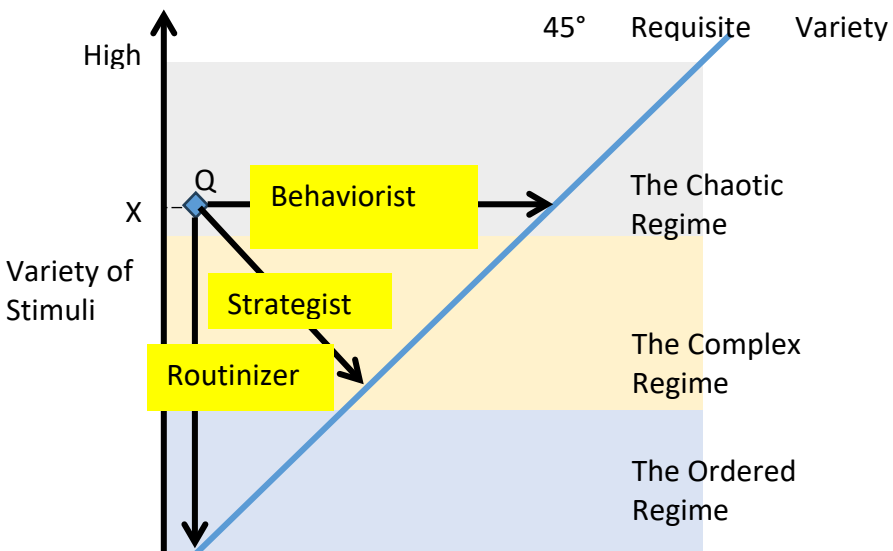

Figure 4: The Ashby space (Source: Boisot and McKelvey (2011))

If a system operates above the diagonal, external variety overwhelms internal adaptability, leading to breakdowns or failure. If a system operates below the diagonal, it possesses excess internal variety, potentially leading to inefficiencies, unnecessary complexity, or decision paralysis. The optimal position is on or near the diagonal, where response variety effectively counterbalances environmental stimuli.

The Ashby Space also introduces three different regimes in which systems operate:

- **The Ordered Regime** – A low-complexity environment where cause-and-effect relationships are clear and predictable, requiring minimal internal variety for regulation.
- **The Complex Regime** – A higher-variety environment where relationships are nonlinear and require dynamic adaptation. Responses need to evolve as patterns emerge.
- **The Chaotic Regime** – An extreme-complexity environment where no clear cause-and-effect relationships exist. Systems operating in this space must reduce external variety or develop entirely new response mechanisms.

4.2 Overcoming the adaptive frontier

A key concept in the Ashby Space is the **Adaptive Frontier**, which represents the **upper limit of a system's ability to process and regulate variety** (see Figure 5). Ashby emphasized that while systems must develop internal variety to match external complexity, there is a fundamental constraint on how much variety can realistically be managed. This constraint arises from the system's **information-processing capacity**: the ability to absorb, interpret, and respond to environmental stimuli.

The **Adaptive Frontier curve** illustrates this limitation by defining the boundary beyond which a system **can no longer effectively regulate external variety**. Any complexity that exceeds this frontier lies beyond the system's **"adaptation budget"**; meaning that it lacks the resources,

cognitive capacity, or structural flexibility to process and respond adequately. When external variety surpasses this threshold, the system risks becoming overwhelmed, leading to instability, decision paralysis, or failure.

One way to manage this challenge is through regulation and filtering mechanisms, which help reduce unnecessary variety before it reaches critical decision points. For example, organizations implement hierarchical decision-making structures, automated systems, or strategic prioritization frameworks to focus on the most relevant variables. However, if regulation is too rigid or fails to adapt, the system may miss important signals, resulting in inflexibility and slow response times.

The Adaptive Frontier highlights the need for a balanced approach, where systems must continuously refine their regulatory mechanisms, ensuring that they neither under-process critical complexity nor overwhelm themselves with excessive information. This concept is particularly relevant in contexts such as corporate strategy, crisis management, and governance, where leaders must navigate uncertain and rapidly evolving environments while maintaining decision-making effectiveness.

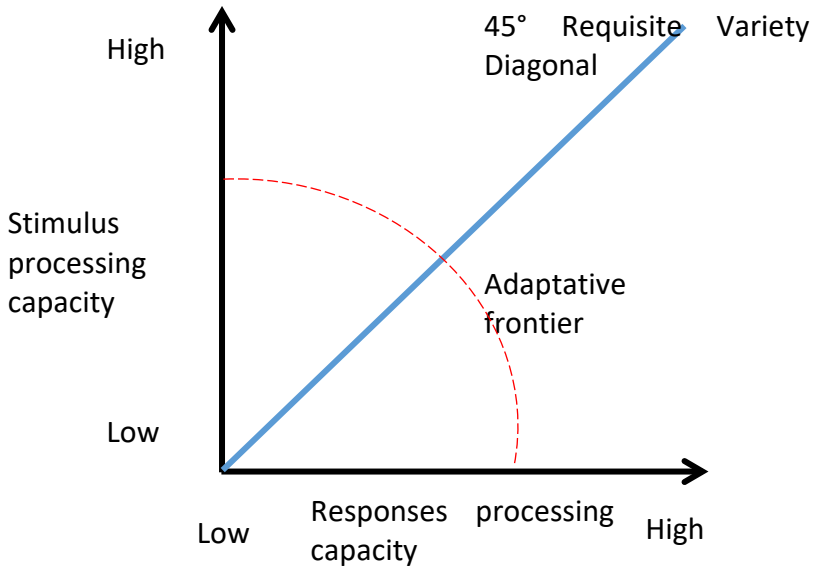

Figure 5: The adaptative frontier (Source: Boisot and McKelvey (2011))

Boisot and McKelvey describe three distinct ways in which a system or agent might respond to external stimuli, each reflecting a different approach to processing variety and maintaining adaptation (see Figure 4). These responses illustrate the challenges of managing complexity within the constraints of the adaptive frontier and demonstrate how different cognitive and strategic approaches influence an agent's ability to survive and thrive in a dynamic environment.

- The first type of response, often referred to as the headless chicken reaction, or **behaviourist**, occurs when an agent attempts to respond indiscriminately to all incoming stimuli without filtering or prioritization. This approach leads to an overwhelming variety of responses, pushing the agent beyond its adaptive frontier (the limit of its capacity to process and regulate complexity). Unable to allocate resources effectively, the system collapses under the weight of excessive input, failing to extract meaningful information and generate appropriate responses.
- In contrast, the **routinizer** takes an overly conservative approach, filtering out most of the incoming variety by relying on familiar patterns and past experiences. This type of agent assumes that all new stimuli fit within pre-existing categories, leading to a failure to recognize novel patterns or emerging threats. While this strategy can work in stable environments where past regularities remain relevant, it becomes a liability in dynamic or unpredictable settings, where misclassification and rigidity can prevent effective adaptation.
- The **strategist**, by comparison, takes a balanced and adaptive approach. Rather than reacting indiscriminately or relying too rigidly on past knowledge, the strategist filters out irrelevant noise while actively identifying meaningful patterns in the environment. This requires both recognizing regularities within the incoming data and developing new cognitive models when existing frameworks prove insufficient. As environmental complexity increases, the strategist ensures that their interpretation mechanisms evolve accordingly, refining schemas and adjusting responses to remain within the adaptive

frontier. This approach allows for effective complexity management, ensuring that the system neither underreacts nor becomes overwhelmed.

The Ashby Space provides a conceptual foundation for understanding how systems regulate complexity and manage the balance between excessive reaction and inflexible routine. The ability to distinguish meaningful information from noise is central to this process, allowing systems to filter, interpret, and respond efficiently to environmental stimuli. However, as Boisot and McKelvey emphasize, what is considered meaningful is not an objective property of the environment but rather a function of an agent's past experiences, cognitive models, and strategic priorities. This highlights the role of sensemaking (Weick, 1988), where organizations and decision-makers must continuously adjust their schemas to align with evolving external conditions.

Karl Weick and colleagues further argues that as complexity increases, so does the challenge of perception and interpretation. The greater the diversity of perspectives within a system, the more effectively it can recognize and process emerging patterns. However, this does not mean that a system must mirror the full complexity of its environment. As Boisot notes, not all environmental variety is relevant for survival, and much of it can be simplified or ignored without reducing effectiveness. The key is to develop mechanisms that selectively absorb variety where necessary while filtering out irrelevant complexity (Weick and Sutcliffe, 2007).

This perspective naturally leads us toward the concept of requisite resilience. If requisite variety is about matching internal complexity with external complexity, *Requisite Resilience* builds on this idea by emphasizing the dynamic, multi-level, and adaptive nature of resilience. Resilience is not just about possessing the right structures at a given moment but about continuously evolving in response to uncertainty. It is about distinguishing between reducible and irreducible complexity, knowing when to simplify and when to expand response capacity.

As we transition to Section 5, we will explore how these ideas can be adapted to a resilience framework. While Ashby's law provides a theoretical basis for managing complexity, ***Requisite Resilience*** requires changes some of the argument of Boisot and McKelvey and introduce some different measure that those exposed so far.

5. *Requisite Resilience* – Bridging Crisis, Complexity and Adaptation

5.1 Defining Variety of Levels/Layers and Variety of Actors

A key challenge in adapting Ashby's Law to resilience thinking is distinguishing between different types of variety that shape a system's capacity to respond to complexity. In particular, two fundamental dimensions of variety must be considered: **variety of levels/layers** and **variety of actors**. These two dimensions interact dynamically, influencing how systems absorb complexity, distribute responsibilities, and coordinate responses.

- **Variety of levels/layers** refers to the number of hierarchical, functional, or systemic layers within a system. This includes institutional hierarchies (e.g., global, national, regional, organizational, and individual levels), functional structures (e.g., finance, operations,

logistics, emergency response teams), and informal networks (e.g., stakeholder coalitions, grassroots initiatives, expert advisory groups). A system with a high variety of levels can distribute response functions across multiple points, which may enhance coordination and specialization but can also create bottlenecks and slow down decision-making during crises.

- **Variety of actors** refers to the number and diversity of decision-making entities involved in managing a crisis. These include governments, corporations, NGOs, local communities, and individuals, each bringing different perspectives, resources, and strategic priorities. More generally we can talk about knowing communities that are formed spontaneously after the crisis, turning a individuals, part of a crowd into a concern and wanting to act community glued together by a need. A high variety of actors can introduce diverse problem-solving approaches, increasing adaptability. However, if not well-coordinated, it can lead to fragmentation, conflicting responses, and inefficiencies in crisis management.

To formalize this relationship, we introduce a **variety ratio**, expressed as:

VR = Variety of Levels ÷ Variety of Actors

This ratio provides an indication of how complexity is structured within a system:

- **When VR < 1 (more actors than levels or layers)**: The system is actor-dominated. Multiple independent actors interact within a relatively shallow structural framework. This often leads to **decentralized, network-driven decision-making**, which can be highly adaptive but also chaotic if coordination mechanisms are weak.
- **When VR ≈ 1 (balanced levels and actors)**: The system has a roughly equal distribution of structural levels and participating actors. This is often an indicator of a **well-aligned governance system**, where decision-making capacity is neither too concentrated nor too fragmented.
- **When VR > 1 (more levels than actors)**: The system is structure-dominated. A deeply layered system with relatively few active decision-makers may indicate **bureaucratic** rigidity, slow adaptation, or an excessive focus on internal processes rather than external responsiveness**.**

This ratio helps frame a central challenge in resilience: ensuring that a system has both sufficient structural depth to manage complexity and enough actor diversity to generate adaptive responses. An imbalance in either direction can weaken resilience, either by over-centralizing decision-making in rigid hierarchies or by over-distributing control among too many uncoordinated actors.

5.2 Linking Internal Variety with Environmental Variety

While the **variety ratio (VR)** provides a way to quantify the distribution of complexity within a system, it remains an internal measure. It reflects how variety is structured across **levels/layers** and **actors**, but it does not capture the broader complexity that a system must absorb and respond to; namely the **variety of the environment**. In essence, the VR ratio is a computation for analysing the internal organization of variety**.**

This perspective aligns with Ashby's Law of Requisite Variety, which states that a system must have sufficient internal variety to regulate external disturbances. However, in real-world scenarios, variety is not a single-dimensional property, it emerges from multiple interacting sources. The ratio format of VR is not meant to suggest a rigid mathematical rule but rather to emphasize that internal variety is composed of multiple forms of complexity that must be balanced to achieve resilience.

The decision to use a ratio between levels/layers and actors stems from the fact that variety within a system is inherently multidimensional. The number of hierarchical layers and the number of participating actors are two fundamental sources of internal variety, but they do not exist in isolation. Instead, they shape each other:

- A system with many hierarchical levels but few active actors may struggle with slow decision-making, bottlenecks, and rigidity.
- A system with many actors but few structured levels may experience fragmentation, lack of coordination, or conflicting responses.

Thus, the **VR ratio acts as a simplified way to represent the balance (or imbalance) between different forms of internal complexity**. It does not claim to capture all dimensions of variety but rather provides an intuitive way to examine how a system structures its decision-making, governance, and response mechanisms**.**

The next logical step is to place VR in relation to the variety present in the system's external environment**.** No matter how well internal variety is structured, a system cannot be resilient if it is fundamentally misaligned with the external complexity it faces. This requires examining:

- The **number and diversity of external factors influencing the system** (e.g., market volatility, regulatory shifts, political instability, technological disruptions).
- The **pace of environmental change** (e.g., a system operating in a stable industry faces a different challenge than one in a high-uncertainty environment).
- The **degree of interconnection between external variables** (e.g., tightly linked global supply chains create cascading risks that increase complexity).

We propose representing environmental variety on the vertical axis, capturing the complexity, uncertainty, and number of external factors affecting a system. This dimension includes variables such as market volatility, regulatory shifts, geopolitical instability, technological disruptions, and ecological changes—all of which contribute to the system's external complexity. Meanwhile, the variety ratio (VR) is mapped as diagonal, reflecting how a system structures its internal complexity through the balance of levels/layers and actors. This approach allows us to visualize how different systems position themselves in relation to

external complexity and whether their internal configurations align with the variety they must process (See Figure 6).

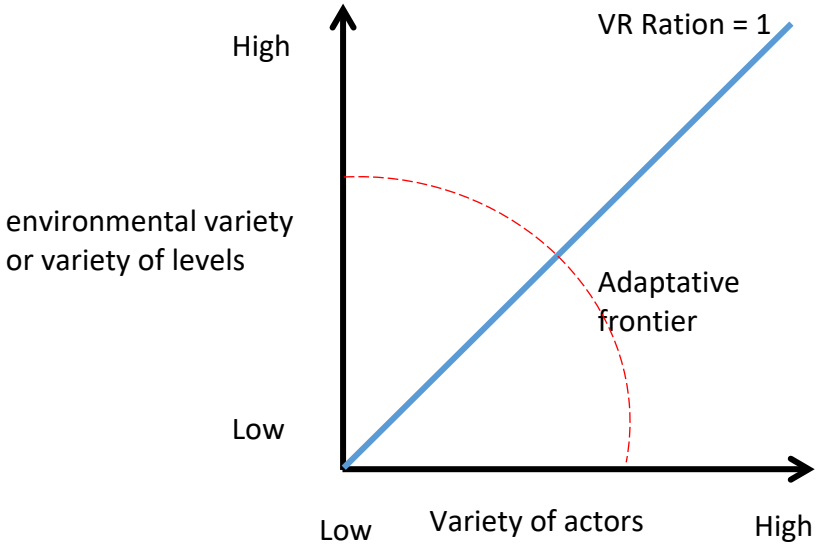

Figure 6: Towards a *Requisite Resilience* Representation

By adopting this representation, we can explore how different systems respond to varying degrees of environmental complexity. A system with low VR but high environmental variety may lack the internal coordination needed to manage complexity, leading to fragmentation or instability. Conversely, a system with high VR but low environmental variety may be overly structured for its external conditions, leading to inefficiencies or unnecessary rigidity. The key to resilience lies in finding an adaptive balance, where the internal variety of the system evolves in proportion to the complexity of the external environment.

This proposed mapping raises the question of whether it aligns with Boisot and McKelvey's representation of the Ashby Space. Their framework also uses a vertical axis to represent environmental complexity, but their horizontal axis represents the variety of responses available to a system. In our adaptation, the VR ratio serves as a proxy for response variety, but with a structural interpretation, linking response capacity to how variety is distributed internally rather than just measuring the absolute number of responses.

The fundamental logic remains consistent with Ashby's original principle: a system must adjust its internal variety to match external complexity. However, the way we express this relationship shifts the focus from individual decision-making to multi-level, multi-actor configurations. This adaptation helps integrate organizational resilience, governance structures, and institutional response capacity into the broader discussion of requisite variety.

As environmental variety increases, the complexity of external factors, such as economic shifts, technological disruptions, political instability, or ecological crises, grows. At lower levels

of environmental variety, systems can operate with relatively low internal variety, as the challenges they face are predictable and manageable. In this stage, organizations and institutions can maintain stable structures without requiring significant adjustments. However, as external variety continues to rise, a critical transition zone emerges, where the existing internal structures and decision-making frameworks may no longer be sufficient to process the complexity effectively.

A crisis does not necessarily emerge instantly but instead manifests when the system fails to adjust to the increasing complexity of its environment. This can happen due to slow institutional responses, rigid hierarchical structures, or a lack of coordination among actors. The point at which this transition occurs can be understood as a crisis threshold, beyond which external complexity overwhelms the system's ability to regulate itself.

By mapping environmental variety on the vertical axis and the variety ratio (VR) on the diagonal, and actors on the horizontal axis, we can visualize how different systems position themselves in response to increasing complexity. Those that fail to adjust remain below the diagonal, where they are vulnerable to collapse. Systems that align with the diagonal achieve requisite resilience, maintaining a balance between internal adaptation and external pressures. Those above the diagonal may be over-engineered, expending excessive resources on complexity management when simplification could be a more effective strategy.

5.3 From Requisite Variety to Requisite Resilience

While requisite variety provides a strong foundation for managing complexity, it does not fully account for the dynamics of crises and how systems must evolve to remain functional in the face of uncertainty. Crises emerge when environmental variety surpasses a system's adaptive capacity, forcing it to either reconfigure its internal mechanisms or risk failure. This shift requires a broader approach—requisite resilience—which extends the principle of requisite variety by integrating multi-level adaptation, continuous recalibration, and strategic sensemaking to ensure that systems can absorb shocks, adapt in real-time, and transform over the long term.

Requisite Resilience operates at multiple levels, requiring the coordination of individuals, teams, organizations, and institutions in shaping crisis responses. The ability to adjust internal variety to match external complexity is not just a structural issue but a cognitive and strategic challenge. Decision-makers must not only react to external disruptions but also interpret, prioritize, and refine their responses over time. This ability to make sense of complexity, what Karl Weick terms sensemaking, is a core component of resilience.

5.4 Building Requisite Resilience

Requisite Resilience is about balancing variety with resource efficiency, ensuring that systems neither underreact (becoming fragile in the face of crises) nor overreact (wasting resources on unnecessary complexity management). This is particularly relevant in corporate strategy, international business, crisis governance, and public policy, where organizations must navigate shifting environments while maintaining operational coherence and adaptability.

The transition from requisite variety to *Requisite Resilience* underscores the importance of adaptive governance, continuous learning, and multi-level coordination. Resilient systems do not simply survive crises; they evolve through them, using instability as a driver for structural and strategic transformation.

6. Conclusion

This paper set out to define and explore the concept of Requisite Resilience, with the aim of contributing to a better understanding of how systems and organizations respond to crises. *Requisite Resilience* refers to the capacity of a system to align its internal variety with external disturbances across multiple levels and actors. While the concept draws on Ashby's Law of Requisite Variety and extensions proposed by Boisot and McKelvey, it differs by shifting the focus from complexity to resilience in situations of rupture. When *Requisite Resilience* is not met, meaning internal variety is too low, the system becomes fragile and unable to absorb shocks. If internal variety exceeds what is needed, the result can be confusion, inefficiency, or loss of responsiveness.

This work remains an initial step, an attempt to mark a position in the ongoing discussion and to allow future developments. The concept, as it stands, is still logically incomplete and presents several limitations.

The next phase should aim to clarify and reduce the framework to its essential components before building it up again with greater precision. This includes 1/ a clearer distinction between resilience and systems, 2/ a better articulation of the relationship between resilience and the resources available to actors, and 3/ the development of actionable managerial insights. It will also be necessary to examine whether 4/ contextual factors such as organizational culture, AI or size influence the structure and relevance of the model.

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