Operational Readiness in Defense Aviation: A Conceptual Model Based on Technology Roadmapping

Emanuel Verderosa[1], Daniel A. Pamplona[1], Mauro Caetano[1]
[1]Brazilian Air Force (FAB) / Aeronautics Institute of Technology (ITA), São José dos Campos/SP, Brazil

***Abstract* — Amid growing geopolitical instability and budgetary constraints, sustaining military Operational Readiness (OR), particularly in defense aviation, is a critical challenge. The literature addresses OR through segmented, non-interchangeable frameworks, leaving its organizational factors fragmented and disconnected from innovation management. This study develops the Conceptual Model for Operational Readiness Assessment (CMORA). From a full-text synthesis of the literature, this study codes the organizational factors that determine OR and those mobilized by innovation processes, and organizes them through a technology roadmapping (TRM) logic adapted to a readiness-pull. The resulting model shows that the same factors (leadership, culture, knowledge management, absorptive capacity, training, and resources) that drive readiness are those on which innovation process management acts, so that OR can be treated as a managed outcome. CMORA offers decision-makers a tool to identify actionable factors and a basis for future quantitative research in defense aviation.**

***Keywords* — Operational readiness; Innovation process management; Technology roadmapping.**

I. INTRODUCTION

Operational readiness (OR), understood as the ability of an organization to react, within a given time frame, to the demands for which it was designed, is a critical prerequisite for the effectiveness of defense aviation. Amid growing geopolitical instability and budgetary constraints, air forces must keep their resources prepared and available to execute their missions [1]. At the same time, low-cost innovative initiatives have reshaped what readiness demands: inexpensive drones now neutralize armored vehicles worth tens of millions of dollars [2], and the accelerated adoption of disruptive technologies (artificial intelligence, cyber warfare, and additive manufacturing) has become a key factor of deterrence and strategic advantage [3]. Sustaining OR under tight budgets while absorbing such innovation is, therefore, a central management challenge [1].

Over the last two decades, OR has been addressed by a substantial and growing body of research, spanning domains as diverse as public health, industry and manufacturing, supply-chain and disaster management, and defense. Each field has produced its own readiness models, indicators and measurement scales.

This breadth, however, carries a structural limitation: the proposed frameworks are segmented by domain, each anchored in its own constructs, calibration and measurement logic. A readiness instrument developed for one sector encodes assumptions that do not carry over to another.

As a consequence, these structural proposals are largely non-interchangeable, and the factors they identify remain fragmented and dispersed across the literature [4]. Even within a single field, readiness is operationalized in divergent ways [5], [10]. To the extent investigated, no approach offers an integrative framework that relates these factors to one another and, in particular, treats OR as an outcome that can be managed through innovation processes.

Innovation process management offers a path to bridge this gap. The OR literature repeatedly identifies organizational factors (leadership, organizational culture and climate, knowledge management, absorptive capacity, training, and resource allocation) as drivers of readiness; these are precisely the factors on which innovation process management acts. In an early example from naval aviation, a knowledge-management process built on flight data improved maintenance, safety and training, translating into higher operational readiness [6]. Consistently, Bashir and Alsaeed [7] show that an organization's capacity to manage innovation rests on dynamic capabilities such as knowledge management, leadership and digitalization; Abrahão and Gomes [8] model how innovation capability emerges across organizational levels; and Marodin et al. [9] show how informal learning fosters team innovation. More broadly, technology roadmapping (TRM) in open-innovation environments delivers strategic alignment, resource efficiency, and cost reduction [10], organizational gains that the readiness literature associates with OR.

The challenge, then, is to establish, grounded in the literature, a conceptual model that relates the organizational factors managed by innovation processes to the organizational factors that determine OR, so that the model itself becomes a target for innovation process management to generate readiness. This study addresses that challenge through two research questions: (RQ1) is it possible to establish a cause-and-effect relationship between innovation process management and operational readiness? and (RQ2) can the OR-related organizational factors identified in the literature be organized within a single integrative model, managed through innovation processes? To answer them, this study synthesizes the organizational factors reported in the literature through a structured thematic coding [11], [12] and organizes them with a TRM logic [10], producing the Conceptual Model for Operational Readiness Assessment (CMORA).

II. LITERATURE REVIEW

A. Operational readiness and its organizational factors

Operational readiness is defined differently across domains, and the contrasts are instructive. At the individual level, de Vries et al. [13] describe it as the degree to which a person is prepared to sustain competent performance in complex, unpredictable environments, noting that the construct remains fragmented, and Koltun et al. [14] tie it to maintaining performance under physical and psychological stress. At the system level, Tan et al. [15] frame readiness as a system's ability to respond to unexpected tasks, and Konwerski et al. [16] as the probability that a system is in a functional state capable of performing its task. At the organizational level, de Rooij et al. [17] expose a preparedness–response gap

E. Verderosa, verderosa@ita.br; D. A. Pamplona, pamplona@ita.br; M. Caetano, caetano@ita.br.

and stress the time frame within which an organization must react, whereas Watson et al. [18] and Domlyn et al. [19] cast readiness as the motivation and collective capacity of an organization to adopt and sustain change. Crossing these levels (individual, system, and organization) and the dimensions of capacity and time, and as summarized in Table I, this study adopts a synthesized concept: operational readiness is the ability of an organization to react, within a given time frame, to the demands for which it was designed.

TABLE I. OPERATIONAL READINESS ACCORDING TO THE LITERATURE

Reference	Operational readiness (key concept)
[13]	Be prepared to operate in complex and unpredictable environments.
[15]	The ability of a system to respond to unexpected tasks.
[17]	Time frame within which an organization should react.
[14]	Maintain adequate performance under physical and psychological stress.
[16]	The probability that a system is in a functional state capable of performing the task.
[18], [19]	Motivation and collective capacity to adopt and sustain an innovation.

Beyond its definition, the OR literature converges (across otherwise disconnected domains) on a recurring set of organizational factors as determinants of readiness: leadership [8], organizational culture and climate [5], knowledge management [6], absorptive capacity [29], training and competencies [20], resource allocation [21], top-management support [22], communication and feedback [23], performance measurement [1], maintenance and logistics [15], stakeholder and workforce engagement [24], and the organization's readiness for change [19]. An early defense example is illustrative: in naval aviation, Haas et al. [6] showed that a knowledge-management process built on flight data improved maintenance, safety and training, raising operational readiness.

B. Innovation management and innovation processes

Innovation management organizes a very similar set of organizational factors, mobilized by the innovation process (structured as motivation, process, and result). The innovation literature identifies innovation strategy [25], ambidextrous and transformational leadership [26], innovative work behavior [26], process innovation [27], technology and digital infrastructure [28], open innovation and partnerships [10], R&D and portfolio management [29], organizational learning [9], change management [30], regulation and governance [31], and organizational structure and ambidexterity [8] as the levers of innovative performance.

These two sets of factors overlap substantially. Because innovation process management operates on the very organizational factors that the readiness literature identifies as drivers of OR, an innovation-management method can be repurposed to manage operational readiness: OR can be treated as an outcome generated by acting through innovation processes on shared organizational factors.

C. Technology roadmapping

Among innovation-management methods, TRM is well-suited to this role. Caetano and Amaral [10] showed that in open-innovation environments (settings that openly encourage innovation) TRM delivers strategic alignment, expanded networking, improved collaboration, resource efficiency, and cost reduction, organizational gains that the readiness literature associates with OR. Their market-pull roadmap is shown in Fig. 1.

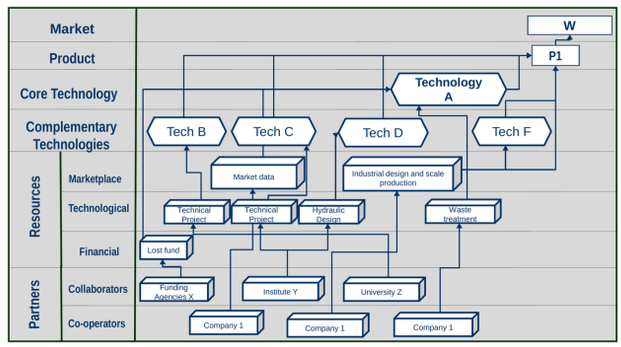

Fig. 1. TRM for innovation planning. Source: adapted from [10].

With the necessary adaptations, the roadmap's ultimate goal shifts from a market segment to operational readiness. The application of TRM, oriented toward OR through innovation processes, is detailed in the Method section.

III. METHOD

This is a conceptual study that builds the CMORA from the literature in three steps (Table II): (i) a systematic search to assemble the evidence base; (ii) thematic coding of the organizational factors that the literature relates to operational readiness and to innovation management, together with the relationships among them; and (iii) organization of these factors through a TRM logic adapted to a readiness-pull, which produces the CMORA. Throughout, TRM is the organizing method and the CMORA is the model it produces.

TABLE II. STEPS FOR CONSTRUCTING THE CMORA

Step	Description	Output
1	Systematic literature search [32]	Evidence base (study corpus)
2	Thematic coding of factors and relations [11], [12]	Organizational factors and their links
3	Organization via TRM, readiness-pull [10]	The CMORA

A. Systematic literature search

A conceptual model is only as trustworthy as the review that feeds it. While narrative reviews risk selective coverage, Kitchenham [32] advocated an explicit, reproducible protocol; and because organizational factors are frequently reported only in the body of a study rather than in its abstract, the protocol pairs systematic identification with full-text reading. The evidence base was assembled from the Web of Science Core Collection (English-language documents, 2021–2026), chosen as a single, curated citation index to keep the protocol fully reproducible; the resulting coverage trade-off is discussed in the Conclusions. Two searches were run, each targeting the organizational factors of one domain: one for operational readiness, with TS=("operational readiness"),

returning 267 documents; and one for innovation, combining innovation-process anchors ("innovation process*", "process innovation", "innovation manage*", "managing innovation", "open innovation", "innovation strateg*") with organizational-factor cues ("organi* factor*", determinant*, enabler*, barrier*, driver*, antecedent*, facilitator*, "key/critical/success factor*", "organizational culture", "knowledge management", "absorptive capac*", ambidext*), returning 2,702 documents (2,969 in total, with no overlap between the two). Titles and abstracts were then screened by a lexical rule that retains a document only when a domain anchor co-occurs with a factor cue; retained documents were ranked by a relevance score computed as anchor hits (weight 1, capped at 4) plus cue hits (weight 2, capped at 4) plus named organizational factors (weight 0.5, capped at 8), with a bonus of 2 for reviews and frameworks. The highest-ranked candidates (fewer than one hundred) were read in full, and documents outside the study scope (notably individual-clinical studies without organizational factors) were excluded, yielding 52 included studies: 24 for innovation and 28 for operational readiness. This selection is summarized in Fig. 2, reported following the PRISMA flow [33]. The two searches thus serve one purpose: to surface, from the literature, the organizational factors involved in operational readiness and in innovation. It is these factors (not the individual studies) that populate the model and Figs. 5–7; conceptual definitions, methodological references, and the worked examples used to build Figs. 3–4 were identified through other methods.

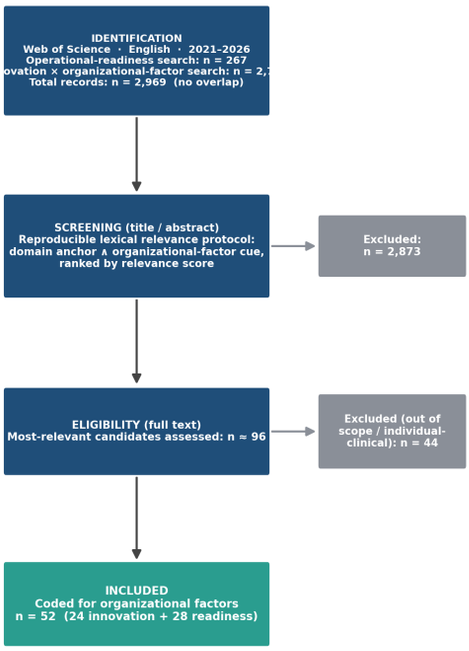

Fig. 2. Literature selection flow: identification, abstract relevance screening and inclusion.

B. Thematic coding of factors and relations

Each study was coded using the thematic analysis process for conceptual model development [11], [12]: the organizational factors a study reports and the causal relationships it proposes were extracted from the full text, never from the authors' own inferences. Factors co-reported by a study were treated as mutually related, and the relationships a study tests were represented as a directed (causal) map.

As an example, Akıncı et al. [26] examine how ambidextrous leadership influences innovative work behavior in a military organization, with the climate for innovation moderating the relationship. The corresponding causal map is shown in Fig. 3.

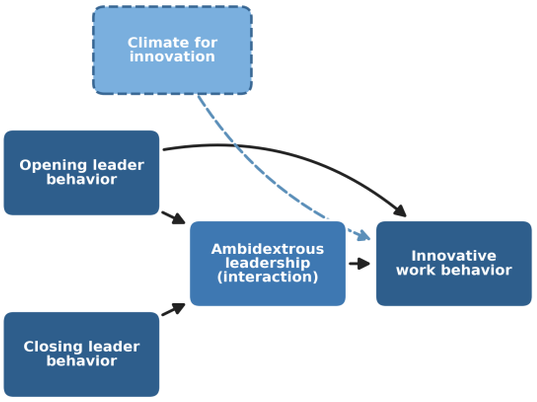

Fig. 3. Causal map of the relationships reported by Akıncı et al. [26].

In Fig. 3, the flow "opening leader behavior → innovative work behavior" indicates a direct, positive effect. "Closing leader behavior" has no isolated significant effect; "ambidextrous leadership (interaction)" denotes that a balanced combination of both fosters innovative behavior; and "climate for innovation" acts as a moderator.

C. Organization through TRM

The coded factors and their relationships were then organized through the TRM logic of Caetano and Amaral [10], adapted so that the top-level pull is operational readiness rather than a market segment. In this readiness-pull roadmap, the organizational factors concatenate and interrelate toward operational readiness as the strategic objective; their consolidation yields the conceptual model presented in Section IV.

IV. RESULTS

Combining the causal maps of individual studies (grounded only in the relationships each study reports) yields the integrated model. Tegethoff et al. [27] analyze how process innovation and Industry 4.0 additive technologies affect operational effectiveness; combining the leadership relations of Akıncı et al. [26] with the process-innovation relations of Tegethoff et al. [27] gives the map of Fig. 4, where innovative work behavior connects to process innovation and, through it, to operational effectiveness (readiness).

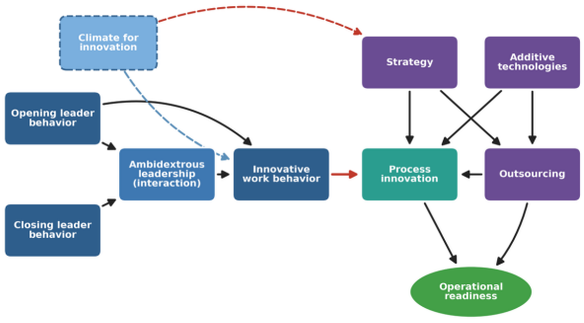

Fig. 4. Combined causal map for Akıncı et al. [26] and Tegethoff et al. [27]; the leftmost block reproduces Fig. 3, extended with the process-innovation relationships.

Consolidating the coded factors through the readiness-pull TRM logic produces the CMORA (Fig. 5). The model arranges the organizational factors into four roles that flow toward operational readiness: innovation process management (the managing mechanism, operationalized through TRM) mobilizes a set of innovation levers (innovation strategy, ambidextrous and transformational leadership, open innovation and partnerships, and R&D/PMO); these act on a core of shared organizational factors (organizational culture and climate, knowledge management, absorptive capacity, training and competencies, innovative work behavior, and resource allocation); which in turn feed the readiness factors (process innovation and technology adoption, readiness for change, maintenance and logistics, and change management) that ultimately generate operational readiness. To avoid ambiguity, the factor labeled readiness for change denotes the motivation and collective capacity of an organization to adopt and sustain change [18], [19]; it is an antecedent, distinct from operational readiness, which is the objective the model generates.

The central result is that the very organizational factors the readiness literature identifies as determinants of OR are those on which innovation process management acts. This is what allows OR to be treated as a managed outcome: by acting through innovation processes on shared factors, the model becomes a target of innovation process management to generate readiness.

A retrospective defense-aviation illustration shows how the model reads a real case. In the naval-aviation program reported by Haas et al. [6], a knowledge-management process built on flight data can be traced through the CMORA chain: an innovation lever (a structured, data-supported innovation process) acted on shared organizational factors (knowledge management, training and competencies), which fed readiness factors (maintenance and logistics, process innovation and technology adoption) and translated into higher operational readiness. Although retrospective, the example illustrates how the CMORA organizes cause and effect in an aviation setting and how a readiness-pull roadmap would formalize the same chain prospectively.

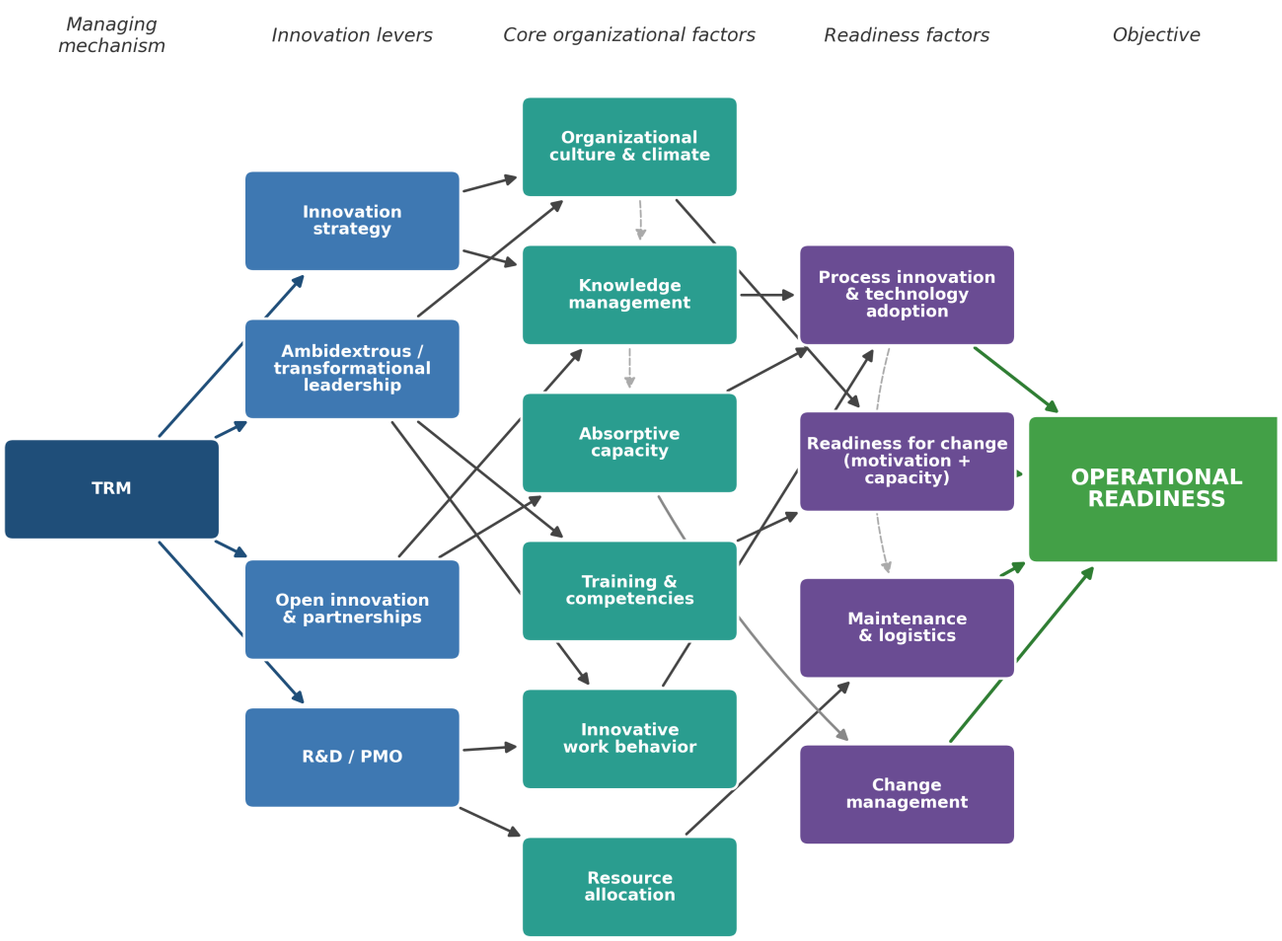

Fig. 5. CMORA: a readiness-pull conceptual model relating innovation process management, via TRM, to operational readiness.

The body of evidence addressing the organizational factors of operational readiness has grown markedly over time, as shown in Fig. 6. From isolated contributions a few years ago, the literature surged to dozens of studies reporting organizational factors per year, most of them published between 2024 and 2026. Each study reports several organizational factors; together they map twenty-one distinct factors connected by 143 co-occurrence links. This steady increase in both the breadth of factors considered and the density of their interrelations reflects the consolidation of operational readiness as a multifactor, organizational phenomenon.

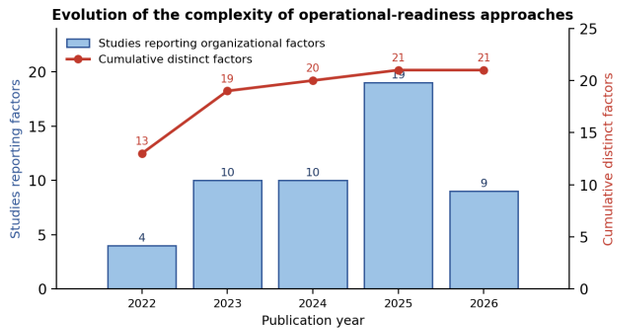

Fig. 6. Evolution of the complexity of operational-readiness approaches: studies reporting organizational factors per year and cumulative distinct factors.

A complementary view of this evidence is given by the co-occurrence network of Fig. 7, where the organizational factors are numbered (see legend) and each study links the factors it reports together; factors shared across studies emerge as larger hubs. The network confirms that a set of factors (open innovation and partnerships, technology and digital infrastructure, training and competencies, resource allocation, organizational culture, and knowledge management) bridges the otherwise separate perspectives, reinforcing their central role in the structured model.

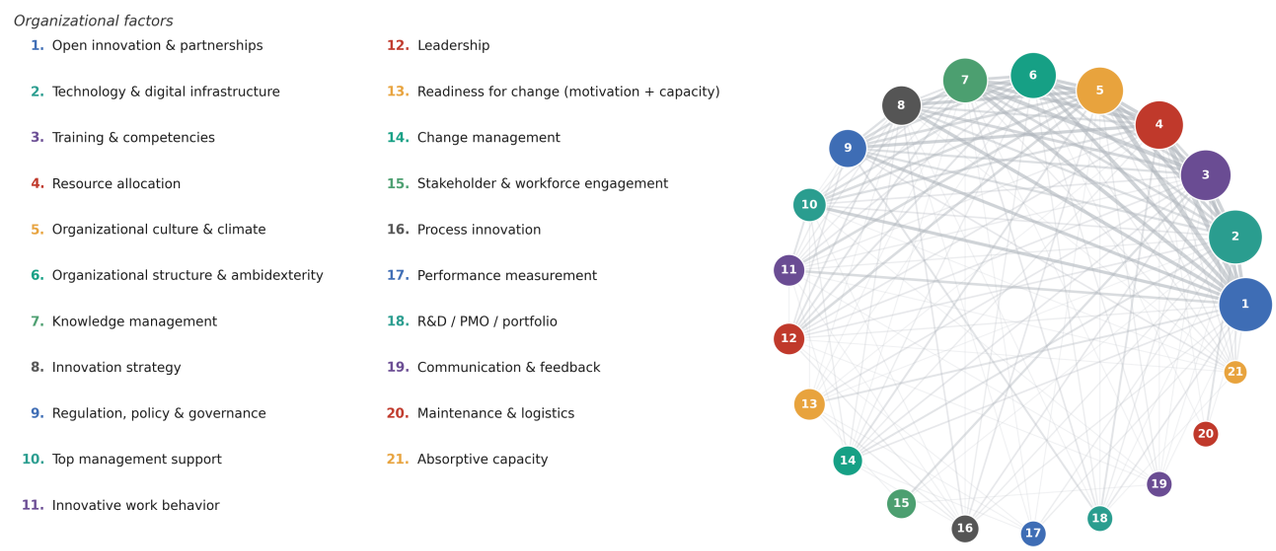

Fig. 7. Complementary co-occurrence network of the organizational factors (numbered; see legend). Edges link factors reported together by the same study; node size = number of studies.

V. CONCLUSIONS

This study developed the CMORA, a conceptual model that establishes operational readiness as an outcome that can be generated through innovation process management. Built from a full-text synthesis of the literature and organized through a TRM logic adapted to a readiness-pull, the model integrates organizational factors previously dispersed across disconnected domains and makes explicit the chain through which innovation processes act on shared factors to produce readiness. The CMORA is thus a conceptual model (an organizing framework for these factors and their relations) and not yet a validated assessment instrument.

As de Vries et al. [13] note, the fragmentation of the readiness construct and Brandsma et al. [4] consider the dispersion of its organizational factors across the literature, this study contributes to narrowing these gaps by giving those factors a common, innovation-managed structure. For decision-makers, the CMORA indicates which organizational factors can be acted upon through innovation process management and how they connect to operational readiness, supporting resource allocation without compromising capabilities. In practice, the model can be operationalized through the construction of a readiness-pull roadmap in facilitated workshops, the assignment of indicators to each factor, and expert assessment of the links most critical to the organization. Its rigor rests on deriving every factor and link from relationships explicitly reported by the primary studies (read in full) and on a documented search and coding protocol [11], [12], [32] that allows the synthesis to be audited and updated.

The approach has limitations that should be stated explicitly. As a conceptual contribution, the CMORA has not

yet been validated empirically, whether through application to a real defense-aviation case, expert elicitation, or survey; its factors and links depend on the relationships explicitly reported in the reviewed literature and on the interpretation of how primary authors stated them, which future inter-coder agreement could strengthen. In addition, the restriction to a single database (Web of Science Core Collection) and to the 2021–2026 window favors reproducibility but introduces a coverage risk, since relevant studies indexed elsewhere (such as Scopus) may be absent. As future directions, quantitative analyses should concentrate on the factors related in the conceptual model (assigning weights to each factor and measuring its contribution to operational readiness) and the readiness-pull TRM should be applied in a real defense organization to instantiate the model into an operational roadmap.

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