CADRE CONCEPTUEL DU LEADERSHIP EN SURETE DANS LES ORGANISATIONS A HAUT RISQUE

FRAMEWORK OF THE LEADERSHIP FOR SAFETY IN HIGH-RISK ORGANIZATIONS

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Résumé — Malgré les progrès considérables réalisés pour assurer la sûreté grâce à diverses barrières techniques, les organisations à haut risque et fortement réglementées n'ont pas été épargnées par les accidents majeurs mettant en jeu les accidents mortels. De plus en plus d'éléments indiquent que ces accidents ne sont pas uniquement imputables aux limites des barrières techniques, mais plutôt au défi que représente la résolution de multiples tensions résultant d'interactions complexes entre les facteurs techniques, humains et organisationnels. Reconnaissant cette complexité, la littérature et les cadres réglementaires ont récemment mis l'accent sur le rôle du leadership. Cependant, même si le rôle du leadership dans la gestion des tensions organisationnelles est de plus en plus reconnu, la littérature sur le leadership en sûreté continue de considérer le leadership comme la capacité individuelle à définir et à atteindre des objectifs de sûreté, en ignorant sa nature processuelle et intégrée dans l'organisation. Nous mobilisons la théorie du leadership de la complexité et plus particulièrement son concept de leadership habilitant pour fournir une analyse plus nuancée des tensions à plusieurs niveaux et de leurs interrelations, qui va au-delà de la représentation des différentes logiques, mécanismes ou processus comme des extrêmes polaires irréconciliables. Grâce à une revue intégrative de la littérature scientifique et à une approche d'élicitation des connaissances des experts, nous développons un cadre conceptuel de tensions dynamiques et intégrées dans l'organisation, que les dirigeants devraient adopter pour améliorer la sûreté. En décryptant les dimensions de la complexité liées au leadership en sûreté, nos résultats contribuent au développement de futures pistes de recherche sur le leadership et guident des politiques et des réglementations plus nuancées dans les industries à haut risque.

Mots-clefs — leadership de la complexité, tensions, leadership en sûreté, encastrement organisationnel, industries à haut risque

Abstract — Despite substantial advancements in ensuring safety through various technical barriers, high-risk and highly regulated organizations have not been immune to major life-threatening accidents. Growing evidence indicates that these accidents are not soley attributable to the limitations of technical barriers but rather to the challenge of resolving multiple tensions arising from complex interactions among technical, human, and organizational factors. Recognizing this complexity, both the literature and regulatory frameworks have recently pointed to the role of leadership. However, even if the role of leadership in managing organizational tensions has been gaining ground, the literature on leadership for safety continues to view leadership as the individual ability to define and attain safety objectives, ignoring its processual and organizationally embedded nature. We mobilize complexity leadership theory and more specifically its concept of enabling leadership to provide a more nuanced analysis of tensions at multiple levels, and their interrelations, that go beyond depicting the different logics, mechanisms, or processes as irreconcilable polar extremes. Through an integrative literature review and an expert knowledge elicitation approach, we develop a conceptual framework of organizationally embedded and dynamic tensions that leaders should embrace to enhance safety. By unpacking dimensions of complexity related to leadership for safety, our findings contribute to the development of future research avenues on leadership and guide more nuanced policies and regulations in high-risk industries.

Keywords — complexity leadership, tensions, leadership for safety, organizational embeddedness, high-risk industries

I. INTRODUCTION

Due to their potential for major negative impacts on public health and the environment, high-risk organizations are heavily regulated and controlled (Hamer et al., 2021; Karlesky, 2012; Madsen, 2013; Nakamura & Kikuchi, 2011; Oliver et al., 2017; Starbuck & Farjoun, 2005). However, despite considerable progress in ensuring safety, in the past decades these organizations have not been able to avoid major accidents. There is strong evidence suggesting that these accidents resulted from the difficulty in resolving tensions stemming from complex interactions among technical, human, and organizational factors (Boin & Schulman, 2008; Guntzburger & Pauchant, 2014; Nakamura & Kikuchi, 2011; Oliver et al., 2017; Shrivastava, 1987; Starbuck & Farjoun, 2005; Vaughan, 2007). Nuclear power plants are emblematic of high-risk and highly regulated organizations that continually strive to enhance the safety of their operations and sometimes face challenges in doing so.

The international nuclear community has recently acknowledged the limitations of technical barriers in ensuring the safety of civilian nuclear activities. This acknowledgment has led to an increased consideration of organizational factors and leadership in international safety standards, as evident in the International Atomic Energy Agency's (IAEA) fundamental safety principles (International Atomic Energy Agency, 2016). However, even if the role of leadership in managing organizational tensions has been gaining ground, the dominant literature on leadership for safety continues to view leadership as the individual leader's ability to define and attain safety objectives. As a result, and notwithstanding significant improvements in understanding the processual and organizationally embedded nature of leadership for safety (Dinh & Lord, 2012; Tseng & Levy, 2019; Uhl-Bien et al., 2007), safety standards continue to largely rely on a classical, leader-centric vision of leadership. Recognizing this challenge, scholars advocate for the adoption of novel perspectives and the development of new theoretical frameworks to provide fresh insights into organizational embeddedness of leadership for safety processes. Shifting the focus to the impact of organizational dynamics on leadership for safety emphasizes the role of leaders' capacity to navigate ambiguities and address tensions.(Collinson, 2014; Knight & Paroutis, 2017; Uhl-Bien & Arena, 2018; Waldman & Bowen, 2016; Zheng et al., 2018).

Advocating a shift from a leader-centric to a more organizationally embedded, distributed, and processual view of leadership, complexity leadership theory (Alok, 2022; Uhl-Bien et al., 2007), particularly its concepts of enabling leadership and adaptive space, provides a promising framework for examining the dynamics of leadership for safety in high-risk and highly regulated organizations. However, it is noteworthy that complexity leadership theory remains somewhat unexplored, with most empirical studies focusing on innovation and overlooking other organizational goals, such as safety. Although recent studies have addressed safety at the individual level (Paananen et al., 2022; Uhl-Bien, 2021), there is a limited understanding of complex organizational processes (Rosenhead et al., 2019; Tourish, 2019) and their mutual influence on enhancing safety in high-risk environments. This gap has resulted in a scarcity of empirical research adopting a complexity leadership perspective on leadership for safety.

Through an integrative literature review coupled with expert input from academics and practitioners, this article contributes to bridging the existing gap by constructing a multi-level conceptual framework of tensions and their interrelations that leadership should navigate to continually enhance safety. Beyond its capacity to inform more nuanced safety policies and regulations in complex environments, this framework also redefines leadership for safety as an organizationally embedded process.

In what follows, we present an overview of key developments in complexity leadership theory and leadership for safety research. We then describe the expert elicitation method and provide details of our analytical strategy. Finally, we discuss our results and their main implications

II. CONCEPTUAL BACKGROUND

A. Complexity Leadership Theory: Embracing Tensions.

Complexity leadership theory (Paananen et al., 2022; Uhl-Bien et al., 2007; Uhl-Bien, 2021; Uhl-Bien & Arena, 2018) represents a contemporary perspective (Antonakis et al., 2014) rooted in complexity science, elucidating the behavior of systems comprising numerous interconnected sub-systems, interactions among which produce unpredictable effects (Coveney, 2003). Complex systems are characterized by nonlinear, recursive causalities and emergence, limiting predictability (Coveney, 2003; Uhl-Bien et al., 2007).

Complexity leadership theory marks a departure from the traditional hierarchical view of leadership (individual leaders focusing on control and alignment) to a more distributed, processual, and contextual one. In other words, leadership is no longer seen as a top-down, direct influence over individuals; rather, it is viewed as part of a large set of interacting forces (Uhl-Bien et al., 2007). This perspective suggests that leaders cannot entirely predict, determine, or control subordinates' behaviors but can create a context that fosters interactions and self-organization.

Complexity leadership theory identifies three modes of leadership to achieve organizational results (Marion & Uhl-Bien, 2001; Uhl-Bien et al., 2007; Uhl-Bien, 2021). First, *operational* leadership relies on formal systems and structures (rules, standard procedures, plans, rewards, sanctions) and aims to achieve managerial efficiency in terms of productivity and results. Second, *adaptive* leadership relies on informal interactions to generate innovative responses to the unexpected and adaptation to pressure. Third, *enabling* leadership, includes both of the previous two types of leadership, and is aimed at achieving both

stability to enable coordination flexibility (Murphy et al., 2017). *Enabling* leadership fosters the conditions required for adaptive processes (Uhl-Bien & Arena, 2018). Adaptive processes emerge at the interface of tensions between pressure for organizational stability and change (Murphy et al., 2017; Paananen et al., 2022; Uhl-Bien, 2021). Leadership can enable such change by creating and maintaining an *adaptive space*. This entails navigating tensions associated with diverse perspectives on the development of adaptive responses. Responses that demonstrate effectiveness are subsequently incorporated into the operational system.

The role of leadership in managing tensions has received some attention in the organizational literature (Alfes & Langner, 2017; Collinson, 2014; Farjoun, 2010; Uhl-Bien & Arena, 2018; Zheng et al., 2018). Tensions arise from contradictory but interdependent and simultaneous organizational logics, mechanisms, and processes, such as exploration and exploitation or control and autonomy (Smith et al., 2017). However, scholars caution against oversimplifying complexity by depicting these different logics, mechanisms, or processes as irreconcilable polar extremes. They advocate for a more nuanced examination of tensions (Collinson, 2014; Farjoun, 2010; King & Badham, 2019). This involves reframing polarities as conflicting yet not mutually exclusive forces and acknowledging their dynamic co-development and mutual influence (Farjoun, 2010). Therefore, effective leaders need to develop a "paradox mindset" (Alfes & Langner, 2017; Zheng et al., 2018, Denison et al., 1995).

Dynamic and complex environments necessitate greater adaptability, a quality that leadership should promote by creating an adaptive space for confronting different ideas, allowing for the emergence of innovative solutions (Uhl-Bien & Arena, 2018). In this perspective, the effectiveness of leadership depends on the leader's cognitive and behavioral abilities to both recognize and manage tensions, contradictions, and ambiguities. These abilities are not limited to a single leader; all employees are required to actively engage with complexity, create new social constructs, and influence the organizational context (Osborn, 2008; Scott et al., 2018; Tseng & Levy, 2019).

B. Leadership in high-risk and highly regulated organizations: resolving tensions to improve safety.

High-risk organizations are characterized by non-linearity, highly variable outcomes, and tensions between conflicting forces and goals (Berti & Simpson, 2021; Hannah et al., 2009). In such complex contexts, leadership is crucial for ensuring safety by embracing these organizational tensions (Conchie et al., 2013; Griffin & Talati, 2014; Martínez-Córcoles et al., 2021; Mirza & Isha, 2017). A particularly important tension arises from the need to simultaneously develop two different forms of safety, namely, regulated and managed (Jubault Krasnopevtseva, 2022). While regulated safety relies on technical and procedural barriers to cope with predictable or foreseeable events and is aimed at *reducing* uncertainty, managed safety is aimed at the development of organizational capabilities to proactively deal with unpredictable events, and thus with uncertainty (Amalberti, 2021; Besnard et al., 2017; Morel et al., 2008).

Safety can be ensured only if these two forms of safety develop jointly and become mutually reinforcing. An excessive focus on the development of one form of safety can jeopardize the development of the other, and potentially lead to accidents (Oliver et al., 2017). Therefore, *enabling leadership* refers to a simultaneous and synergistic development of regulated and managed safety (Paananen et al., 2022; Uhl-Bien, 2021). However, existing leadership-for-safety studies focus mainly on exploring the link between leaders' personal traits and behaviors, and their impact on organizational safety (e.g. Lekka & Healey, 2012; Pilbeam et al., 2019).

The review of the literature leads to the identification of research gaps. On the one hand, the complexity leadership literature only marginally deals with tensions leadership has to resolve to enhance safety. On the other, notwithstanding some interesting advances in style- and behavior-based leadership theories, most perspectives are based on the premise that leaders have direct influence over followers and organizational outcomes (Barling et al., 2002; Smith et al., 2020). As such, they overlook the complex, embedded, and interactive nature of leadership influence (Uhl-Bien et al., 2007). The objective of this article is to fill these gaps. In what follows, we first explain our research methodology. Second, we identify leadership for safety tensions at multiple levels, and their interrelations. Finally, we then build an integrative conceptual framework of tensions related to leadership for safety in high-risk and highly regulated environments.

III. RESEARCH APPROACH

In order to confront and enrich our conceptual model developed through the review of the literature on leadership and, in particular, complexity leadership, safety and leadership for safety, we used an expert knowledge elicitation approach (Gavrilova & Andreeva, 2012; Morgan, 2014). We gathered 35 international experts from academia and the nuclear sector (operators and regulators) to participate in a three-day workshop to discuss and elicit their perspectives and experience related to tensions inherent in safety management, and their impact on leadership. Purposive expert sampling (Patton, 2002) was used to select the participants from 11 countries in Europe and North America (21 men and 14 women). A total of 22 renowned scholars from 15 universities and business schools (covering expertise in leadership, knowledge management, psychology, sociology, ethics, risk management, and engineering) and 13 experts from 11 international institutions (nuclear operators and regulatory bodies) participated. Our objective was to use the accumulated understandings to shape future research on leadership for safety. The discussions and the results of this workshop were intended to be neither specific to the nuclear industry (many other high-risk and highly regulated industries share similar characteristics) nor country-specific (our experts had experience in many countries, and especially in North America and Europe).

While leadership for safety is a complex phenomenon at the intersection of different domains (leadership, safety management, psychology, sociology, etc.), this interdisciplinary approach was a great opportunity to confront the different perspectives and co-construct a shared representation of leadership for safety process. The elicitation approach took the form of a structured conversational process of knowledge co-creation within a safe communication space, in which groups of people discussed specific topics during 2-3 hour-long sessions before exchanging in plenary sessions (Tanner, 2019).

In this paper, we focus on the nuclear sector. However, we argue that similarities and challenges related to safety in other sectors make our study relevant to other high-risk organizations such as aviation, chemistry, aerospace, pharmaceuticals among many others.

IV. RESULTS – IDENTIFYING LEADERSHIP FOR SAFETY TENSIONS AT MULTIPLE LEVELS AND THEIR INTERRELATIONS

The co-construction methodology used during the workshop allowed shared representations between scholars and industry experts to emerge. This cross-perspective facilitated a common understanding and definition of leadership for safety and recognition of three interrelated levels of tensions which leaders should embrace to improve safety. The detailed presentation of the results of this study is available in the article of Jubault Krasnopevtseva et al. (2024).

In defining "leadership for safety," two distinct but interconnected key concepts emerged: (1) safety management as a system of principles, rules, knowledge, and design, and (2) leadership as a process of intentional influence guiding and facilitating activities and relationships. Leadership for safety may be considered as *the exercise of influence over employee behavior and cognition to meet the expectations of safety management* through management of tensions.

Numerous lower-order organizational tensions previously identified in the literature were discussed. They can be grouped into three higher-order categories operating at different levels: 1) regulated versus managed safety (collective level), 2) normative versus vivid risk perception (individual level), and 3) structure versus action (articulation between individual actions and collective structures). Figure 1 depicts these higher-order tensions.

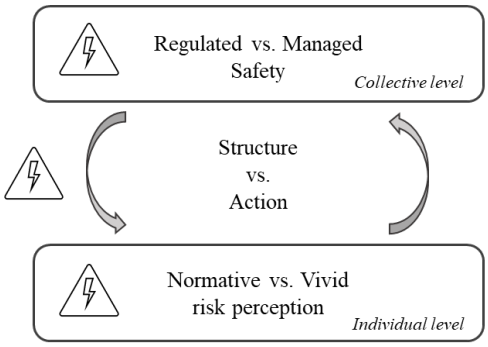

Fig. 1. Higher-order tensions and their articulation

A. Regulated versus Managed Safety: Higher-Order Tension on the Collective Level.

In the pursuit of safety, organizations face three types of tensions: (1) diminishing versus dealing with uncertainty, (2) procedural and technological barriers versus adaptability, and (3) control versus autonomy.

First, a particularly salient tension is related to the organizational degree of tolerance of uncertainty (Barton et al., 2015; Cicero et al., 2009; Grote, 2007; King & Badham, 2019). According to Grote's (2007) uncertainty management framework, organizations can either "diminish" uncertainty by reducing freedoms and standardizing technology or "deal with" uncertainty by maximizing freedoms and enhancing competencies to perform complex tasks. Second, a tension was identified between procedural and technological barriers on the one hand and the need for adaptability on the other (Grote et al., 2009; Hale & Borys, 2013; Morel et al., 2008). In addition to the "paradox of almost totally safe systems" (Amalberti, 2001; Oliver et al., 2017), this tension echoes organizational limits theory (Farjoun & Starbuck, 2007). Along similar lines, the third tension of control versus autonomy (Grote et al., 2009; Onjewu et al., 2023; Reason, 1998; Weick et al., 1999; Wildavsky, 1988), also surfaced from the literature and the workshop discussions. For example, the participants pointed to the difficulty involved in complying with rules and procedures in the context of unexpected events, and stressed that development of adaptability was especially important in the context of regulated safety based on regulatory compliance (Bourrier & Bieder, 2013; Grote et al., 2009; Jubault Krasnopevtseva, 2022).

These three lower-order tensions can be viewed in terms of managed and regulated safety theory (Amalberti, 2021; Besnard et al., 2017; Morel et al., 2008; Nascimento et al., 2014). The joint development of the two types of safety, with no unnecessary trade-offs, is difficult and requires constant resolution of lower-order tensions at the collective level. This includes diminishing or dealing with uncertainty, relying on procedural and technological barriers and adaptation capabilities, and promoting control or autonomy. Figure 2 depicts the lower-order tensions between regulated and management safety at the collective level.

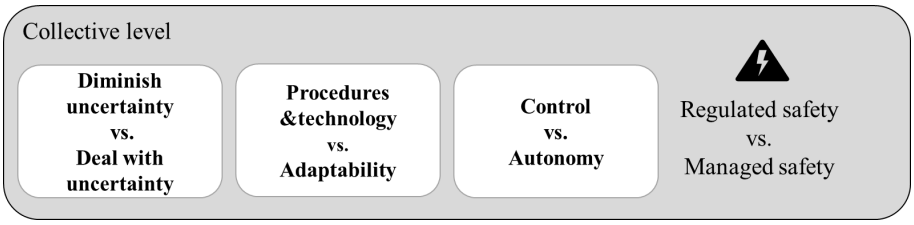

Fig. 2. Safety management tensions relative to regulated and managed safety at the collective level

In identifying lower-order tensions, which contribute to higher-order tensions, our results shed new light on theories related to regulated versus managed safety. These tensions emerge differently in different organizations and could be resolved in part through the redesign of organizational structures and adaptations to organizational practices implemented by individual actors in their local work environments. The possibility of resolving these tensions by adapting practices will depend on individual capabilities and individual limitations related to the perception and handling of risk and uncertainty.

B. Normative versus Vivid Risk Perceptions: Higher-Order Tension at the Individual Level.

To achieve mutual reinforcement of regulated and managed safety at the collective level, the importance of balancing tensions at the individual level was emphasized. Our findings revealed three lower-order tensions: complacency versus vigilance, abstract versus concrete view, and long-term versus short-term view. First, the tension between individual complacency and vigilance (Barton & Sutcliffe, 2009; Christian et al., 2009; Flin & Fruhen, 2015; Reason, 1998; Vogus & Welbourne, 2003) appeared particularly salient in the context of nuclear safety. Awareness of risk involves avoiding overconfidence and implies alertness to possible risks and the need "*not to forget to be afraid*" (Reason, 1998, p. 305). Accidents tend not to happen without some warning signals (Weick & Sutcliffe, 2006). Second, the importance of a construal–psychological distance tension (Berson et al., 2015) was emphasized, marking the difference between abstract and concrete views of possible risks. For example, a more concrete, more easily measured goal may attract more attention due to higher perception of harm compared to a potentially abstract goal to maintain safety as "dynamic non-event" (Weick, 1987). Third, the impact of temporal distance from action (Trope & Liberman, 2003) was highlighted by both the literature and the workshop participants. During the decision-making process, temporal distance changes the individuals' response to future events by changing their mental representations of those events (Hofmann & Morgeson, 2004). For example, long-term investment in safety equipment might be perceived as less important comparing to short-term maintenance action.

These three lower-order tensions contribute to a higher-order tension relative to individual risk perception. When situated far from the action and with sufficient time to plan, individuals may perceive a risk as controllable (normative risk perception). If individuals are closer to the action occurring within a short time frame, they are likely to be aware that not all situations can be managed by applying the rules since the rules do not cover unpredictable events (vivid risk perception). Whereas the perception that everything is controllable reinforces an attitude of complacency, vivid risk perception promotes an attitude of vigilance. Figure 3 depicts lower-order tensions between normative and vivid risk perceptions at the individual level.

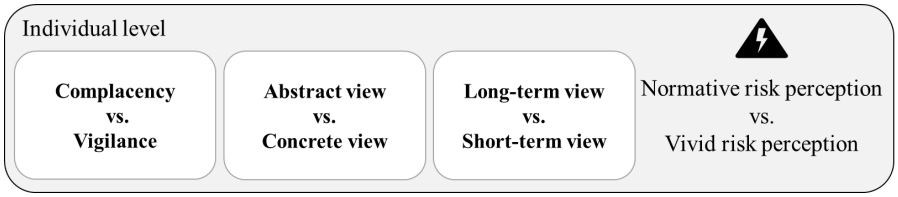

Fig. 3. Safety management tensions relative to risk perception at the individual level

The strength of tensions inherent in individual risk perception can vary and influence the articulation between rule compliance and initiative in day-to-day practices. This individual-level aspect resonates with regulated versus managed safety tensions at the collective level. An individual is required to follow safety procedures when performing core safety activities but if necessary, must be able to take initiative to deal with an unexpected event or to participate in the development of safety requirements.

Neither fully normative nor fully vivid risk perception is appropriate to balance rule compliance with initiative. The literature suggest that to achieve this balance requires of the organization to develop individual mindfulness, by fostering employees' abilities to focus on a particular object while remaining vigilant to weak signals of future problems (Atkins, 2008; Dane, 2011; Sutcliffe et al., 2016; Weick & Sutcliffe, 2006). Mindfulness maintains attention to what is happening "here and now" in real time, and helps the individual make the right choice between compliance and initiative (Weick & Sutcliffe, 2006). Mindfulness refers to what the individual does to notice, make sense of, and interact with their surroundings (Dane, 2011; Sutcliffe et al., 2016; Weick et al., 1999; Weick & Sutcliffe, 2006) to achieve present-centric attention to the "here and now" (Sutcliffe et al., 2016; Weick & Sutcliffe, 2006). The attention to the here and now further depends the individual ability to evaluate what is relevant and what must be dealt with immediately using either a known (compliance) or innovative (initiative) response.

Confronting literature with expert elucidation allowed to identify various tensions which must be considered to develop individual mindfulness, defined as the individual ability to adopt the relevant behavior (compliance or initiative). However, the development of mindful behavior at the individual level in relation to balancing regulated/managed safety at the collective level, requires a deep understanding of the tensions that exist between these two levels.

C. Tensions in the Interaction Between the Collective and Individual Levels: Structure versus Action.

As expected, the workshop discussions reinforced the importance of understanding tensions between collective values and rules (incorporated within the organizational structure) and how they were intertwined with individual behaviors and actions. In the case of safety management, tensions at this interface have their source in three different domains: 1) culture versus climate, 2) knowledge versus knowing, and 3) planning versus execution.

First, organizational culture and climate are two important safety behavior variables, which eventually converge (Zohar, 2002). While organizational culture is defined as a pattern of shared values, beliefs, and basic assumptions (Schein, 2004), organizational climate is a cognitive social construct referring to shared perceptions of employees on the kinds of roles and behaviors likely to be recognized and rewarded (Zohar, 2002). The translation of cultural values into the construction of an organization climate and operational practices is difficult. Second, tensions were identified in the learning process in terms of tensions between codified knowledge (contained in rules, models, documentation) and knowledge in action (adaptations to the situation). Knowledge management refers to the creation of models enacted through routines (Gherardi & Nicolini, 2000). Third, the interplay between planning and the reality of operational execution is a crucial, but a demanding process involving the notion of distance between the design of rules and plans, and the operational reality (Hale & Borys, 2013; Kudesia et al., 2020; Ocasio, 2005).

All of these lower-order tensions contribute to the tension between structure and action. Actions are performed through day-to-day routines. For some participants, this structure–agency tension echoes the tension between ostensive routines (abstract generalized ideas of routines) and performative routines (linked to specific actions) (Feldman & Pentland, 2003; Spee et al., 2016). Figure 4 depicts lower-order tensions structuring the higher-order tension between structure and action. This is a novel way of considering safety management in which safety – conceived as the outcome of a collective construction process involving people, technologies, and rules – is enacted through the articulation of tensions on three levels.

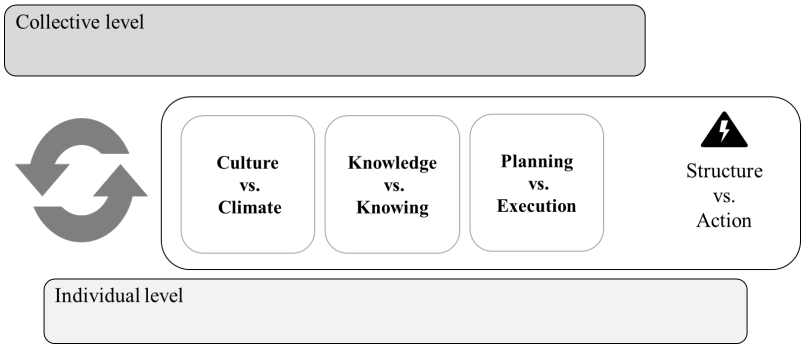

Fig. 4. Safety management tensions between the collective and individual levels

Our results highlight how tensions are manifested in the articulation between the individual and collective levels, and how they allow contextualization of structure–action tension in the context of safety development.

V. DISCUSSION

A. Building an integrative conceptual framework of leadership for safety tensions.

The present article develops a conceptual framework of tensions related to leadership for safety in high-risk and highly regulated environments. The findings are the result of the literature review and exchanges between scholars and nuclear industry experts and contribute to a co-constructed model (see Figure 5) of the main lower-order and higher-order dynamic tensions that evolve at the individual and collective levels and their interface.

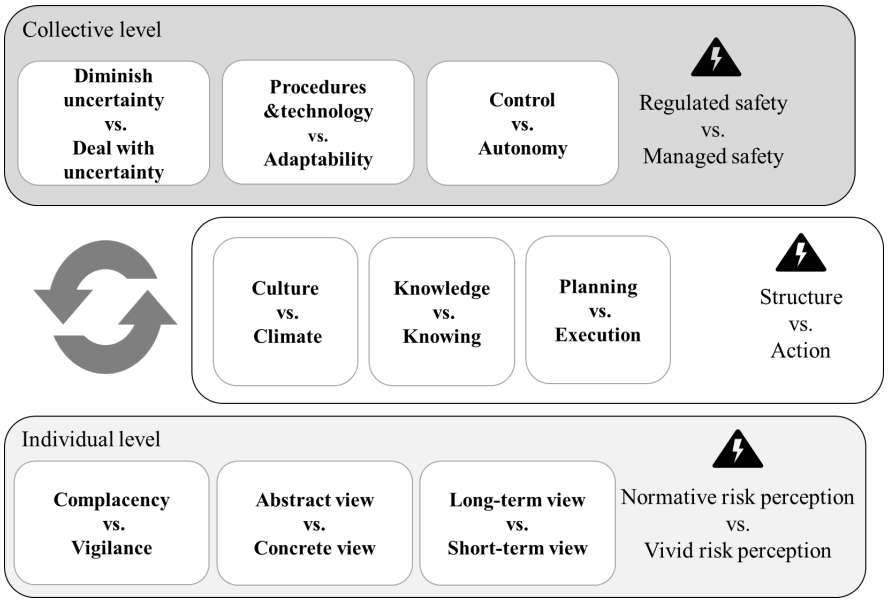

Fig. 5. Integrative framework of the tensions of leadership for safety

In day-to-day activities, the boundaries to the dimensions identified and their corresponding sub-tensions become blurred and can overlap; that is, there is a degree of porosity among the tensions. How these tensions are managed in an organizational context both influences and is influenced by the leadership (Osborn, 2008; Osborn et al., 2002). To enhance safety, leaders need to develop a profound understanding of tensions related to both safety management and organizational dynamics (structure–action), and how they interact. Leadership for safety implies the coupling of structure (rules and principles) and action (safety practices) through management of tensions at the collective and individual levels in day-to-day practices. This level of intertwinement between the individual and collective levels highlights the depth of organizational embeddedness (Dacin et al., 1999; Tseng & Levy, 2019). The proposed framework (Figure 5) allows to better understand the embeddedness of the leadership process as an articulation between the collective and individual levels, the tension between the elements of the structure (values, rules, codified knowledge, standards, planning) and collective and individual actions at the heart of this articulation.

B. Theoretical Contributions.

Our research enriches the existing theory in several significant ways. First, our results contribute to complexity leadership theory by identifying and characterizing tensions at different levels, and their interactions, in high-risk and highly regulated organizations. Our framework helps to unpack tensions involved in the adaptive space in which organizational members can develop safety capabilities (Paananen et al., 2022; Uhl-Bien, 2021; Uhl-Bien & Arena, 2018). Tensions identified are presented from a multi-level perspective, which draws attention to the mutually interrelated different levels of analysis (Collinson, 2014; Pearce et al., 2019), which nuances complexity-leadership theory and more specifically the enabling leadership concept. While the traditional adaptive process is seen as a set of sequential stages such as disequilibrium of tensions, amplification, emergence through recombination, and stabilization in new order (Uhl-Bien, 2021), our framework suggests a more dynamic perspective implying a less ordered complexity. We argue that tensions occur simultaneously at different levels, possibly making it difficult for leaders to achieve a new equilibrium at all levels at the same time. Ways to deal with these tensions represent pressing topics for future research on leadership applied to high-risk industries, but also to a broader set of organizations – "reliability-seeking organizations", that operate in uncertain environments (Vogus & Welbourne, 2003).

Second, this article contributes to work on leadership for safety by explaining the embeddedness (Dacin et al., 1999; Tseng & Levy, 2019) of this complex process. In line with contextual approaches to leadership for safety (e.g. Barton et al., 2015; Williams et al., 2017), our results highlight that leadership for safety is embedded in organizational dynamics, and especially in the articulation of structure (ostensive dimension) and action (performative dimension) (Archer, 1998; Feldman & Pentland, 2003; Giddens, 1984). This means that leadership is not the result of a combination of leaders' traits or behaviors as in a leader-centric perspective (e.g. Clarke, 2013; Gracia et al., 2020; Mirza & Isha, 2017), but rather is a complex, organizationally embedded process of influence that has important practical implications. Leadership is not just an act of direct influence, but rather it is a result of a complex web of influence among many interacting forces (Uhl-Bien et al., 2007). Therefore, an effective leadership process requires the ability to understand multiple simultaneous dynamics within the organization and their interactions (Fischer et al., 2017; Tourish, 2014). Leadership for safety implies recognition, understanding and acting upon a multitude of dynamic safety issues. The tensions identified must be understood and managed continuously. Our tensions framework suggests complementarity among what might, at a first glance, appear to be contradictory elements, echoing the duality principle described by Farjoun (2010).

C. *Practical Implications.*

This reconceptualization of leadership for safety aims to contribute to the higher education and training of professionals in the different institutions, regulators, and operators. Leadership training can be unsuccessful as a result of managerial and organizational barriers, which make it difficult to apply in daily practice (Beer et al., 2016). Our findings can help to overcome these problems. Specifically, our study considers leadership as a process rather than a set of personal traits and considers it to be embedded in the broader set of organizational dynamics. This reconceptualization of leadership is crucial for effective leadership training in complex public administrative environments (Murphy et al., 2017; Seidle et al., 2016), particularly training in leadership for safety (Nielsen et al., 2010; Schwatka et al., 2020; Tafvelin et al., 2019).

Paananen et al. (2022) refer to complexity in terms of dimensions which offer leaders a framework and a vocabulary to interpret their environment and manage complexity. By allowing a better understanding of the challenges decision and policy makers face in complex and high-risk environments, our study can encourage them not to deny, but to embrace tensions (Alfes & Langner, 2017; Murphy et al., 2017). We hope this understanding will have a direct influence on regulating, evaluating, measuring, and controlling leadership for safety practices. Balancing actions with tensions faced by leaders does not imply the search for the optimal solutions, but rather acceptance of the simultaneous presence of the different tensions and a joint development of solutions. The framework developed in this article offers some guiding principles/directions for leaders, regulators, and policy makers to allow them to exploit tensions, and come up with new ideas and codify them as organizational capabilities (Uhl-Bien & Arena, 2018).

Finally, our article contributes to a recent debate on the research/practice gap in safety science as it argues for more effective cross-fertilization between theoretical and empirical knowledge (Hamer et al., 2021; Rae et al., 2020). This innovative, co-constructive workshop methodology, complementing integrative literature review, supports an effective combination of the knowledge held by scholars and industry experts, allowing the creation of a common representation of issues involved in leadership for safety. This representation provides new theoretical knowledge on the problems involved. Reflecting on the ostensive–performative dimensions of safety, an expert from the nuclear sector commented: "*You have put into words a few issues that we felt but could not name*."

VI. CONCLUSION

This article provides a study of leadership in complex and high-risk organizations, where the leaders' attention is on a particular organizational objective: safety. The main idea was to identify tensions involved by unpacking and reintegrating the complexity dimensions of leadership for safety. We built an integrative conceptual framework identifying tensions that need to be managed for enhancing safety. To ensure safety, leaders need a deep understanding of the tensions at the individual (normative vs. vivid risk perceptions) and collective (managed vs. regulated safety) levels, and how they interact (structure vs. action). Efficient leadership for safety in complex environments needs to embrace of these multi-level tensions embedded in a set of organizational dynamics.

Our results point to some interesting avenues for future research. The multi-level tensions identified point to the need to deal with individual, collective, and inter-level tensions in line with Pearce et al.'s (2019) meta-paradoxical leadership. Our results suggest that this framework would be particularly salient for leadership for safety. However, while most work on paradoxical leadership considers leadership as an individual style (Batool et al., 2023; Denison et al., 1995; Pearce et al., 2019; Waldman & Bowen, 2016), we need more investigation of a processual approach to leadership and specifically leadership for safety to deal with paradoxes.

A tension lens is recognized as useful for studying safety-related issues (Kettunen et al., 2007) and issues related to priorities and resource allocation. The combination of the literature review and the expertise of our nuclear sector experts and scholars helped to identify three levels of tension, which leaders need to manage. More fieldwork is needed to explore how leaders in practice manage (or not) these tensions, and more particularly, how leaders create and maintain the adaptive space. More research is needed on how to deal with the tensions involved in leadership for safety.Style Corps de texte.

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