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The Quantum-Cognitive Maturity Model (QCM²): A Framework for Reflexive Resilience in Complex Information Environments

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Abstract

Contemporary information environments are characterized by increasing complexity, algorithmic mediation, and continuous exposure to competing narratives. Under such conditions, human cognition operates not only as a mechanism for interpretation but also as a point of interaction within structured informational systems. This shift introduces new demands on cognitive processes, requiring individuals and institutions to maintain coherent judgment while navigating uncertainty, ambiguity, and influence. The Quantum-Cognitive Maturity Model (QCM²) is proposed as a conceptual analytical framework for examining how cognitive maturity develops and operates under such conditions. The framework conceptualizes cognition as a dynamic, context-sensitive system shaped by the interaction of internal capacities and external informational structures. Cognitive maturity is defined as the capacity to regulate interpretation, integrate multiple perspectives, and sustain coherence of judgment across varying temporal and contextual conditions. Central to the framework is the concept of reflexive resilience, which describes the ability to adapt cognitive processes by integrating disruption, uncertainty, and feedback. Mechanisms, including reflexive cognition, metacognitive regulation, adaptive learning, and temporal integration, support this capacity. QCM² introduces a structured representation of cognitive variability through the Cognitive States Matrix, which describes how different configurations of cognitive maturity and processing modes influence perception, interpretation, and decision-making. These states range from reactive, stimulus-driven processing to integrative, temporally extended reasoning. The framework provides an analytical structure for examining how cognitive capacity influences resilience and decision-making in complex environments. By positioning cognition as both developmental and context-dependent, QCM² contributes to interdisciplinary discussions in cognitive science, organizational learning, and human-centered security.

Keywords: Quantum-Cognitive Maturity Model (QCM²); cognitive maturity; reflexive resilience; metacognition; decision-making under uncertainty; cognitive systems; adaptive cognition

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1. Introduction

The convergence of complexity, speed, and uncertainty defines modern information environments. Digital communication systems, algorithmically mediated information flows, and globally interconnected networks continuously shape how individuals and institutions encounter, interpret, and act upon information (Zuboff, 2019). Under these conditions, cognition operates within environments that are not neutral but structured through processes that filter, prioritize, and frame informational inputs.

This transformation alters the conditions under which decision-making occurs. Information is encountered not as discrete, stable inputs but as part of continuous, dynamic flows that often lack reliable verification mechanisms. As a result, individuals and institutions must maintain coherent judgment while navigating ambiguity, competing narratives, and rapidly evolving contexts.

Traditional models of resilience, which emphasize recovery following disruption, are insufficient in such environments (Hollnagel et al., 2006). The primary challenge is no longer the restoration of stability after disturbance, but sustaining adaptive cognitive functioning amid ongoing conditions of uncertainty and informational pressure.

This expanded understanding of resilience may be described as **reflexive resilience**—the capacity to maintain interpretive coherence while continuously adapting cognitive processes in response to new information, feedback, and contextual change.

The Quantum-Cognitive Maturity Model (QCM²) is proposed as a framework for examining how such capacity develops and operates. QCM² is positioned as an extension of existing frameworks in cognitive science, including dual-process models of reasoning, metacognitive theory, and resilience engineering, by integrating these perspectives into a unified model of cognition as a dynamic, context-dependent system operating within structured information environments. Rather than presenting a comprehensive theory of cognition, QCM² provides a structured analytical lens for understanding how cognitive processes function in complex environments and how they contribute to resilience in digitally mediated environments. This article aims to establish QCM² as a conceptual framework for understanding how cognitive maturity shapes decision-making and reflexive resilience in complex information environments.

Subsequent articles in this research program extend this foundation by examining how cognition interacts with structured information environments, how influence operates through cognitive exposure and memetic propagation, and how these dynamics necessitate a broader post-linear understanding of cognitive development. Furthermore, this study adopts a conceptual, interdisciplinary analytical approach, integrating cognitive science, organizational learning, and information systems literature to examine cognition as a dynamic, context-dependent system operating within complex information environments.

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2. Conceptual Foundations

2.1 Cognition as a Dynamic System

QCM² conceptualizes cognition as a dynamic and context-sensitive system. Cognitive processes emerge through the interaction between internal capacities—such as attention, memory, and reasoning—and external conditions, including informational environments and technological mediation (Friston, 2010; Simon, 1991).

This perspective aligns with contemporary views of cognition as adaptive, relational, and embedded within broader systems of interaction (Weick, 1995). Cognition is therefore:

- adaptive rather than static,
- relational rather than isolated,
- temporally structured rather than moment-bound.

2.2 Cognitive Maturity

Cognitive maturity refers to the capacity to interpret complex environments, regulate cognitive processes, and integrate multiple perspectives when making decisions under uncertainty.

This concept extends beyond intelligence or knowledge. While analytical ability contributes to performance, cognitive maturity concerns the structure and regulation of cognition (Kahneman, 2011).

Key characteristics include:

- interpretive flexibility,
- tolerance for ambiguity,
- integration of multiple perspectives,
- revision of assumptions, and
- sustained coherence of judgment.

Cognitive maturity is developmental and context-dependent, evolving through reflective practice and the integration of feedback (Argyris & Schön, 1978).

2.3 Reflexive Resilience

Reflexive resilience extends traditional notions of resilience by emphasizing adaptive cognitive regulation rather than recovery alone (Hollnagel et al., 2006).

It refers to the capacity to:

- sustain coherent judgment under uncertainty,
- integrate feedback from disruption,
- revise interpretive frameworks, and
- maintain adaptive orientation.

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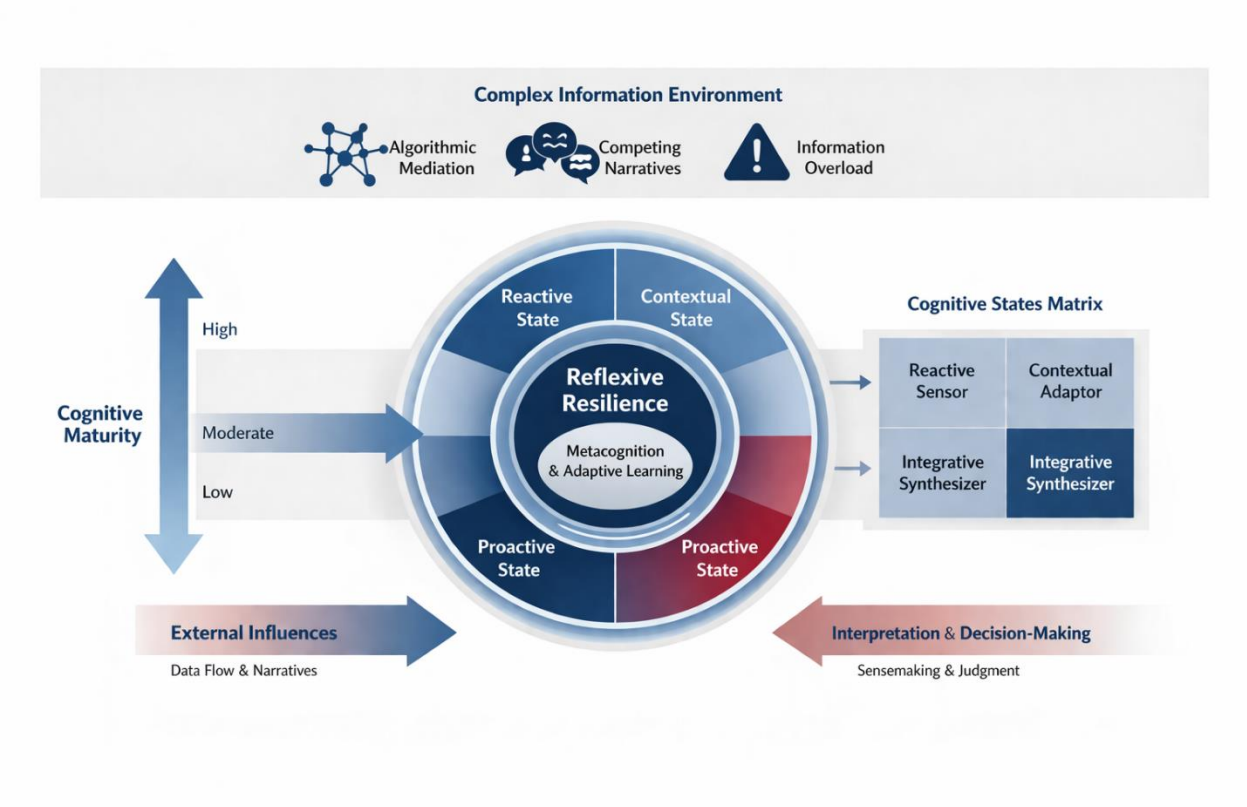
This capacity is supported by reflexive cognition, metacognitive regulation, and adaptive learning. Unlike existing cognitive and resilience frameworks that address these mechanisms separately, QCM² integrates cognitive regulation, environmental structure, and reflexive adaptation within a unified analytical model.

To operationalize the conceptual structure of the Quantum-Cognitive Maturity Model (QCM²) and illustrate the interaction among cognitive maturity, environmental conditions, and reflexive resilience, Figure 1 presents the framework's integrated architecture.

Figure 1

Conceptual Architecture of the Quantum-Cognitive Maturity Model (QCM²)



Note. Author created. The figure illustrates the core components of QCM², including cognitive maturity levels, reflexive resilience, cognitive states, and their interaction with complex information environments and decision-making processes.

As illustrated in Figure 1, cognitive maturity serves as a regulatory dimension that shapes how individuals and organizations process information, while reflexive resilience functions as the central mechanism that enables adaptive interpretation and decision-making amid complexity, uncertainty, and structured influence. QCM² is not intended as a prescriptive model but as an

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analytical framework for examining how cognitive processes operate under conditions of complexity, uncertainty, and structured influence.

3. Cognitive Architecture of Maturity

3.1 Reflexive Cognition

Reflexive cognition refers to the ability to examine one's own interpretive processes as one engages with information. Rather than responding automatically, individuals can evaluate assumptions and consider alternative interpretations.

Research on judgment under uncertainty demonstrates that unexamined heuristics and cognitive shortcuts can lead to systematic error (Tversky & Kahneman, 1974; Kahneman, 2011). Reflexive cognition introduces cognitive distance, enabling more deliberate interpretation and reducing susceptibility to premature conclusions.

3.2 Metacognition and Adaptive Learning

Metacognition involves monitoring, evaluating, and regulating cognitive processes (Flavell, 1979). It enables individuals to adjust reasoning strategies, reconsider assumptions, and revise mental models.

Adaptive learning emerges through this regulatory capacity. Individuals integrate feedback from experience and modify interpretive frameworks accordingly (Argyris & Schön, 1978). This process is essential in environments characterized by uncertainty, incomplete information, and rapid change.

3.3 Temporal Integration

The interaction of past experience, present perception, and anticipated futures shapes cognition. Research in cognitive neuroscience indicates that memory and future simulation rely on overlapping neural systems (Schacter & Addis, 2007; Eichenbaum, 2017).

Within QCM², this is formalized through **Temporal Adaptive Frames (TAF)**, which describe how cognition is structured across time. Temporal integration supports:

- long-term planning,
- consequence evaluation,
- adaptive decision-making.

3.4 Cognitive Resilience

Cognitive resilience represents the operational expression of cognitive maturity. It is the capacity to maintain a coherent interpretation and to make adaptive decisions under conditions of uncertainty, informational disruption, and influence.

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This aligns with resilience engineering perspectives, which emphasize adaptability and learning rather than recovery alone (Hollnagel et al., 2006).

Cognitive resilience emerges from the interaction of:
- reflexive cognition,
- metacognitive regulation,
- adaptive learning,
- temporal integration.

4. The Cognitive States Matrix

4.1 Conceptual Overview

The **Cognitive States Matrix** provides a structured representation of how cognition operates under varying conditions. It integrates:
1. Level of cognitive maturity
2. Mode of cognitive processing

This approach reflects the principle of bounded rationality, where decision-making is shaped by cognitive and environmental constraints (Simon, 1991).

4.2 Cognitive States

The framework identifies five primary cognitive states:
- **Reactive** – stimulus-driven, present-focused
- **Reflective** – self-aware and evaluative
- **Dialogical** – multi-perspective and socially informed
- **Entangled** – systemic and interconnected
- **Temporal-Fluid** – strategic and multi-horizon

These states are dynamic configurations rather than fixed stages, reflecting the interaction between cognitive capacity and environmental conditions.

4.3 Analytical Function

The Cognitive States Matrix:
- maps cognitive variability,
- supports analysis of decision-making under complexity,
- provides a framework for understanding resilience and vulnerability.
  It demonstrates that cognitive outcomes are shaped not only by information availability but by how cognition is structured and regulated.

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5. Implications

QCM² contributes to several domains:

- **Cognitive Science**: by framing cognition as dynamic and context-dependent
- **Organizational Learning**: by linking cognitive maturity to adaptive capacity (Weick, 1995)
- **Human-Centered Security**: by identifying cognition as a critical resilience factor (Zuboff, 2019)

The framework highlights that cognitive capacity can be developed, degraded, and recalibrated depending on internal and environmental conditions.

6. Conclusion

The Quantum-Cognitive Maturity Model (QCM²) provides a structured framework for understanding how cognition operates under conditions of complexity, uncertainty, and influence.

By shifting focus from outcomes to processes, the framework emphasizes how decisions are formed, how uncertainty is managed, and how cognitive systems adapt over time. Cognitive maturity enables individuals and institutions to sustain coherence of judgment while navigating dynamic informational environments.

QCM² does not prescribe deterministic outcomes or specific interventions. However, the framework may inform how organizations assess decision-making resilience under conditions of uncertainty, ambiguity, and structured informational influence. Instead, it provides an analytical framework for examining, understanding, and developing cognitive processes across contexts.
This analysis is intended as a conceptual and interdisciplinary contribution rather than an empirical claim. The framework is designed to support future empirical investigation and applied research across multiple domains, including cognitive science, organizational systems, and digitally mediated environments.

Authorship Statement

Mr. Aslak Molvær originated the initial concept of the Quantum Cognitive Maturity Model (QCM²). Dr. Robb Shawe substantially expanded, structured, and operationalized the framework through an interdisciplinary synthesis of cognitive science, systems theory, organizational learning, cybersecurity governance, and socio-technical analysis.

Dr. Shawe authored the four foundational articles that establish the theoretical, structural, and analytical architecture of the QCM² research program. He also produced major revisions to the QCM² manuscript (Revisions 16–19), including conceptual development, narrative integration, structural refinement, and alignment with contemporary scholarly discourse.

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Both authors contributed to the analytical development of the framework, the integration of interdisciplinary perspectives, and the final review and approval of each manuscript.

Author Note and Research Program Statement

The Quantum-Cognitive Maturity Model (QCM²) originates from an initial conceptual idea developed by Mr. Aslak Molvær. The formal scholarly articulation, theoretical expansion, and interdisciplinary integration of the model were advanced through a coordinated research program co-developed with Dr. Robb Shawe.

Across this program, Dr. Shawe authored the four foundational articles that establish the theoretical, structural, and analytical architecture of QCM². These works introduce and elaborate the model's core constructs, including reflexive resilience, cognitive exposure, memetic propagation, and post-linear cognition. His contributions include the development of the model's conceptual boundaries, the integration of cognitive science with systems theory, organizational learning, cybersecurity governance, and socio-technical analysis, and the refinement of the framework's analytical coherence. Dr. Shawe also produced major revisions to the QCM² manuscript (Revisions 16–19), shaping its narrative structure, conceptual clarity, and alignment with contemporary scholarly discourse.

Mr. Molvær contributed the originating conceptual insight for QCM² and participated in the collaborative development of the framework. Together, the authors integrated interdisciplinary perspectives to position QCM² as a structured, human-centered approach for examining cognition, resilience, and influence within complex information environments.

This manuscript forms part of a unified research program that advances QCM² as a comprehensive analytical framework for understanding cognition as a dynamic, context-dependent system shaped by interaction with digitally mediated environments. The series is designed to contribute to interdisciplinary scholarship spanning cognitive science, organizational learning, information systems, and human-centered security, and to support future empirical and applied research across these domains.

Conflict of Interest

The authors declare no conflicts of interest associated with the development, analysis, or publication of this manuscript. The research was conducted independently and was not influenced by financial, institutional, or personal relationships that could be perceived as affecting the objectivity or integrity of the work. No external funding, sponsorship, or commercial support was received for this study. All interpretations, conclusions, and scholarly contributions reflect the authors' independent academic judgment and professional expertise.

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Originality Statement

This manuscript represents original scholarly work produced collaboratively by the authors as part of the Shawe–Molvær Research and Mentorship Program. The conceptual frameworks, analytical interpretations, and written materials are the result of independent intellectual development and have not been published previously in any form. The manuscript is not under review by any other journal or publication outlet, nor has it been submitted elsewhere for consideration.

All ideas, models, and arguments presented herein were developed exclusively for this research initiative and reflect the authors' combined scholarly and practitioner expertise. Any use of external sources has been appropriately cited in accordance with academic standards. The authors affirm that the work is free from plagiarism, duplication, or unauthorized reuse of prior publications.

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References

Argyris, C., & Schön, D. A. (1978). *Organizational learning: A theory of action perspective*. Addison-Wesley.

Eichenbaum, H. (2017). Memory: Organization and control. *Annual Review of Psychology, 68*, 19–45.

Flavell, J. H. (1979). Metacognition and cognitive monitoring. *American Psychologist, 34*(10), 906–911.

Friston, K. (2010). The free-energy principle. *Nature Reviews Neuroscience, 11*(2), 127–138.

Hollnagel, E., Woods, D. D., & Leveson, N. (2006). *Resilience engineering: Concepts and precepts*. Ashgate.

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.

Molvær, A. (2026). The Quantum-Cognitive Maturity Model (QCM²) [Unpublished manuscript; foundational work].

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Schacter, D. L., & Addis, D. R. (2007). Constructive memory. *Trends in Cognitive Sciences, 11*(2), 49–55.

Simon, H. A. (1991). Bounded rationality and organizational learning. *Organization Science, 2*(1), 125–134.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty. *Science*, *185*(4157), 1124–1131.

Weick, K. E. (1995). *Sensemaking in organizations*. Sage.

Zuboff, S. (2019). *The age of surveillance capitalism*. PublicAffairs.