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Collaborative Innovation in a Military Organization: The Importance of Transactive Memory, Knowledge Sharing, and Learning From Failure

Mysha A. S. van Lamoen, Myriam Cloodt, and Alex A. Alblas

***Abstract*—For addressing grand challenges, in recent decades, we have seen a growing focus on collaborative innovation in the public sector. However, despite important work, current research is paying relatively little attention to what facets of collaborative innovation are relevant and how they enhance the required innovative performance. To face the grand challenge of public safety, international military organizations, such as the North Atlantic Treaty Organization (NATO), need to pursue a collaborative innovation process. In this study, we open up the black box of collaborative innovation by unraveling three critical mechanisms that improve a public organization's innovation performance. Our specific aim was to unfold the ways that Transactive Memory (i.e., knowing who knows what), Knowledge Sharing, and Learning From Failure affect innovation performance. We do this by examining 166 responses from multiple innovation teams at NATO, Ministries of Defense, and Centers of Excellence. Qualitative and quantitative analyses show that the knowledge coordination aspect of Transactive Memory and learning from others' failures enhance innovation performance. Surprisingly, the effect of knowledge sharing on innovation performance is nonexistent and fully mediated by learning from failure. So, we contribute by unraveling how these three critical mechanisms influence innovation performance in a public organization. Future research could validate our findings in different public sector contexts (e.g., healthcare), focus on transactive memory's role in relation to the two sides of knowledge sharing (sending and receiving), and further examine how knowledge sharing impacts innovation performance in a public military context.**

***Index Terms*—Collaboration, innovation management, knowledge transfer, learning.**

I. Introduction

WHILE the need for innovation has increased over time, the general perception is that the public sector cannot deliver effective innovation. However, this critique was based more on opinion than solid empirical evidence [1], [2]. Research has shown that innovation in the public sector is successful [3], and improves the quality of service delivery, unlocks efficiency gains [4], and fosters the creation of greater public value.

Innovation and creativity are becoming even more significant nowadays in light of the public sector's need to address several grand societal challenges that lie ahead [5]. As such, the need for constant evolution in developing new technologies, products, and services has become a key guiding principle for public organizations [4].

This study focuses on public safety as one of the grand challenges urgently requiring a more permanent and systematic approach to innovation in the public sector [6]. Facing rival states' advancing capabilities and a changing innovation landscape, military policymakers must invest substantially in breakthrough technologies to preserve (inter)national security and public safety. Although public safety is a grand challenge, little scientific attention has been paid to innovation in this context. Yet military organizations have to ensure the safety of uniformed personnel and civilians and guarantee their army is at least as good as the enemy's [7].

Innovation in military organizations is particularly difficult because of these organizations' complexity, operating and cooperating on a global scale. Unlike traditional production organizations that are mainly structured around products or services, there is not one clear primary process in military organizations. There, networks of public managers and employees are the primary sources of innovation, which is not an isolated local activity but occurs through these networks of people across different levels and locations that share knowledge and learn from each other. This study is, thus, anchored on the assumptions of collaborative innovation theories in the public sector, showing the importance of collaboration and organizational learning in innovation [8]. Because innovation is almost always a collaborative process, individuals, teams, and organizations combine their resources and skills to develop new products and services. Organizations collaborate internally through multifunctional teams with members from different disciplines, such as R&D, production, purchasing, sales, service, and finance, but they also collaborate externally with customers, suppliers, and other parties. We focus on the cooperation within a team between members with different backgrounds and experiences, different military and civil functions, or from a different country.

Collaborative innovation has been increasingly adopted by the public sector to address grand challenges and improve its

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efficiency [5], [9], [10], [11]. While New Public Management stimulated the focus on innovation in the public sector, the focus on seeking innovative solutions through collaboration aligns with the principles of New Public Service and New Public Government [12], [13], [14]. Collaborative innovation theories in the public sector build on the importance of collaborative networks of employees that enable innovative solution-finding and (inter-)organizational learning through interaction and collaborative processes [15].

To comprehend what is unique about the public sector context and how this impacts its approach to innovation, we focus on the international military organization North Atlantic Treaty Organization (NATO) that has offices across the world. As an organization, NATO focuses on bringing together 30 members from different countries to collaborate and organize collective safety, cooperative security, and crisis management. Innovation in a NATO context happens both at the local level (within a partner context) and at the network (between partners) level. While one of the obstacles to collaboration is the difference in each NATO nation's approach and culture, at the same time, this diversity in culture and experience provides the required pluriformity to solve complex problems from different perspectives. Consequently, employee diversity can be considered an enabler for innovation [16], [17]. Greater employee diversity, however, increases the need for interaction and collaboration inside the organization [18]. In other words, as an organization whose members have a variety of experiences, NATO is better able to exploit its internal knowledge through collaborative innovation [19], [20].

Our preliminary qualitative study identified what impacts an international military organization's innovation performance. We focused on collaborative innovation, implying internal actors' cooperation and the exploitation of their knowledge to preserve international safety and create public value [21]. Because innovation starts with knowledge, the fundamental issue for innovation addressed here relates to how and where knowledge can be acquired or developed collaboratively. We found that the acquisition of knowledge is mostly done through the Knowledge Sharing process, which Baruch and Lin [22, p. 1155] define as: "individuals' sharing organizationally relevant experiences and information with one another, increasing the resources of a team (or an organization)." Learning also emerged as an important factor affecting innovation performance. We found that the development of knowledge mostly emerges from Learning From Failure. Carmeli et al. [23, p. 33] define Learning From Failure as: "the extent to which a team reflects upon the problems and errors it experiences, interprets and makes sense of why they occurred, and discusses what actions are needed to produce improved outcomes." Most importantly, we found that Transactive Memory was one of the key drivers of knowledge acquisition and development in a collaborative way. Transactive Memory can be defined as: knowing who knows what [24]. One of our interviewees for instance stated: "It is very difficult to identify who you should talk to." What we note from our preliminary study data is that innovation in this study's context emerges through networks of people, driven by the relationships between people and knowledge mutually coordinated and shared, i.e., by Transactive Memory, Knowledge Sharing, and Learning From Failure.

We tested the effects of the above constructs on innovation performance using quantitative regression analysis. Our specific aim was to discover how it transpires that Transactive Memory, Knowledge Sharing, and Learning From Failure affect innovation performance. Innovation performance improved the most where there is sufficient Learning From Failure in the organization. Learning From Failure is, in turn, impacted by Knowledge Sharing and one aspect of Transactive Memory, namely coordination. Our mediation analysis showed that the knowledge coordination aspect of Transactive Memory impacts innovation performance significantly and that this relationship is partly mediated by Knowledge Sharing and Learning From Failure. Furthermore, the effect of Knowledge Sharing on innovation performance is fully mediated by Learning From Failure.

This research contributes in three important ways. First, by focusing on collaborative innovation in a military organization context that is not yet apparent in public innovation research, even though these types of organizations address grand challenges, such as the security and safety of civilians [7]. This is also clearly linked to the United Nations Sustainable Development Goal 16, which focuses on peace, justice, and strong institutions. Second, we respond to calls by Jukić et al. [21] and Vries et al. [25] to expand the number of quantitative studies, especially mixed-method ones, in the next generation of research on public innovations. Third, the study unravels three important mechanisms that can improve innovation performance in a public organization.

II. Empirical and Theoretical Background

A. *Empirical Context*

The context of this study differs from what is traditionally seen as public sector. To start with, military organizations have clear hierarchical levels, demonstrated by the use of rank. Military organizations generally have three branches: the Navy, Army, and Air Force. The Netherlands additionally has the military police. The military is unique in that it is a large, hierarchical, yet diverse organization operating in an uncertain, volatile world, carrying out missions that profoundly impact both the nation and the world [26]. A military organization is often huge compared to other organizations. For example, the U.S. military has 1.37 million troops (excluding reserves).

A military organization is a term describing multiple organizations, for example, the ministries of defense. Like in many countries, the Dutch Ministry of Defense (NL MOD) oversees the Dutch army. Another well-known military organization is NATO. Established in 1949, NATO currently consists of 30 member countries. NATO's purpose is: "to guarantee the freedom and security of its members through political and military means." When one member is attacked, this is considered an attack on all NATO members, which ensures collaboration on defense, security, and crisis-management ("What is NATO," n.d.). Other kinds of military organizations are Centers of Excellence (COEs), international military organizations specializing

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in one functional area. COEs are funded by one or more national Ministries of Defense and coordinated by NATO [27].

Innovation is crucial within a military organization. For example, the Dutch MOD has released an Innovation Strategy with guidelines on how the MOD can innovate and absorb innovations faster, connecting the current organization with the exploration of new possibilities. Additionally, the Defense Vision 2035 highlights strong innovative ability [28]. Describing innovation in this setting is a quote from the Dutch Military Hospital's former Chief Operations Officer, June 12, 2020.

> *"Picture an F-16 jet fighter flying a mission. The plane malfunctions and the pilot needs to eject and parachute down to earth. While landing near enemy territory, he is injured. Luckily, a cleverly packed medical survival kit containing all essential first aid equipment is attached to the ejection seat. This small box fitted into the tiny available space in the plane, extremely light and able to withstand the G-forces of a dogfight, is a real lifesaver. After being found by the Medevac-helicopter, first medical treatment is applied by a combat-lifesaver, carrying an intelligently packed backpack designed to treat wounded soldiers under fire and in very cramped spaces. The first item that comes out is a morphine auto-injector, specially designed for military use. The pilot is delivered to an inflatable mobile hospital, the POON, with air-sealed compartments for triage, an operating theatre, and quarantine wards. There he will be treated by a team of reservists, who all have a regular job in a civil hospital. Based on innovative civil-military cooperation, they provide dedicated mission capability for the military. To guarantee the availability and shelf life of blood-products, to be used to treat patients and prevent shock, e.g., unique deep-freezing procedures developed by the Dutch Ministry of Defense are used."*

Besides medical innovations, innovations in the field of weapon systems are essential to ensure that the organization does not fall behind the geocompetition, described by NATO in the London Declaration [157]. Military organizations thus describe the need for innovation in their policies. For example, in 2019, NATO's Deputy Secretary General, Mrs. R. Gottemoeller published a Policy Brief "NATO at 70: Modernizing for the future," emphasizing the key importance of "continuous innovation" for NATO to keep up with the rapid pace of technological change and ensure NATO has the right tools and capabilities of carrying out its mission. NATO performs several tasks: it establishes an incubator framework, creates innovation accelerators, and provides funding to invest in innovative new technologies. An example of a NATO incubator framework is the cyber incubator. Efthymiopoulos [29] demonstrates the need for a military strategic framework in cyber-security policy that is innovative and entrepreneurial among allies and partners.

B. Empirical and Theoretical Background

1) Knowledge-Based Theory of the Firm: We adopt the knowledge-based view of the firm as theoretical framework to investigate the role of collaborative innovation at NATO in addressing the grand challenge of public safety. The knowledge-based view is built on the foundations of the resource-based view, which originates from the private sector but is increasingly used as a theoretical lens for studying public organizations [30], [31]. The resource-based view describes the firm as a unique collection of difficult-to-imitate resources, competencies, and capabilities [32], [33], [34]. The emerging knowledge-based view is an offshoot of the resource-based view in that it focuses on knowledge as the firm's strategically most important resource [33], [35], [36], [37]. Compared to the private sector, knowledge is a vital resource for public sector organizations [38], [39] and sharing knowledge both within and between organizations plays an important role in the advancement of public services [39]. Additionally, knowledge is also a key factor in several other research traditions that stress the importance of organizational learning and the transfer and diffusion of innovative capabilities within the firm (e.g., [33], [40], [41], [42]). Innovation is often considered a highly knowledge-intensive task requiring organizations to possess the relevant specialized knowledge for finding the best innovation opportunities [43], [44], [45], [46], [47]. Consequently, our study assumes that innovative performance is one of the critical outputs of a firm's underlying knowledge base [33]. By developing, acquiring, and utilizing diverse sets of knowledge, the organization creates a richer and broader knowledge base, whose full potential for combinatory capabilities is increased, creating opportunities to innovate [48], [49], [50].

However, when studying innovation, it is important to realize that organizational members have a limited capacity of developing and utilizing knowledge [33]. As a result, efficiency gains in knowledge development and utilization within a public organization can be achieved through specialization, and so organizations' fundamental task is to coordinate the activities of their many members with specialized knowledge. Also, because most of the knowledge relevant to organizations is tacit, the transfer of knowledge between organizational members becomes very difficult [51]. Grant [33] states that knowledge integration is more effective than knowledge transfer: organizations must establish a mode of interaction that enables knowledge integration between multiple organizational members' tacit and specialized knowledge areas. Some tasks depend on simple cost-efficient forms of knowledge coordination, such as rules and directives (plans, schedules, forecasts) and sequencing (i.e., where individuals' inputs occur independently through time-patterned sequencing); other tasks such as innovation require more intensive forms of integration. Especially the more challenging and crucial activities involving specialized members' complex knowledge integration are seen as distinct organizational capabilities that create an organizational competitive advantage [33].

The coordination and integration of this specialized knowledge require collaboration because partners can acquire knowledge they otherwise could not access [52]. This study addresses several facets of collaboration. Based on insights from the preliminary interviews and the empirical problem, we postulate that especially knowing what others know (i.e., Transactive Memory), sharing knowledge between organizational members, and learning from others' failures are important enabling knowledge coordination and integration mechanisms that can improve innovation performance.

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2) Relevance of Three Mechanisms for Innovation Performance: The limited knowledge of what drives innovation in military organizations motivates this study. A total of 12 preliminary interviews revealed three focal issues concerning collaboration and innovation performance within military organizations.

The first issue relates to the knowledge of who is doing what within the organization. In the literature, this is called Transactive Memory [53]. It became clear from the interviews that confusion about "who is doing what" hinders innovation performance. Moreover, there is no overview of innovation knowledge throughout NATO and its members, and finding the right individual often takes up too much time and resources.

> *"Nobody knows enough about what is going on in other places, and because of the different IT systems, we also cannot find out what others are doing."* ~ Information Environment Assessment Employee
>
> *"It is very difficult to identify who you should talk to."* ~ Assistant head of the Innovation Unit

The second concept is Knowledge Sharing [54]; sharing knowledge with others enables people to use that knowledge. This Knowledge Sharing might be more difficult due to NATO employees' different languages and backgrounds. It is also hampered because military officers change their work position every three years, which makes it challenging to transfer and capture knowledge.

> *"Officers move every three years, so there is not always enough Knowledge Transfer."* ~ Information Environment Assessment Employee

The final issue that emerged is Learning From Failure [55]. Military organizations such as NATO are expected to be risk-averse, where mistakes are commonly not seen as acceptable. As such, the military culture might obstruct Learning From Failure. Within NATO, countries could even be less willing to share their failures, making it increasingly difficult to learn from others' failures.

> *"We are afraid to talk about mistakes because we are risk averse. If we make mistakes, people die. However, failure can also be good; we could learn from this."* ~ Scientist at NATO

In sum, strong Transactive Memory enables organizational members to tap into each other's knowledge because they are aware of their other organizational members' expertise [56]. Transactive Memory also helps members share knowledge and learn from each other's mistakes [57].

3) Transactive Memory, Knowledge Sharing, and Learning From Failure:

a) Transactive memory: The scientific literature conceptualizes knowing who knows what in an organization as Transactive Memory [53], [58], [59], [60], [61], [62]. Transactive Memory can be seen as the organization's shared memory. Memory is best understood as undergoing three stages: it starts as information and only becomes memory through encoding, storing, and retrieving. Individuals undergo the process individually; however, these stages should be performed together as a team to achieve shared memory [63]. A group needs to decide what information should be stored collectively and encoding in groups is through communication [64]. The encoded information should be stored in a shared place. Finally, transactive retrieval is possible when the group knows where information is stored, and "who knows what" [59], [65], [66]. Organizations that have shared Transactive Memory, utilize individuals' memories as a source of external memory for their team members [60].

The organizational memory, Transactive Memory, depends on three aspects: Specialization, Credibility, and Coordination within teams [43], [56], [64], [67]. These three aspects can also be conceptualized as memory differentiation (Specialization), task Coordination, and task Credibility [68]. Specialization or memory differentiation focuses on the differences between group members' knowledge [56]. A Transactive Memory is most useful if team members have different knowledge; if others know the same, why would one need to know what others know? [56]. If team members' specialized knowledge is well known within a group, it becomes easier to match the right individuals to tasks [61]. Lewis et al. [64] elaborate that the specialization between team members often increases through effective Transactive Memory because team members choose to learn about things the team does not yet have knowledge about. The second element of Transactive Memory is Credibility. Credibility is high when team members perceive their team members' knowledge as highly reliable and can thus be seen as the level of trust within a team [69]. In teams with high credibility, there is often less specialization because resources are used to check others' knowledge, indicating a correlation between specialization and credibility [56]. The final aspect is Coordination, referring to knowledge processing. Coordination focuses on how teams handle information [56]. High coordination makes it easier to anticipate team members' behavior [65].

Looking at these three aspects shows that Transactive Memory highly depends on team members and differs between diverse teams [61]. A Transactive Memory system (TMS) develops as a group learns about others' experiences and knowledge. This is based on social perception when there is cognitive interdependence with others [59], [62]. Moreover, as Ali et al. [43] show, Transactive Memory becomes stronger over time when teams get to know each other better; and teams who know who is good at what perform better than those who do not know this.

b) Knowledge sharing: Once it is known within the organization "who knows what," the next important facet is to share the knowledge. Knowing where knowledge is stored does not seem to be enough if sharing is lacking [61]. As discussed, innovation highly depends on the right knowledge, so implementing knowledge in innovation projects improves performance [70]. Consequently, knowledge-based organizations need to leverage knowledge in order to develop and deliver products or services [54], [56], [71], [72]. Throughout the organization, knowledge

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can be found in the context, employees, tools, tasks, and even culture [55]. A definition of knowledge is, "Information combined with expertise, insights, beliefs, and lessons learned" [73, p. 335], which has been found important, especially in public services [74]. To share knowledge, individuals need to be proactive and motivated.

Knowledge Sharing can also be called knowledge transfer, knowledge flows, or knowledge acquisition [54]. As all concepts can be compared with Knowledge Sharing, clearly the definition of Knowledge Sharing can differ too. For example, in the organizational learning literature, learning from others' experience is defined as knowledge transfer [55], [61], [75].

Van Wijk et al. [54] elaborate on the antecedents relating to Knowledge Sharing. To fully understand the Knowledge Sharing process, it is crucial to be aware of these antecedents, although they are not considered in this research. As the definition of knowledge is broad, understandably knowledge comes in different forms. Studies have proven that different kinds of knowledge impact Knowledge Sharing in different ways [55], [76]. Additionally, diverse organizational characteristics clearly have different effects on Knowledge Sharing. Organizational size slightly stimulates Knowledge Sharing, while age and decentralization have no effect [54].

If both the sender and receiver of knowledge share the same values, Knowledge Sharing is easier [77]. Furthermore, innovative teams must share more knowledge than other teams because innovation projects rely on differentiated knowledge and information [78]. The more iterations in innovation projects, the more Knowledge Sharing is required [78], [79]. As Choi et al. [67] explain, the ability to share knowledge directly influences organizations' competitive advantage. However, it is essential to note that sharing information is only useful if the knowledge is then applied to improve performance.

c) Learning from failure: Studies of innovation performance, Transactive Memory, and Knowledge Sharing, often highlight organizational learning [55], [61], [68], [69]. Organizational learning can be defined as: "a change in the organization's knowledge that occurs as a function of experience" [55, p. 1124]. An organization can learn either directly from its own experience or indirectly from others' experience. Furthermore, experience can be seen as the number of times a task is performed and interacts with the environment to create knowledge. Organizational learning is a broad concept but can be viewed from a narrower perspective. Argote and Miron-Spektor [55] explain a narrow concept: when organizations gain rare experiences, they can benefit by learning from them. Learning From Failure is learning from mistakes that might have occurred. Organizational learning and Learning From Failure are comparable yet different. These concepts result in a change in the organization while the input differs [61]. Organizational learning starts with internal and external experience, while Learning From Failure starts with knowledge about failures. Learning From Failure can be seen as part of organizational learning; however, organizational learning is a broader concept [80].

Organizations, thus, can learn from their successes as well as failures. However, learning from success increases the likelihood of future failure; therefore, focusing on learning from failure is more important [81], [82], [83]. As Learning from Failure was deemed crucial in the preliminary interviews, we decided to focus on this instead of organizational learning. Also, this concept has been less researched [84]. Furthermore, organizations that excel in Learning from Failure are rare [85]. Innovation projects often go side-by-side with "failed projects" [86]. However, it is debatable whether these projects are actual failures since they can also have an unintended positive outcome. Failure means unrealized strategies, which does not suggest the outcome must be negative [82], [87].

In the context of Learning From Failure literature, Dahlin et al. [80] identify three aspects: the opportunity, motivation, and ability to learn from failures. Opportunity to learn can be defined as "the scope of information and the time that allows actors to learn from future events" [80, p. 254]. Information and the time available to learn are part of this aspect. When a failure occurs, and there is no available time to analyze this mistake, this hinders the opportunity to learn. The time and information should be used to reflect and improve future performance. Motivation is the second aspect of Learning From Failure and can be seen as employees' willingness to perform a task. This motivation is a necessary resource for Learning From Failure. Improving psychological safety is a way of making employees more motivated to learn from failure [84], [88]. If organizations blame individuals for failures, this lowers employees' motivation to learn from their failures [85]. Finally, the ability to learn from failures focuses on identifying, reporting, and understanding them and the capacity of finding and implementing solutions. Edmondson [85] defines that the ability to detect failures is not always easy because organizations tend to hide them. However, if failures are only solved and not learned from, the error will keep occurring [89], [90].

Table I elaborates on studies based on our systematic literature review. Appendix A provides more information on the methodology.

4) Research Question: Based on the above, we conclude that the three aspects of transactive memory, knowledge sharing, and learning from failure are relevant concepts for improving innovation performance but have not been sufficiently studied in their combined effects. Studying their combined effects is particularly important. Collaborative innovation through transactive memory, knowledge sharing, and learning from failures is expected to enhance military organizations' innovation performance, ensuring their ability to defend and protect. Thus, this research focuses on the three identified facets of collaboration as essential enablers for the innovation required to address the grand challenge of public safety. Specifically, we define the following research question.

> *How do Transactive Memory, Knowledge Sharing, and Learning From Failure affect Innovation Performance?*

III. Theoretical Framework and Hypotheses

A. Justification and Operationalization of Innovation Performance

Innovation is essential for organizations—not being able to innovate might have substantial negative consequences. For private companies, this might result in low sales or bankruptcy

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TABLE I
LITERATURE TABLE

Reference	TM	KS	LFF	IP	Additional variables	Methodology
Ali et al. [43]	Me			DV	Absorptive capacity (Me) Social media (IV)	Quantitative
Argote [61]	IV	IV			Organizational learning (DV) Absorptive capacity (IV)	Theoretical
Argote and Miron-Spektor [55]	IV	IV			Organizational learning (DV) Shared values and beliefs (IV)	Theoretical
Baumard and Starbuck [81]			DV	IV	Learning from success (IV) Organizational learning (IV)	Qualitative
Bertels et al. [91]	IV	DV			Supportiveness for innovation (Mo)	Cross-sectional study
Caron et al. [35]		IV	DV		Organizational support and commitment (IV)	Longitudinal case study
Choi et al. [67]	IV	Me			Performance (DV) IT support (IV)	Quantitative
Dahlin et al. [80]		IV	DV		Many	Theoretical
Edmondson [85]			DV	IV	Culture (IV)	Theoretical
Frenz and Ietto-Gillies [92]	IV	IV			Creativity (DV) Openness (IV)	Quantitative
Gino et al. [75]	Me	IV		DV	Different types of experience (Mo)	Quantitative
Ittner et al. [93]		IV		IV	Organizational performance (DV) Cost production volume (IV)	Quantitative
Kim and Lee [82]		IV	IV		Organizational performance (DV) Openness (IV), Absorptive capacity (IV)	Quantitative
Kotlarsky and Oshri [24]			IV	DV	Social ties (IV)	Quantitative
Lewis et al. [64]	IV	DV			Shared values and beliefs (Mo) Effective communicating (Mo) Group stability (Mo)	Longitudinal experiment
Maurer et al. [76]		Me		DV	Teams' performance (DV) Social capital (IV)	Quantitative
Nevo and Wand [68]		IV		DV		Theoretical
Oshri et al. [66]	IV	DV			Shared values and beliefs (Mo) Cultural distance (Mo)	Case study
Schmickl and Kieser [78]	IV	DV			Common language (Mo) Different perspectives (Mo)	Case study
Taylor and Wright [74]		DV	IV		Organizational climate (IV) Vision (IV), Information quality (IV)	Mixed methods
Tsai and Wang [46]		IV		DV	Collaboration with external partners (Mo) Internal investment (Mo)	Quantitative
Welch and Steen [87]		IV	IV		Improved policies and practices (DV) Organizational support and commitment (IV)	Theoretical
Wilhelm et al. [94]	Mo		IV	DV	Performance organization (DV) Psychological safety (Mo)	Quantitative
Yao and Chang [95]		IV		DV	Absorptive capacity (IV) Climate for innovation (Mo)	Quantitative
Zhao and Chadwick [47]		IV		DV	Strategic orientation (IV) Rewards and training (IV)	Quantitative
Zhu et al. [96]		IV	Me	DV	Support for changes (IV)	Quantitative
This study	IV	Me	Me	DV	Support for Innovation (Mo) Shared Vision (Mo)	Mixed methods
DV= Dependent variable, IV= Independent variable, Me= Mediator variable, Mo= Moderator variable						

TABLE II
CORRELATION REGRESSION VARIABLES

	M	SD	TSpe	TCr	TCor	KS	LFF	IP	SV	SI	OPP	Gen	CM	Exis	DurW	NrEm	InEx
TM Specialization (TSpe)	0.02	0.44															
TM Credibility (TCr)	0.06	0.39	0.32														
TM Coordination (TCor)	0.06	0.87	0.25	0.15													
Knowledge Sharing (KS)	0.04	0.46	0.25	0.30	0.42												
Learning from Failure (LFF)	0.07	0.46	0.29	0.35	0.36	0.56											
Innovation Performance (IP)	0.07	0.80	0.21	0.18	0.35	0.37	0.49										
Shared Vision (SV)	0.06	0.70	0.19	0.13	0.28	0.26	0.27	0.29									
Support for Innovation (SI)	0.05	0.84	0.20	0.11	0.30	0.30	0.24	0.17	0.43								
Openness (OPP)	2.01	7.02	0.11	0.18	0.14	0.13	0.23	0.39	0.11	0.13							
Gender (Gen)[a]	1.24	0.51	0.02	0.05	–0.06	–0.08	0.06	0.19	0.00	0.03	0.78						
Civilian/Military (CM)[b]	1.73	0.55	0.07	0.12	0.07	0.06	0.18	0.34	0.07	0.08	0.96	0.91					
Existence of unit (Exis)	1.93	0.68	0.04	–0.08	–0.03	–0.04	–0.03	0.03	–0.08	–0.20	–0.03	–0.14	–0.07				
Average years working for unit (DurW)	4.54	3.82	–0.05	–0.13	0.14	0.04	–0.05	0.06	0.10	0.15	–0.02	–0.02	–0.02	0.19			
Number of employees (NrEm)	2.85	1.14	0.02	0.04	0.16	0.08	–0.01	–0.12	0.04	0.13	–0.01	0.02	–0.02	0.00	0.05		
Innovation experience (InEx)	14.88	16.95	–0.03	0.05	0.08	0.05	–0.06	0.04	0.05	0.19	–0.01	0.00	–0.01	-0.09	0.05	0.37	
Total Experience (ToEx)	2.75	2.67	0.09	0.03	–0.15	–0.18	–0.19	–0.09	–0.11	0.09	0.05	0.06	0.05	0.06	-0.06	-0.02	0.16
Note:	*$p < 0.05$*	*$p < 0.01$*	*$p < 0.001$*														

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[97]. For public organizations, "innovation can contribute significantly to a country's economic growth and prosperity directly by reducing the cost of delivering public services and by increasing the quality and array of those same services" [98]. Innovation is needed in a military environment to ensure that the military can provide safety for citizens and themselves. Innovation guarantees that an army is at least as good as the enemy's [7]. It is, thus, clear that all organizations, including the military, should innovate.

Baregheh et al. [2, p. 1334] define innovation as "the multistage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete, and differentiate themselves successfully in their marketplace." Innovation is an essential aspect of all organizations' survival [82], and as a highly knowledge-intensive task, it requires organizations to have the relevant knowledge to find the best innovation opportunities [43], [44], [46], [47]. There are different forms of innovation. Organizations can innovate their products, processes, or strategies [47], [99], and even people [2].

Innovation performance can be operationalized by, for example, the amount of sales of innovative products [99], the number of patents an organization requests [100], or the number of innovative ideas [101]. Maurer et al. [76] explain innovation performance as developing better products, which seems suitable in an engineering context. Well-known factors for measuring innovation performance are thus patents R&D expenditure, trademarks [100], number of ideas/projects [101], or literature-based innovation output [102]. However, innovation output is more difficult to assess in military contexts. It can be seen as the innovative activities' impact on the organization [103]. The innovative output can, for example, be that it takes less time to implement a new idea than previously [104]. In this study context, employees' behavior also has an enormous impact on the organization's performance [96], [105]. Innovative behavior is defined as "the intentional introduction and application of new ideas, products, processes, and procedures to work roles, units, or organizations" [106, p. 352].

B. Direct Effects on Innovation Performance

1) Direct Effect of Transactive Memory: Multiple researchers have found a direct relationship between Transactive Memory and enhanced organizational performance [24], [64], [66], [67]. However, not much attention is paid to Transactive Memory and innovation performance. Only a few studies have found evidence of a positive relationship between these variables. Ali et al. [43] and Argote [61] show that knowing who knows what increases teams' innovation performance. Knowing who knows what increases teams' innovative performance by allowing them to better utilize each other's knowledge [1], [56], [62]. We expect that the positive influence of Transactive Memory on innovation performance is especially important in the specific context of Public Defense as a major problem in a military environment is the difficulty of locating specialized knowledge [107]. Consequently, Veestraeten et al. [108, p. 78] state that: "Military teams especially benefit from collectively built knowledge structures that enable better coordination and more effective task execution [...]."This coordination via Transactive Memory is indispensable for the success and improvement of multinational military operations [109].

Additionally, Transactive Memory improves collaborative innovation by reducing the time and resources required to find the right people [24]. Again, this is especially important in a military setting with a typically dynamic environment of emerging threats, where timely access to knowledge across the organization is essential [110]. Argote [61] elaborates that the knowledge of who knows what helps save time. In addition, Lewis [59] and Gino et al. [75] state that Transactive Memory increases speed and quality within teams.

In sum, innovation builds on developing and implementing new ideas based on novel (re)combinations of existing knowledge elements [111], which requires knowledge about who knows what. Cross-functional teams, often innovation teams, have diverse knowledge that could benefit from Transactive Memory [94]. Overall, teams without Transactive Memory are expected to need more time and resources to find out who knows what. Thus, it is expected that organizations with sufficient Transactive Memory will enhance their innovation performance. We therefore anticipate the following.

H1: Transactive Memory positively influences Innovation Performance.

2) Direct Effect of Knowledge Sharing: Once you have the knowledge of who knows what, the next step is sharing that knowledge. As mentioned, different organizational characteristics will have different effects on knowledge sharing. In military organizations, we often witness a durable common corporate identity acquired during military training [112]. This creates an environment of trust and strong social relations among the members of the same command, enhancing knowledge sharing [112], [113]. While knowledge sharing within the same command is not usually problematic, the motivation to share knowledge with outsiders might be hindered by a group's overall lack of social cohesion [110], [112].

Moreover, concerns about security, confidentiality, and fear of punishment for incorrect exchange of information are identified as important barriers to knowledge sharing within military organizations [112]. Nevertheless, military innovation is based on a continuous process of knowledge sharing [114]. According to the meta-analytical review by Wijk et al. [54], knowledge sharing ensures a broader knowledge base. As innovations are built on diverse and broad knowledge bases, it is essential to share knowledge, as highlighted by Caron et al. [35]. Sharing knowledge increases the organization's overall innovation performance as well as the individual innovation projects [47], [115]. In addition, Gino et al. [75] found that indirect experience and broader knowledge enhance teams' creativity. The NATO Communication and Information Agency highlights that people's knowledge is their most valuable asset and pleas for the culture of "responsibility-to-share" [112], [116]. In sum, we anticipate a positive effect of knowledge sharing on innovation performance [94].

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H2: Knowledge Sharing positively influences Innovation Performance.

3) Direct Effect of Learning From Failure: As discussed, Learning From Failure is a part of organizational learning. Both concepts are found to impact organizational and innovation performance. Researchers have proven that Learning From Failure impacts future performance because it helps to prevent failures [23], [35], [80], [81], [87], [88], [90], [94]. Although military organizations are often referred to as high-reliability organizations that can operate safely in complex and dangerous situations [117], failures within such a context can have very serious consequences. Think of the loss of civilian and military lives, a state's reduced relative power, or possible destruction [114]. Consequently, major challenges that are facing high-reliability organizations, such as the military, are learning from failures and innovating without upsetting the internal processes that enable their reliability [118].

Moreover, defense sector budgets were reduced after the Cold War [119]. Such reductions have forced military organizations to use research and innovation resources prudently. According to Tucker and Edmondson [89], resources can be saved by preventing mistakes, as correcting these takes much time, effort, and money. Cannon and Edmondson [120] state that organizations can prevent massive failures by learning more from minor mistakes. Cyert and March [121] explain that preventing massive failures enables innovation. Besides, Maslach [86] elaborates that failures provide opportunities to improve future innovations by identifying problems. The knowledge gained from past mistakes can help prevent future failures and learning from nonconformance activities increases an organization's effective handling of failures [93]. Tsai and Wang [46] find that learning from others' mistakes improves Innovation Performance. It is crucial to bear in mind that Learning From Failure cannot be achieved by only knowing the failures [83]. Despite learning from failure's positive impact on innovation performance, it is not always reported in the literature. Kim and Lee [82] elaborate that when problems are identified, and solutions found, Learning From Failure does not improve Innovation Performance. However, there is enough evidence to suggest the following hypothesis.

H3: Learning From Failure positively influences Innovation Performance.

C. Indirect Effects

Although hypotheses 1, 2, and 3 focus on the direct effects of Transactive Memory, Knowledge Sharing, and Learning From Failure, these variables are expected to have both direct and indirect effects.

1) Indirect Effect of Transactive Memory Through Knowledge Sharing: Knowledge Sharing is expected to be positively influenced by knowing who knows what (Transactive Memory). Numerous studies have already proven this relationship. Learning from indirect experience, comparable to Knowledge Sharing, is facilitated by Transactive Memory [55], [61], [69], [75]. According to Argote [61], Transactive Memory will facilitate the gathering and sharing of knowledge throughout the organization. Through this facilitation, Transactive Memory reduces the resources required to identify specialists in the organization [78]. Moreover, Transactive Memory increases knowledge allocation among individuals [66], [68]. While researchers such as Argote [61] demonstrate the effect of Transactive Memory on Knowledge Sharing, Nevo and Wand [68] explain that Knowledge Sharing is dependent on the ability to create collective memory (Transactive Memory). Furthermore, Choi et al. [67] report a positive impact of Transactive Memory on Knowledge Sharing. Considering the hypothesized effect of Transactive Memory and Knowledge Sharing on Innovation Performance, we propose Hypothesis 4.

H4: Knowledge Sharing mediates the relationship between Transactive Memory and Innovation Performance.

2) Indirect Effect of Transactive Memory Through Learning From Failure: According to Wilhelm et al. [94], the information resources gained through a TMS are essential for Learning from Failure. Furthermore, a shared process for encoding and retrieving, a necessity for Transactive Memory, relates to the learning activities [66]. Akgün et al. [60] also report that Transactive Memory has a positive impact on Learning From Failure. Although only a few studies include both Transactive Memory and Learning From Failure [94], multiple articles combine Transactive Memory and Organizational Learning [55], [61], [68], [69]. Many researchers found that learning processes are impacted by Transactive Memory in a team or organization [55], [60], [94]. Having an organizational memory helps to embed the lessons learned in the organization [61]. Transactive Memory can be seen as a particular form of organizational memory focusing on knowing who knows what. The metaknowledge gained through TMSs enhances organizations' learning activities [55]. According to Lewis et al. [64], this TMS enhances learning performance by broadening learning activities, thanks to a broader focus related to the Specialization aspect. Because it was hypothesized that Learning From Failure impacts Innovation Performance directly, this study hypothesizes that Learning From Failure mediates the relationship between Transactive Memory and Innovation Performance.

H5: Learning From Failure mediates the relationship between Transactive Memory and Innovation Performance.

3) Indirect Effect of Knowledge Sharing Through Learning From Failure: Caron et al. [35] illustrate that developing a learning culture, as well as sharing knowledge, forms the basis of Learning From Failure. Additionally, Edmondson [85] elaborates on the need for this supportive and sharing culture as a crucial aspect of learning. Learning from indirectly shared experiences increases with Knowledge Sharing [96], and the new knowledge acquired from this experience enhances the ability to absorb the lessons from past failures [93]. In their study on public services, Taylor and Wright [74] conclude that Knowledge Sharing depends on the acceptance of—and learning from—failure. Dahlin et al. [80] relate this aspect to the opportunity of Learning From Failure. Because several researchers

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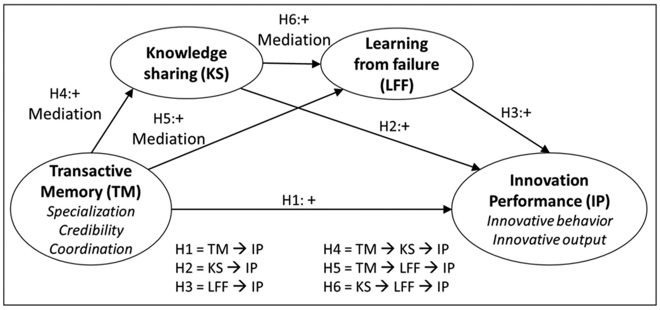

Fig. 1. Conceptual model.

highlight the importance of knowledge sharing for learning from failure [35], [74], [87], we postulate the following.

H6: Learning From Failure mediates the relationship between Knowledge Sharing and Innovation Performance.

D. Full Model

Fig. 1 summarizes the hypotheses. Transactive Memory, Knowledge Sharing, and Learning From Failure are hypothesized as impacting Innovation Performance directly and indirectly. Innovation Performance is expected to be affected by Transactive Memory (H1). Because new knowledge is widely recognized as essential for Innovation [43], [45], [47], Innovation Performance is hypothesized to be dependent on Knowledge Sharing (H2). Furthermore, opportunities to improve Innovation Performance are provided by Learning From Failure (H3) [46]. As an indirect path, Transactive Memory is also expected to enhance Knowledge Sharing [61], which suggests mediation of Knowledge Sharing between the Transactive Memory and Innovation Performance relationship (H4). Consequently, Transactive Memory seems to enhance learning and enable the implementation of new solutions [61], suggesting another mediation path: Learning From Failure between the Transactive Memory and Knowledge Sharing relationship (H5). Finally, Knowledge Sharing seems to be a necessary condition to Learn From Failure [80], forming the final hypothesis: the mediation of Learning From Failure on the relationship between Knowledge Sharing and Innovation Performance (H6).

IV. Methodology

This section details the methodology for our research. It begins with an overview of the research process, followed by the survey methodology, and measurements. We then discuss the analysis strategy, including the confirmatory factor analysis (CFA) applied to develop factors.

A. Research Process and Design

Fig. 2 illustrates the research process and design. For this study, we used a combination of inductive and deductive approaches [122]. That is to say, first exploratory in our prestudy, then deductively in the survey and second interview round. For the inductive step, we had specific questions about the issues surrounding innovation and an initial notion of important concepts. This is a typical step for theory building in case study research [123], [124]. The unit of analysis was innovation teams, consisting of members from different military organizations or states.

The research started with a preliminary study examining what factors influence innovation and why collaborative innovation is so difficult. Appendix B is an overview of the questions we asked in the two interview rounds conducted. The first round of interviews aimed to uncover the root causes of innovation problems in NATO and its allies. Afterward, specific discussions took place, based on the interview protocol for round 1 and using a first draft of the cause-and-effect diagram. The types of questions we asked, in line with a predeveloped interview guide, were: Do you see innovation issues in NATO and Allies? If so, why do you think this is a problem? What could be the cause of this problem? Is that the real cause, or is something else causing it? All interviews were transcribed by the first author and analyzed by the team of researchers.

The interview round 1 questions were thus broad and related to innovation problems and challenges. For this round, we also developed and discussed a cause-and-effect diagram of problem causes and consequences with the respondents. This was the direct input for developing our conceptual model. Appendix C provides details of the interviews. Subsequently, we conducted a literature study to substantiate our research framework, resulting in a conceptual model operationalizing the variables. Then we compiled a questionnaire and used the collated survey data to test the model. The model was further validated through a second interview round. At this stage, we discussed potential implications of the model with the round 2 interviewees. We elaborate on the survey methodology in the following section.

B. Survey Methodology

The research's sampling method is a mix between snowballing and convenience sampling. This is not probability sampling, which implies that not all innovation units in the population have an equal chance of being included in the study. Snowball sampling means that the first cases are used to find other cases. Each participant in this research was asked for contacts in other innovation units. The first innovation units were selected based on easy access to these teams, meaning a convenience sample [125]. The aim was to speak to at least one team member to gain in-depth information on the innovation unit. The questionnaire was developed in Qualtrics, and distributed via email, accessible via an anonymous hyperlink.

C. Measurements

For each of the identified variables, we found measurements and, where necessary, adapted them to match the scope of this research.

Innovation Performance is the most difficult variable to measure. Well-known measurement indicators are mentioned in Section III-A. Gómez et al. [45] state it is crucial to take multiple

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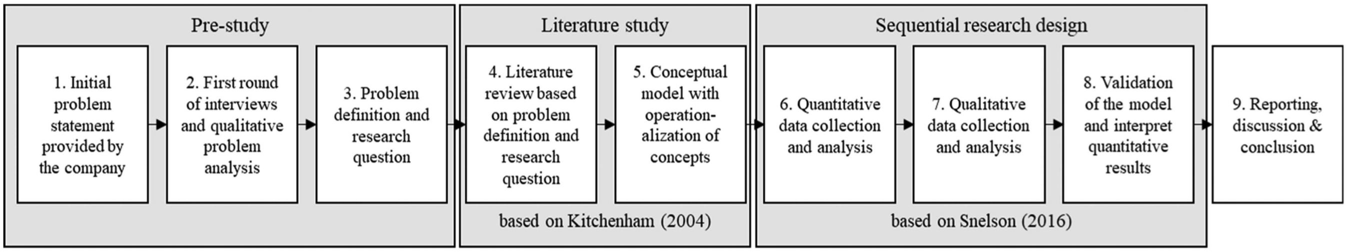

Fig. 2. Research process and design.

measurements into account for innovation performance. We applied two measurements: one innovation behavior measurement developed by Litchfield et al. [106] using items adapted from [126] and [127]. This uses a five-point Likert scale (1 = never, 5 = always) in responding to statements about experiences over the past 12 months. No Cronbach Alpha was reported for the final measurements. The second measurement focused on the innovation unit's performance output impact. A measurement for this was developed by Lazzarotti et al. [103]. By measuring the impact on five aspects, using a four-point Likert scale (1 = "disagree", 4 = "agree") the outcome was $\alpha = 0.91$. Several researchers, including Aloini et al. [104] and Bengtsson et al. [128], have adopted this measurement.

For Transactive Memory, we used the measurement developed by Lewis [56]. Akgün et al. [60] used this measurement as well as many other researchers [53], [58], [61], [75], [94], [129]. Lewis [56] created the measurement comprising three aspects: specialization, credibility, and coordination. Each of the three aspects was measured using five statements, so 15 in total, on a five-point Likert scale (1 = "strongly disagree," 5 = "strongly agree"). A sufficient α was reported for each individual measurement by Lewis [56] and Argote [61] reported $\alpha = 0.78$ for all the measurements.

Bock et al. [130] developed the measurement for Knowledge Sharing: 5 items using a five-point Likert scale (1 = "strongly disagree," 5 = "strongly agree"). Although this measurement was originally developed for the individual level, we found it the best one, since no measurement was identified at team level. Consequently, we adapted the statements to match the scope of our research. The initial α was 0.92 [130], and this measurement was used again by Cabeza-Pullés et al. [131] ($\alpha = 0.92$) and adapted by Chow and Chan [132] ($\alpha = 0.89$).

Learning From Failure was measured using seven statements on a five-point Likert scale (1 = "strongly disagree," 5 = "strongly agree") developed by Carmeli et al. [88]. Carmeli et al. [88] based these statements were used in [89] and they were used again by Carmeli et al. [23] and Carmeli and Gittell [84]. We found an α of 0.89 for this measurement and added one statement as a result of the pretest.

We also included control variables, such as personal and innovation unit characteristics. Personal characteristics were gender, whether the individual was a civilian or in the military, and years of work experience in innovation. The information gathered on innovation unit characteristics were the organization (NATO, Ministry of Defense, and in which country, or Center of Excellence), the size and age of the unit, the average number of years an employee has worked there, and the unit's openness is considered an essential aspect of innovation to be taken into account as control variable [45], [103]. We applied [105] measurement for openness, which observes openness in terms of breadth and depth. We gave the respondents 16 external sources to indicate at what level they used them (on a 4-point scale), and they reported $\alpha = 0.83$. Depth was calculated using the mean score of the Likert scale. And to calculate breadth, we adapted the four-point Likert scale to a binary scale (first point is 0; second, third, and fourth points are 1), and the sum of the binary answers gave the breadth. This measurement has also been done using fewer external sources (Garcia et al. [133] used 8, and Salge et al. [134] used 12). This research used eight knowledge sources for all measurements (Suppliers, Clients, Competitors, Consultants, Universities, Research institutes, Commercial laboratories/R&D enterprises, and Government agencies) as well as think tanks, added after the pretest.

D. Data Analysis, Including Confirmatory Factor Analysis and Regression

The size of the survey sample was 166 respondents (31 NATO, 43 COE, 87 MOD, and 5 others). We analyzed the gathered data with the program RStudio (RStudio, n.d.), which defines the measurements, consisting of multiple statements applying Likert-scales. To check if the measurements worked in the new population, we used CFA. CFA is used to validate and develop latent constructs [135]. The CFA models were validated by observing the Chi-square, CFI, and RMSEA. Reliability was checked by observing the Cronbach alpha. According to Brown and Schutte [136], the RMSEA should be lower or close to 0.06, and the CFI should be higher or close to 0.95. The chi-square p-value should be higher than 0.05, indicating a nonsignificant p-value, which shows there are similar samples and model covariances [137]. The Cronbach alpha should be between 0.7 and 0.9 since lower indicates missing items and higher indicates redundant items [138].

To identify the effects between variables, we put the newly developed latent variables in different regression models. To assess regression models, the data must meet four assumptions: there must be a linear relationship, there should be homoscedasticity, observations must be independent, and data should be normally distributed [139].

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TABLE III
DIRECT EFFECT REGRESSIONS (MODELS 1, 2, 3, AND 4; DV = IP)

Dependent Variable = Innovation Performance	**Model 1**		**Model 2**		**Model 3**		**Model 4 (H1)**	
	B	**Se B**	**B**	**Se B**	**B**	**Se B**	**B**	**Se B**
(Intercept)	–1.23$^{(1)}$	0.44	–1.64$^{(2)}$	0.47	–1.08$^{(3)}$	0.41	–1.22$^{(4)}$	0.45
Gender (Gen)	0.12	0.12	0.14	0.12	0.12	0.11	0.12	0.11
Civilian/Military (CM)	0.05	0.11	0.02	0.11	0.07	0.10	0.06	0.10
Ave years worked in unit (DurW)	0.03	0.06	0.03	0.06	0.06	0.05	0.06	0.05
Existence of unit (Exis)	–0.20$^{(1)}$	0.08	–0.19$^{(1)}$	0.08	–0.20$^{(2)}$	0.07	–0.19$^{(1)}$	0.08
Number employees (NrEm)	–0.09	0.06	–0.05	0.07	–0.03	0.06	–0.02	0.06
Innovation experience (InEx)	0.19	0.12	0.16	0.12	0.18	0.12	0.16	0.12
Total experience (ToEx)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Openness (OPP)	0.04$^{(3)}$	0.01	0.04$^{(3)}$	0.01	0.04$^{(3)}$	0.01	0.03$^{(3)}$	0.01
TM Specialization (TSpe)	0.12	0.14	0.10	0.14	0.02	0.13	0.02	0.14
TM Credibility (TCr)	0.34	0.31	0.15	0.32	–0.03	0.30	–0.07	0.31
TM Coordination (TCor)	0.24$^{(3)}$	0.08	0.19$^{(2)}$	0.07	0.17$^{(1)}$	0.07	0.16*	0.07
Knowledge Sharing (KS)			0.77$^{(1)}$	0.34			0.25	0.34
Learning From Failure (LFF)					0.65$^{(3)}$	0.13	0.61$^{(3)}$	0.14
R^2	0.299		0.322		0.394		0.3964	
F	5.73$^{(3)}$		5.84$^{(3)}$		7.98$^{(3)}$		7.38$^{(3)}$	

Note: $^{(1)}p < 0.05$. $^{(2)}p < 0.01$ and $^{(3)}p < 0.001$.

V. RESULTS

A. Factor Testing

Since this research measured latent variables, the factors were first determined using CFA, for which three assumptions must be met. First, the sample size must be relatively large and $n = 166$ met this assumption. Second, the data must be continuous and normally distributed [135]. Normality was checked by observing Skewness (must be <3) and Kurtosis (must be <10), which did not seem problematic. All factors, except Innovation Performance (consisting of Innovative behavior and Performance output indicators) were individually developed and checked for a correct fit. The three Transactive Memory concepts, Coordination, Credibility, and Specialization, were developed separately, since the construct including all three latent variables had a poor factor fit (CFI = 0.84, RMSEA = 0.09, and chi-square p-value <0.001). Harman's single-factor test clearly showed insufficient evidence that other factors should be developed [140]. Appendix D presents all the developed factors with their factor fit indicators.

B. Direct Effects

The relationship between variables was accessed using multiple regression after checking what assumptions the data must meet to use this. The data were normally distributed, with no outliers, and regarding the residual and regression plots, the relationships between independent and dependent variables were linear [139]. Next, the Cronbach alpha (all higher than 0.6) indicated reliable measurements. Finally, we checked homoscedasticity with the Breusch–Pagan test.

Table III lists the first four regression models, which can all (Dependent variable (DV) = IP) be considered significant. The R2 showed substantial variance increase by adding Knowledge Sharing (model 2) and Learning From Failure (model 3). Analysis of VIF scores and the Breusch–Pagan test showed no evidence of multicollinearity or heteroscedasticity in any model. As we will later elaborate, the three aspects of Transactive Memory did not form a second-order factor and all aspects were individually assessed.

TABLE IV
EFFECTS ON DEPENDENT VARIABLES KS AND LFF (MODELS 5, 6, AND 7)

	Model 5 (DV = KS; H2)		Model 6 (DV = LFF; H3)		Model 7 (DV = LFF; H4)	
	B	Se B	B	Se B	B	Se B
(Intercept)	0.73$^{(3)}$	0.01	0.07$^{(1)}$	0.03	–0.68$^{(3)}$	0.13
TM Coordination (TCor)	0.09$^{(3)}$	0.02	0.16$^{(3)}$	0.04	0.07	0.04
Knowledge Sharing (KS)					1.03$^{(3)}$	0.18
R^2	0.221		0.149		0.304	
F	14.76$^{(3)}$		9.09		16.92$^{(3)}$	

Note: $p < 0.1$. $^{(1)}p < 0.05$, $^{(2)}p < 0.01$, and $^{(3)}p < 0.001$

Model 1 only showed evidence of the effect of Transactive Memory Coordination on Innovation Performance (B = 0.24, $p < 0.001$), not Specialization and Credibility. This partly supports Hypothesis 1. When Knowledge Sharing was added to model 2, the impact of Transactive Memory Coordination dropped (B = 0.19, $p < 0.01$), but this model supports Hypothesis 2. Knowledge Sharing impacted Innovation Performance (B = 0.19, $p < 0.01$). The impact of Transactive Memory Coordination was even lower when Learning From Failure (B = 0.16, $p < 0.05$) was added to Model 3. Model 3 supports Hypothesis 3: Learning From Failure impacts Innovation Performance (B = 0.65, $p < 0.001$).

C. Indirect Effects

To check for mediation, both the independent and mediation variables should significantly impact the dependent variable, and the independent variable must impact the mediation variable [141]. These conditions were proven in the first four models, and the interactions between independent and mediation variables were proven in Models 5–7 (see Table IV). Since only the impact of Transactive Memory Coordination was significant, mediation was only tested

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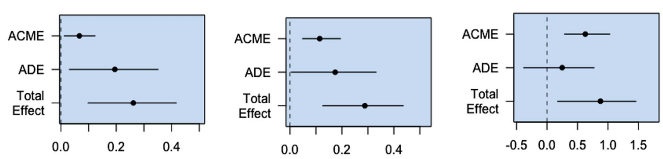
TABLE V
MEDIATION DIRECT, INDIRECT, AND TOTAL EFFECTS

	ACME (indirect effect)	ADE (direct effect)	Total effect
TCor (mediator = KS)	$0.077^{(1)}$	$0.195^{(1)}$	$0.262^{(2)}$
TCor (mediator = LFF)	$0.104^{(1)}$	$0.167^{(3)}$	$0.271^{(2)}$
KS (mediator = LFF)	$0.628^{(3)}$	0.248	$0.876^{(2)}$
Note: $p < 0.1$. $^{(1)}p < 0.05$, $^{(2)}p < 0.01$, and $^{(3)}P < 0.001$.			



(a) (b) (c)

Fig. 3. (a) Mediation KS (TCor). (b) Mediation LFF (TCor). (c) Mediation LFF (KS).

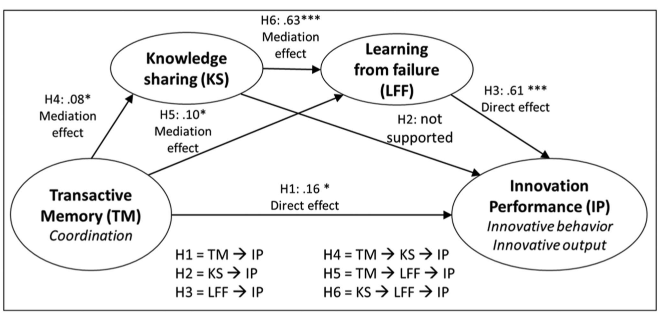


Fig. 4. Empirical model.

with this variable, not Transactive Memory Credibility and Specialization.

The mediation models were estimated with bootstrapping. The two predefined models were mediated using RStudio. The mediation of Knowledge Sharing on Transactive Memory and Innovation Performance was tested in Models 5 and 2, while the mediation of Learning From Failure on Transactive Memory and Innovation performance was tested in Models 6 and 3. As given in Tables IV, V, and Fig. 3(a), (b), the direct effect of Coordination was greater than the expected indirect effect (ACME<ADE). This indication partly supports Hypotheses 4 and 5.

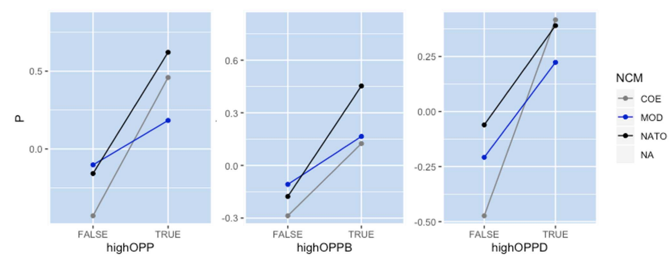
The mediation of Learning From Failure on Knowledge Sharing and Innovation Performance was tested in Models 4 and 7. Here the direct effect became insignificant when adding mediation. Indicating a full mediation of Learning From Failure, this thus supports Hypothesis 6 [see Table IV and Fig. 3(c)].

D. Full Empirical Model With Significant Paths

Based on the regression and mediation results, we developed a full model (see Fig. 4). Clearly, higher Innovation Performance is achieved through serial mediation (see Table VI). The bootstrapping methodology [142] proved serial mediation. As Fig. 4 shows, the indirect effect of Transactive Memory was low and significant. It seems that Knowledge Sharing and Learning From Failure are more important.

TABLE VI
SERIAL MEDIATION TM>KS>LFF>IP

	B	Se B
KS ~ Cor	$0.100^{(3)}$	0.014
LFF ~ TCor	$0.080^{(1)}$	0.041
LFF ~ KS	$1.060^{(3)}$	0.184
IP ~ TCor	$0.161^{(2)}$	0.077
IP ~ KS	0.366	0.335
IP ~ LFF	$0.677^{(3)}$	0.156
Indirect effect := (KS ~ Cor)*(LFF ~ KS)* (IP ~ LFF).	$0.072^{(2)}$	0.024
Note: $p < 0.1$, $^{(1)}p < 0.05$, $^{(2)}p < 0.01$, and $^{(3)}P < 0.001$ ~ connects explanatory variables to the explained variables; := defines the new object.		



(a) (b) (c)

Fig. 5. (a)–(c) Visualization OPP impact on IP.

E. Post HOC: Effect of Openness

It is interesting to note that one of the control variables, Openness, had a significant impact on Transactive Memory in Models 1–4. The variable Openness was assessed by observing a Depth and Breadth aspect. It might be interesting to observe the individual effects of Depth and Breadth to see which is more important. Splitting the data into subgroups—higher than the mean and lower than the mean (for each variable)—could reveal different effects. The separate datasets were divided into organizations: Ministry of Defense, NATO, and COEs. Fig. 5(a) shows that high overall Openness always results in higher Innovation Performance, especially in Center of Excellence teams and least of all in Ministry of Defense teams. High Openness Breadth especially impacts NATO teams' innovation performance, shown in Fig. 5(b). And high Openness Depth has the greatest impact on Center of Excellence teams, see Fig. 5(c).

VI. CONCLUSION

This study aims to advance collaborative innovation as an important approach for public organizations to tackle grand challenges. From our findings, several results stand out. First, by opening up the black box of collaborative innovation, we unravel three critical mechanisms for improving a public organization's innovation performance. Based on our qualitative analysis insights, we suggest that innovation performance is enhanced by one of the three aspects of Transactive Memory, which are knowledge coordination and integration mechanisms, sharing knowledge with organizational members, and learning

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from others' failures. Second, through our quantitative analysis, we reveal that the ways Transactive Memory, Knowledge Sharing, and Learning From Failure affect innovation performance. We show that the knowledge coordination aspect of Transactive Memory has a positive impact not only on innovation performance but also on Knowledge Sharing and Learning From Failure. Surprisingly, Knowledge Sharing has no effect on innovation performance and is fully mediated by Learning From Failure. In turn, Learning From Failure has a greater effect on innovation performance than the two other mechanisms. So, to address the grand challenge of public safety, international military organizations, such as NATO, need to pursue a collaborative innovation process. Importantly, NATO members and their employees need to learn from each other's mistakes. To do so, they must have a proper TMS in place and effectively share the collectively stored knowledge among their organizational members.

A. *Implications for Theory*

Our findings provide several important theoretical implications. Over recent decades there has been growing interest in collaborative innovation in the public sector [6], [11], [143], [144], and the literature on public sector innovation confirms collaboration's positive impact on innovation [3], [145]. Yet, despite this important work, relatively little attention has been paid to which facets of collaborative innovation are relevant and how they enhance innovative performance. Our study unravels three specific and critical mechanisms, and discovers the paths these mechanisms take to influence innovation performance. Hence, our study makes a significant contribution to the literature by providing more detailed insights on collaborative innovation in the public sector. In doing so, we also answer the question raised by Sørensen and Torfing [6], whether collaboration is a viable path to public innovation.

Second, we contribute to the need for more insight on organizational learning and Knowledge Sharing in a specific context, as called for by Argote [61]. It is also essential to take the context into account when studying organizational learning and knowledge concerning the public sector [39]. Our study shows a clear contribution in that respect. We focus on collaborative innovation in a global military organization context not yet apparent in innovation research, despite these organizations having to address grand challenges, such as the security and safety of civilians [7].

Third, by analyzing the specific ways Transactive Memory, Knowledge Sharing, and Learning From Failure influence innovation performance, we indicate the boundary conditions for collaborative innovation to happen within the context of an international public military organization. In doing so, we offer several interesting insights. To begin with, there seems to be little research on Transactive Memory in global organizations [66]. Indeed, previous research shows that sharing experiences and developing team familiarity and transactive memory is more challenging in globally distributed projects [146]. Our study, which takes place within such a global organization, addresses this gap, demonstrating that the coordination aspect of Transactive Memory plays a significant role in advancing innovation performance. Coordination is vital in such contexts as innovation tasks addressing grand challenges often require intensive specialization, group problem solving and decision making, and more rigorous integration [33]. The fact that Transactive Memory's credibility and specialization have no effect is explained by Veestraeten et al. [108]. Their study focuses on Transactive Memory in relation to learning in military teams. They also found that the credibility aspect of Transactive Memory was insignificant, and the specialization aspect impacted coordination.[1] Regarding the nonsignificant impact of credibility, this might be unique to the military. Military personnel need to trust each other unconditionally. Especially in war or mission situations, they depend on one another [147]. This trust and reliability might also be relevant in nonwar teams within the military organization because of the number of high-ranked officers who are accustomed to full trust. This could be an interesting theory for further exploration.

Fourth, Maurer et al. [76] called for more research into the relationship between Knowledge Sharing and innovation performance. We respond to that call by analyzing the effect of Knowledge Sharing on innovation performance in a public organization. Today, public organizations are regarded as knowledge-intensive organizations [148]. This knowledge resides in employees' minds [12], and employees need to share their knowledge with other employees within the organization to optimally utilize this valuable resource [12], [149]. It is generally assumed that Knowledge Sharing is essential to induce innovation [54]. Several studies have shown that Knowledge Sharing positively affects an organization's innovation capability [150], [151]. However, conversely, our study's surprising finding is that the direct effect of Knowledge Sharing on innovation performance is nonsignificant and fully mediated by Learning From Failure. A potential explanation is that, to the best of our knowledge, our study is the first to include Transactive Memory, Knowledge Sharing, Learning From Failure, and innovation performance in one model, given in Table I. As such, an important outcome of our study is that teams first need to draw relevant learning from the shared knowledge before they can have a significant effect on innovation.

Fifth, the final important finding in our study is that Learning From Failure has a relatively considerable effect on innovation. Kim and Lee [82] state that Learning From Failure within organizations is highly dependent on the organization itself and that more contextual research is therefore required. In our case, the context of this study is a global public military organization and focuses on innovation that is complex and difficult to implement. That is why these types of organizations sometimes fail to implement innovation successfully. Our study shows that these unsuccessful implementations are a valuable source of information and provide critical lessons for innovation.

[1] As given in Table II, Specialization and Coordination have a significant correlation of 0.25, indicating this might be the case here as well; however, this was not further analyzed.

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Sixth, although not theoretical, an empirical contribution is through measuring the Innovation Performance variable, an organization's ability to innovate [47]. Earlier research used numerous indicators to measure this capability, such as the number of new products [99], number of patents [100], number of innovative ideas [101], innovative output [103], or innovative behavior [106]. Gómez et al. [45] show that applying different measurements is better than just one.

This study shows that the variables Innovation Behavior, developed by Litchfield et al. [106], and Performance Output Impact, developed by Lazzarotti et al. [103], are useful for measuring a public organization's innovation performance.

Finally, we respond to calls by Jukić et al. [21] and Vries et al. [25] to enhance the number of quantitative studies, and especially mixed-method studies, in the next generation of research on public innovation.

B. Implications for Practice

Our study has shown that (military) organizations need to have a proper TMS in place. This TMS should improve coordination between diverse innovation teams and their projects. The TMS should include all innovation teams and their projects. For example, the Dutch MOD has made a great start at implementing a TMS specifically for innovation. A well-established TMS will also enhance effective Knowledge Sharing. Both are important preconditions for learning. Teams should not only share knowledge but also learn from this knowledge to effectively address a given challenge. If such a challenge is grand and complex, it is often based on a long-struggled solution yet to be found. In such a context, one can learn from success but even more from failure [152]. Accordingly, Learning From Failure is an important mechanism of collaborative innovation to address the grand challenge of public safety. However, Learning From Failure is not straightforward in a public organization where the need for accountability to the public makes it more challenging to create an environment where employees feel safe to fail [74]. Here lies an important task for managers in the public sector. They should make sure that failure is not perceived as something bad but rather as something valuable that should be shared with colleagues across different levels and locations to be able to learn from each other. This can be achieved with the following essential steps.

1) Managers should make sure employees are aware of what Learning from Failure can bring to themselves, the team, and the organization.
2) Employees must have the right skills to learn from their failures. They can achieve such skills through an online/offline course, or via group discussions about how to learn from these mistakes.
3) It is preferable to discuss an employee's mistakes initially in a private and safe environment. Eventually, managers must motivate the employee to share such errors with their colleagues to enable colleagues to equally learn from these mistakes.
4) Awarding employees who are either best in sharing failures or grew the most in sharing failures could increase employees' motivation to share, as well as "address" noncommunicated failures.

C. Limitations and Further Research

There is no official list covering all innovation teams within NATO, so we had to identify these teams ourselves. The process of identifying innovation teams within NATO showed that there seemed to be a lack of coordination between innovation teams. Even the innovation branch (ACT) seemed to have difficulty identifying other innovation teams, this made it difficult to find the relevant innovation teams. The mix of convenience and snowball sampling for the survey, and convenience sampling for the interview, might have resulted in additional relevant players not being considered for inclusion in our study. In addition, only teams that indicated they were innovative teams are included; however, arguably, it might be worthwhile to also study policy teams working on innovation. Second, a large proportion of the survey respondents are from The Netherlands, and therefore, our conclusions need to be generalized to all NATO allies with caution. Consequently, although our results suggest validity to obtain a more in-depth understanding, additional research could provide more data from all relevant innovation teams and all NATO countries.

We suggest other areas for future research. First, the findings presented in this research might also be interesting for other risk-averse bureaucratical organizations in the public sector, such as healthcare, law enforcement, and infrastructure. To validate this, more research should be conducted in different contexts. Second, as Transactive Memory helps to identify who knows what [24], [61], [64], [66], [67], [68], [78], it is proven to help share knowledge [55], [61], [69], [75]. We confirm this finding, but we did not consider the two sides of Knowledge Sharing—sending the knowledge to others and receiving others' knowledge. A future study could help discover if Transactive Memory plays a different role in these two sides of Knowledge Sharing. Furthermore, regarding the aspects of Transactive Memory, our results indicated that only coordination has a significant impact in a military organization. Although this (partly) confirms the findings of [108], this might be interesting to further explore in other contexts. Unlike previous studies, our results demonstrate that Knowledge Sharing has no direct effect on innovation performance in a public military context. This finding may seem surprising and merits further attention. Furthermore, the innovation teams in this study are diverse and relate to different types of innovation. However, this is not explicitly included in our model. Follow-up research could examine the impact of innovation type and team composition on innovation performance. Finally, regarding the nonsignificant impact of the Transactive Memory's credibility, this might be unique to the military. Military personnel need to trust each other unconditionally, especially in war or mission situations where they depend on one another [147]. This trust and reliability might also be relevant in nonwar teams within the military organization because of the number of high-ranked officers who are accustomed to full trust. This could be an interesting area for further exploration.

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APPENDIX A
METHODOLOGY LITERATURE REVIEW

A literature review creates the foundation for research, is used to synthesize research findings and identifies gaps in the existing literature [158]. To explore the concepts identified in the preliminary problem analysis, we conducted an exploratory literature review in order to explore the variables. This review helped define the research problem and research questions more clearly.

The exploratory literature review's theoretical background formed the basis for the systematic literature review we conducted. Most researchers use a systematic literature review for synthesizing research findings in order to identify all the evidence available on a topic. Systematic literature reviews involve developing specific search queries and assessing all the articles found [159]. This methodology is not possible if there are too many articles about a specific topic [158]. This review consists of three main phases and their underlying stages, as determined by [159]. The first two, 1) planning the review and 2) conducting the review, are discussed in this section. The final phase, 3) reporting on the review, is included in the main text.

A. Planning the review

1) The Need for a Systematic Review: This research includes a wide range of variables but does not examine all the variables' interrelationships. It is important to identify all relevant studies that include these variables. The systematic literature review will help identify any research gaps. Although the exploratory literature review includes a few literature reviews about scope variables, however, as these are often about only one variable, it is, therefore, important to conduct a systematic literature review.

2) Development of a Review Protocol: The research question for the literature review is the first subquestion: How do the variables Transactive Memory, Knowledge Sharing, and Learning from Failure interact?

The databases "Web of Science" and "Scopus" are used to collate the literature, with access provided by the Eindhoven University of Technology. We look at the status of the journals in which the collated articles were published (ERIM, n.d.) as well as the year of publication and number of citations, and show these details in the documentation.

B. Conducting the Review

1) Identification of Research: This stage includes developing search strings, according to steps devised by Brereton et al. [160]. We identified synonyms for the main term (if applicable) in the exploratory research analysis and included them in the search strings. In some cases we only took the original term into account, as otherwise there would be too many results to review.

The search strings use the Boolean terms "AND" and "OR." "AND" identifies that both search terms should be included, and "OR" means including synonyms. As given in Table VII, there were no results for a search string including all variables; therefore, we looked at the variables individually. These search strings, however, came up with too many articles to review and making pairs seemed the best option.

TABLE VII
INITIAL SEARCH STRINGS

Search string	**Results Web of Science**	**Results Scopus**	**Included**
TS = ("Transactive Memory") AND TS = ("knowledge transfer" OR "Knowledge Sharing") AND TS = ("Learning from Failure" OR "learning from errors" OR "learning from mistakes")	0	0	**Yes**
TS = ("Innovation performance") AND TS = ("Transactive Memory" OR "knowledge transfer" OR "Knowledge Sharing" OR "Learning from Failure" OR "learning from errors" OR "learning from mistakes")	175	181	**Yes**
TS = ("Transactive Memory")	647	576	No
TS = ("knowledge transfer" OR "Knowledge Sharing")	1335	28208	No
TS = ("Learning from Failure" OR "learning from errors" OR "learning from mistakes")	3874	1047	No
TS = ("knowledge transfer" OR "Knowledge Sharing") AND TS = ("Learning from Failure" OR "learning from errors" OR "learning from mistakes")	0	9	No
TS = ("knowledge transfer" OR "Knowledge Sharing") AND TS = (Learning from Failure)	25	135	**Yes**
TS = ("Transactive Memory") AND TS = ("knowledge transfer" OR "Knowledge Sharing")	82	92	**Yes**
TS = ("Transactive Memory") AND TS = ("Learning from Failure" OR "learning from errors" OR "learning from mistakes")	1	1	**Yes**

2) Study Selection: The goal was to review around 30 articles. In the first assessment round, articles with fewer than 50 citations were not included, unless they were less than two years old or if the journal score was P or STAR. Also, only articles digitally available and in English were accepted. After the first selection of studies, 105 remained for a quality assessment, as given in Table VIII.

3) Quality Assessment: The second assessment round involved reading the abstracts as these should indicate if the article was useful and which variables are central. Articles about more than one of the variables were not included in the systematic literature because the variables were individually studied in the exploratory literature review. Also, articles including an expert opinion were not included because the quality of these articles was lower than for example an experiment. After this round, we fully read 66 articles.

After this second round, we selected 23 articles to include in the systematic literature review. Among this total, some articles were duplicates since they were found in both databases. Of the 23 articles finally included, 8 were found in both data bases, 10 useful articles were found in Web of Science, and 5 useful articles in Scopus.

4) Data Extraction and Synthesis: The two final steps, data extraction and data synthesis, are summarized in Table VIII, with only the final selected articles, based on a full review. Based on the literature found with TM, KS, LFF and Innovation performance, we identified three potentially related variables. We did

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TABLE VIII
SYSTEMATIC LITERATURE REVIEW 1: OVERVIEW

	Search string	Database	Results	Selection round 1	QA, selection round 2	Full article review
#1	TS = (Transactive Memory) AND TS = (knowledge transfer OR Knowledge Sharing OR knowledge acquisition) AND TS = (Learning from Failure OR learning from errors OR learning from mistakes)	Web of science	0	0	0	0
		Scopus	0	0	0	0
#2	TS = ("Innovation performance") AND TS = ("Transactive Memory" OR "knowledge transfer" OR "Knowledge Sharing" OR "Learning from Failure" OR "learning from errors" OR "learning from mistakes")	Web of science	175	30	13	6
		Scopus	181	14	12	5
#3	TS = ("Transactive Memory") and TS = ("knowledge transfer" OR "Knowledge Sharing")	Web of science	82	27	18	8
		Scopus	92	13	9	4
#4	TS = ("Learning from Failure" OR "learning from errors" OR "learning from mistakes") AND TS = ("knowledge transfer" OR "Knowledge Sharing")	Web of science	25	8	6	3
		Scopus	135	11	6	3
#5	TS = ("Transactive Memory") AND TS = ("Learning from Failure" OR "learning from errors" OR "learning from mistakes")	Web of science	1	1	1	1
		Scopus	1	1	1	1
#6	TS = (Innovation performance) AND TS = (Openness)	Web of science	77	34	16	7
		Scopus	102	31	15	7
	Total articles (including duplicates)		**871**	**170**	**97**	**45**
	Total articles					**23**

TABLE IX
SYSTEMATIC LITERATURE REVIEW 2: OVERVIEW

	Search string	Database	Results	Selection round 1	QA, selection round 2	Full article review
#7	TS = ("Support for Innovation" OR "management support innovation") AND TS = ("Transactive Memory" OR "knowledge transfer" OR "Knowledge Sharing" OR "Learning from Failure" OR "learning from errors" OR "learning from mistakes")	Web of science	3	2	2	2
		Scopus	8	3	3	2
#8	TS = ("Shared Vision") AND TS = ("Transactive Memory" OR "knowledge transfer" OR "Knowledge Sharing" OR "Learning from Failure" OR "learning from errors" OR "learning from mistakes")	Web of science	44	19	9	7
		Scopus	91	27	7	5
	Total articles (including duplicates)		146	**51**	21	**16**
	Total articles					**10**

an additional literature search on these variables, following the same procedure (see Table IX).

All the articles are included in Table X. The first column refers to the search string used to identify each article.

APPENDIX B
INTERVIEW PROTOCOLS

A. *Interview Protocol: First Interview Round*

Thank you for agreeing to talk to me about the root causes of the problems regarding innovation, and the role of knowledge in improving innovation performance at NATO and Nations.

I now focus on understanding the problems related to innovation performance. To do that, I would like to ask you some questions. Of course, your answers will be handled confidentially and assuring anonymity. Do you have any questions so far?

If yes, answer the questions.
If no, continue with the interview.

Up to now, I have determined a few causes and subcauses for the problem indicated by the Innovation Branch Head and Innovation Hub Analyst. I will ask you about these later, but first I would like to focus on what you think are the causes of this problem.

Question 1: Do you see any problems regarding innovation at NATO and Allies?

a) **If so, why do you think there is a problem?**
b) **What could be the cause of this problem?**
c) **Is that the real cause or is something else causing the problem?**

(Method: Five times WHY?)

Summarize their answers from your own notes:

d) **Are these all the problems?**

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TABLE X
ALL INCLUDED ARTICLES FOUND WITH THE SYSTEMATIC LITERATURE REVIEW

Search no.	Author	Title	Journal	JOURNAL RATING	Citations	Year
#2	M. Frenz	The Impact On Innovation Performance Of Different Sources Of Knowledge: Evidence From The UK Community Innovation Survey	Research Policy	STAR	477	2009
#2	I. Maurer	The Value Of Intra-Organizational Social Capital: How It Fosters Knowledge Transfer, Innovation Performance, And Growth	Organization Studies	STAR	321	2011
#2	H. Bertels	Communities Of Practice Versus Organizational Climate: Which One Matters More To Dispersed Collaboration In The Front End Of Innovation?	Journal Of Product Innovation Management	P	106	2011
#2	N. Kim	Who Is Leaping Through Failure? The Influence Of Innovation Characteristics On Learning from Failure	Industry And Innovation	N.A.	0	2020
#2	A. Ali	Improving Team Innovation Performance: Role Of Social Media And Team Knowledge Management Capabilities	Technology In Society	N.A.	0	2020
#2	F. Yao, S. Chang	Do Individual Employees' Learning Goal Orientation And Civic Virtue Matter? A Micro-Foundations Perspective On Firm Absorptive Capacity	Strategic Management Journal	STAR	39	2017
#2	Q. Zhu, H. Krikke, M. Caniels	Supply Chain Integration: Value Creation Through Managing Inter-Organizational Learning	International Journal Of Operations & Production Management	P	49	2018
#2	H. Tsai, J. Wang	External Technology Sourcing And Innovation Performance In Lmt Sectors: An Analysis Based On The Taiwanese Technological Innovation Survey	Research Policy	STAR	297	2009
#2	Z. Zhao, C. Chadwick	What We Will Do Versus What We Can Do: The Relative Effects Of Unit-Level NPD Motivation And Capability	Strategic Management Journal	STAR	43	2014
#3	L. Argote	An Opportunity For Mutual Learning Between Organizational Learning And Global Strategy Researchers: Transactive Memory Systems	Global Strategy Journal	P	8	2015
#3	L. Argote, Miron-E. Spektor	Organizational Learning: From Experience To Knowledge	Organization Science	STAR	477	2011
#3	S. Choi, H. Lee, Y. Yoo	The Impact Of Information Technology And Transactive Memory Systems On Knowledge Sharing, Application, And Team Performance: A Field Study	Mis Quarterly	STAR	203	2010
#3	F. Gino, L. Argote, E. Miron-Spektor, G. Todorova	First, Get Your Feet Wet: The Effects Of Learning From Direct And Indirect Experience On Team Creativity	Organizational Behavior And Human Decision Processes	STAR	124	2010
#3	I. Oshri, P. Van Fenema, J. Kotlarsky	Knowledge Transfer In Globally Distributed Teams: The Role Of Transactive Memory	Information Systems Journal	S	108	2008
#3	C. Schmickl	How Much Do Specialists Have To Learn From Each Other When They Jointly Develop Radical Product Innovations?	Research Policy	STAR	19	2008
#3	J. Kotlarsky, I. Oshri	Social Ties, Knowledge Sharing And Successful Collaboration In Globally Distributed System Development Projects	European Journal Of Information Systems	P	186	2005
#3	K. Lewis, D. Lange, L. Gillis	Transactive Memory Systems, Learning, And Learning Transfer	Organization Science	STAR	209	2005
#3	D. Nevo, Y. Wand	Organizational Memory Information Systems: A Transactive Memory Approach	Decision Support Systems	P	101	2005
#4	D. Welch, A. Steen	Repositioning Global Staff Transfers: A Learning Perspective	Human Resource Management	P	4	2013
#4 & #7	W. Taylor	Organizational Readiness For Successful Knowledge Sharing: Challenges For Public Sector Managers	Information Resources Management Journal	N.A.	341	2004
#4	C. Ittner, V. Nagar, M. Rajan	An Empirical Examination Of Dynamic Quality-Based Learning Models	Management Science	STAR	150	2001
#4	J. Caron, S. Jarvenpaa, D. Stoddard	Business Reengineering At Cigna-Corporation - Experiences And Lessons Learned From The 1st 5 Years	Mis Quarterly	STAR	82	1994
#5	H. Wilhelm, A. Richter, T. Semrau	Employee Learning from Failure: A Team-As-Resource Perspective	Organization Science	STAR	0	2020

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TABLE X
(CONTINUED)

Search no.	Author	Title	Journal	JOURNAL RATING	Citations	Year
#6	H. Chen, S. Zeng, B. Yu, and H. Xue	Complementarity in Open Innovation and Corporate Strategy: The Moderating Effect of Ownership and Location Strategies	IEEE Transactions On Engineering Management	P	3	2019
#6	Y. Cho, C. Lee	Effect of Competitive Activity on Innovation and Management Performances in the Structural Context	Science Technology And Society	N.A	0	2019
#6	K. Laursen, A. Salter	Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms	Strategic Management Journal	STAR	5954	2006
#6	J. Love, S. Roper, P. Vahter	Learning from openness: the dynamics of breadth in external innovation linkages	Strategic Management Journal	STAR	227	2014
#6	K. Rangus, M. Cerne	The impact of leadership influence tactics and employee openness toward others on innovation performance	R & D Management	S	9	2019
#6	S. Roper, J. Love, K. Bonner	Firms' knowledge search and local knowledge externalities in innovation performance	Research Policy	STAR	94	2017
#6	S. Roper, P. Vahter, J. Love	Externalities of openness in innovation	Research Policy	STAR	85	2013
#6	C. Wang, T. Chin, J. Lin	Openness and firm innovation performance: the moderating effect of ambidextrous knowledge search strategy	Journal Of Knowledge Management	N.A.	0	2020
#7	J. Lee, C. Chen	Exploring the team dynamic learning process in software process tailoring performance, A theoretical perspective	Journal Of Enterprise Information Management	N.A.	0	2020
#7	Z. Zhang, P. Hempel, Y. Han, D. Tjosvold	Transactive Memory system links work team characteristics and performance	Journal Of Applied Psychology	STAR	135	2007
#8	L. Abrams, R. Cross, E. Lesser, D. Levin	Nurturing interpersonal trust in knowledge-sharing networks	Academy Of Management Executive	N.A.	993	2003
#8	Y. Baruch, C. Lin	All for one, one for all: Competition and virtual team performance	Technological Forecasting And Social Change	N.A.	138	2012
#8	R. Calantone, S. Cavusgil, Y. Zhao	Learning orientation, firm innovation capability, and firm performance	Industrial Marketing Management	N.A.	3486	2002
#8	C. Chiu, M. Hsu, E. Wang	Understanding Knowledge Sharing in virtual communities: An integration of social capital and social cognitive theories	Decision Support Systems	P	3391	2006
#8	C. Lechner, K. Frankenberger, S. Floyd	Task contingencies in the curvilinear relationships between intergroup networks and initiative performance	Academy Of Management Journal	STAR	226	2010
#8	L. Li	The effects of trust and Shared Vision on inward knowledge transfer in subsidiaries' intra- and inter-organizational relationships	International Business Review	N.A.	369	2005
#8	J. Zhang, Q. Zhu, Y. Wang	Social Capital on Consumer Knowledge-Sharing in Virtual Brand Communities: The Mediating Effect of Pan-Family Consciousness	Sustainability	N.A.	9	2019

e) Or are there any more?
If there are more problems, same questions as 1-a) to 1-c).
If there are no more problems, continue.

NATO nations are not aware of other nations' innovation projects nor of the aspects needed to successfully innovate. The next few questions focus on the causes I have determined for these problems.

Take an A3 of the predetermined problems and go through this document discussing all determined root causes and intermediate causes.

So, in this diagram I have colored the given problem red; however, I do not think this is the real problem, I think the problems are: duplicate resources are used, it takes longer to implement innovation, and there is no learning between Nations. These are in dark blue; light blue indicates intermediate causes, and orange shows root causes.

Question 2: Do you understand the differences between the colors?

Question 3: Look along each of the paths. Do you agree these paths could be true?

Question 4: Do you think I have missed out any causes?

Question 5: Do you think the three identified symptoms are true?

a) Or are there perhaps any other symptoms?

For now, these were all my questions; do you have any questions for me? If you are interested, I can send you the finalized cause–effect diagram (or thesis).

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If you have any questions later, feel free to reach out.

B. *Interview Protocol: Second Interview Round*

Position:
Date:
Method:
Duration:

First, I would like to thank you for agreeing to this interview. I would like to discuss the results of my analysis. The interviews will be used for validating these results as well as for recommendations. I would like to ask if I can record this interview because I will not be able to write everything down right now. The recording will only be assessed by myself and used to complete my notes. Neither the notes nor the recording will be shared with anyone. I also emphasize that no classified information should be discussed. I can share my notes with you afterwards so you can check no classified information is included, if you so wish.

Is this okay for you and would you like to receive my notes?

Introduction

I will briefly highlight my research and the focus of this interview. As you might know, I am currently conducting a research project commissioned by the Dutch Ministry of Defense—European representatives of ACT at NATO HQ. I have identified three main problems with relation to innovation at NATO, COEs, and Nations: Knowledge sharing, Transactive Memory, which basically means knowing who knows what, and Learning from Failure.

Transactive Memory

From the provisional results it seems the coordination facet of transactive memory is very important to achieve high innovation performance. This coordination facet is measured with five statements asking whether or not the team experienced misunderstandings and needed to start over a lot. It focuses on coordinating the work in the team.

Do you recognize that this coordination facet of transactive memory is often a problem regarding innovation performance? Could you elaborate?

What would be a practical implication that you think could improve coordination between innovation teams in NATO, COEs, and MODs?

Learning from Failure

Next to the coordination aspect of Transactive Memory, Learning from Failure also significantly impacts innovation performance. The survey measures this by observing the level of failure sharing, acceptance of failure, and the ability to analyze these.

Would you agree that this impacts innovation performance? Could you elaborate?

What functional implications could improve Learning from Failure in these organizations?

Overall

Besides the discussed implications, what would you change tomorrow to improve innovation performance if anything was possible?

If you have any ideas or questions later, feel free to reach out. As I briefly mentioned at the start of this interview, the transcription of this interview will be sent to you for checking and will not be added to the report.

Appendix C
Interview Rounds

TABLE XI
Interview Details

#	Organization	Position	Date	Method	Duration
First interview round					
1	NATO	SACREPEUR Capabilities and Development	2020 February	face to face HQ	approx. 25 min
2	NATO	SACREPEUR Chief of staff	2020 February	face to face HQ	approx. 25 min
3	MOD	Dutch Delegation representative	2020 February	face to face HQ	approx. 25 min
4	NATO	Scientist - Science and Technology	2020 February	face to face HQ	approx. 25 min
5	NATO	Staff member – Defense and Investment	2020 February	face to face HQ	approx. 25 min
6	NATO	Staff member – Logistics and Resources	2020 February	face to face HQ	approx. 25 min
7	MOD	Dutch MOD – Innovation coach	2020 February	face to face NLD	approx. 25 min
Second interview round					
1	MOD	Innovation advisor (The Netherlands)	11-06-2020	Skype	58.43
2	NATO	Head innovation unit ESC	15-06-2020	Skype	28.15
3	COE	C2COE	26-06-2020	Microsoft teams	31.50
4	MOD	Member JHub (UK)	26-06-2020	Skype	43.41
5	NATO	Project employee	30-06-2020	Skype for business	38.34
6	MOD	Allied innovation initiatives researcher (Norway)	30-06-2020	Skype	27.10
7	NATO	Innovation branch employee	02-07-2020	Whatsapp call	36.90
8	NATO	Innovation tiger team	03-07-2020	Google meet	37.27
9	NATO	Science and technology	06-07-2020	Skype	41.09
10	COE	NSFA	07-07-2020	Skype	27.53
11	COE	CIMIC	08/07/2020	Skype	48.23

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APPENDIX D
CONSTRUCT DEVELOPMENT

	Construct items	Factor loading	Uniqueness	CR	CFI	RMSEA	α
Transactive Memory Specialization (TSpe)				**0.68**	**1.00**	**0.00**	**0.67**
T1_1	Each team member has specialized knowledge of some aspects of our projects.	0.65	0.57				
T1_2	I have knowledge about an aspect of the projects that no other team member has.	0.45	0.80				
T1_3	Different team members are responsible for expertise in different areas.	0.67	0.54				
T1_4	The specialized knowledge of several different team members is needed to complete project deliverables.	0.59	0.65				
Transactive Memory Credibility (TCr)				**0.84**	**1.00**	**0.00**	**0.82**
T2_1	I was comfortable accepting procedural suggestions from other team members.	0.73	0.47				
T2_2	I trusted that other members' knowledge about the project was credible.	0.91	0.17				
T2_3	I was confident relying on the information that other team members brought to the discussion.	0.78	0.4				
T2_5	I did not have much faith in other members' "expertise." (reversed)	0.56	0.69				
Transactive Memory Coordination (TCor)				**0.73**	**0.99**	**0.05**	**0.74**
T1_1	Our team worked together in a well-coordinated way.	0.57	0.68				
T1_2	Our team had very few misunderstandings about what to do.	0.51	0.74				
T1_4	We accomplished the task smoothly and efficiently.	0.91	0.16				
T1_5	There was much confusion about how we would accomplish the task. (reversed)	0.54	0.71				
Knowledge Sharing (KS)				**0.80**	**0.99**	**0.07**	**0.85**
KS_1	We often share our work reports and official documents with the other members of the team.	0.69	0.53				
KS_2	Team members offer manuals, methodologies and models to the other team members.	0.72	0.49				
KS_3	Team members often share their experience or work knowledge with the other team members.	0.83	0.31				
KS_4	Team members always offer their knowledge or knowledge requested by members of our team.	0.71	0.49				
KS_5	Team members try to share experience from training effectively with other team members.	0.68	0.54				
Learning from Failure (LFF)				**0.77**	**1.00**	**0.00**	**0.79**
LFF_2	When an employee makes a mistake, the team members in the workplace talk to them, not for the purpose of blaming them, but for the value of learning.	0.71	0.50				
LFF_4	A question such as ''why do we do things this way'' is fully appreciated in our team.	0.46	0.79				
LFF_5	In our team, employees are encouraged to ask questions such as ''is there a better way to develop the capability or get the required result?''	0.65	0.57				
LFF_7	People in this team often speak up to test assumptions about issues under discussion.	0.65	0.58				
LFF_8	When a problem is raised concerning a lack of required resources for completing a task, in addition to providing an immediate solution, my colleagues also inform management and the relevant department about the problem.	0.72	0.48				
Support for Innovation (SI)				**0.83**	**0.99**	**0.05**	**0.86**
SI_1	In my organizaiton, creativity is encouraged.	0.62	0.61				
SI_2	In my organization, our ability to function creativly is respected by the leadership.	0.69	0.52				
SI_3	In my organization a person can get into a lot of trouble being different.	0.89	0.20				
SI_4	The best way to get along in this organization is to think the same way as the rest of the group ®	0.69	0.54				
SI_5	In my organization, people are expected to deal with problems in the same way.	0.61	0.63				
Shared Vision (SV)				**0.83**	**0.99**	**0.08**	**0.86**
SV_1	There is a commonality of purpose in my organization.	0.74	0.45				
SV_2	There is total agreement on our organizational vision across all levels, functions, and divisions.	0.77	0.41				
SV_3	All employees are committed to this organization's goals.	0.82	0.33				
SV_4	Employees view themselves as partners in charting the direction of the organization.	0.79	0.38				
Innovation Performance IP				**0.93**	**0.99**	**0.05**	**N.A.**
IB	Innovative behavior	0.82	0.32				
POI	Performance Output Impact	0.71	0.5				
Innovative Behavior (IB)						*0.90*	
IB_2	This team gave a lot of consideration to new and alternative methods and procedures for their work.	0.77	0.40				
IB_3	Team members often produced new service methods or procedures.	0.89	0.20				
IB_4	This was an innovative team.	0.87	0.25				
IB_5	This team created new ideas for difficult issues.	0.76	0.76				
Performance output impact (POI)						*0.67*	
POI_1	The organization's competence base was enlarged.	0.67	0.55				
POI_3	The time to implement new processes/capabilities was reduced.	0.49	0.76				
POI_4	The level of innovativeness of new processes/capabilities improved.	0.79	0.37				

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