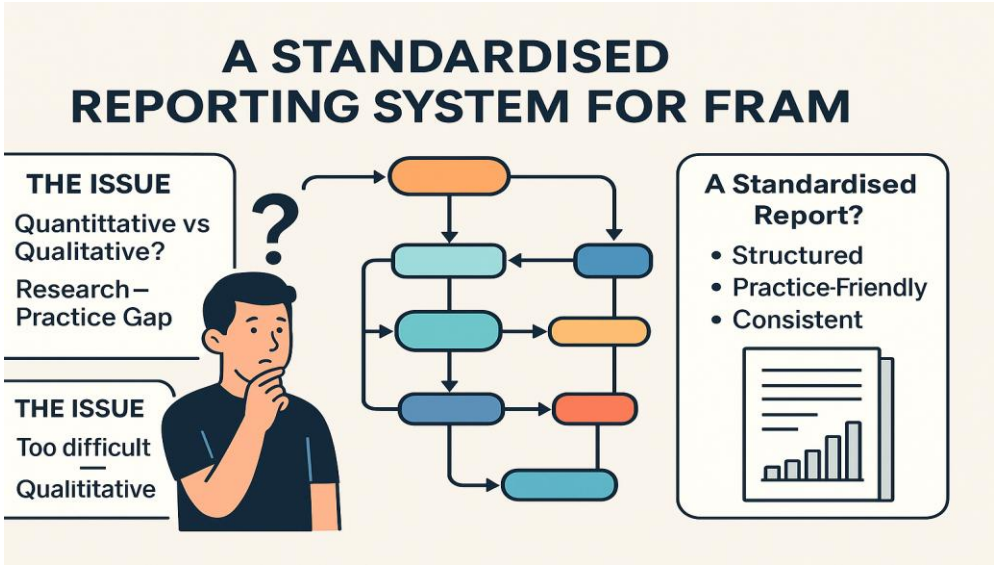

A Standardised Reporting System for FRAM: Towards Wider Adoption and Practical Use

David Slater

The Functional Resonance Analysis Method (FRAM), (Hollnagel 2012).has become an influential framework for modelling complex socio-technical systems. Its ability to account for variability, emergent properties, and non-linear interactions makes it a powerful alternative to linear causal analysis in safety and systems engineering. However, despite its conceptual strength and flexibility, the method remains underutilized in practice. This paper outlines the core barriers to its broader adoption and proposes the development of a standardized reporting tool to support practitioners in applying FRAM more consistently and effectively.

From Theory to Practice: The Persistent Gap

FRAM is unusual among systems analysis tools in that it accommodates both qualitative and quantitative paradigms. As Sujan et al. (2023) explain, the method can be employed from a **realist perspective**, producing computational models capable of simulating and evaluating functional variability with some degree of objectivity. Alternatively, it can be used **phenomenologically**, allowing analysts to craft reflexive, narrative-based accounts of how system functions interact to produce outcomes. These dual interpretations make FRAM remarkably versatile—but they may also contribute to its uneven application.

This epistemological ambivalence plays into what Underwood and Waterson (2013) identified as a **research–practice gap** in systemic accident analysis (SAA). Despite evidence of the advantages offered by systemic approaches like FRAM, they are rarely used routinely in operational settings. As the authors note, “evidence within the scientific literature indicates that systemic analysis models and methods are not being widely used in practice.” This implies not only limited awareness but also a lack of support tools that bridge the conceptual elegance of FRAM with the practical constraints of real-world application.

The Case for Structured Support

One of the most persistent criticisms of FRAM in practice is its **perceived complexity**. Analysts have repeatedly reported that applying FRAM rigorously requires significant time, effort, and expertise. Herrera and Woltjer (2010), for example, noted the difficulty in using FRAM to propose actionable safety constraints, citing challenges in structuring variability, defining meaningful indicators, and generating clear recommendations. Their conclusion was that while FRAM's principles are sound, it lacks a **standardized approach to guiding users from model to intervention**.

This limitation has not gone unnoticed. Kumar et al. (2024) highlight the **pressing need for improved tools** that can make FRAM, more accessible. They stress the importance of disaggregating internal, external, and coupling variabilities and establishing consistent rules for their aggregation and propagation. Moreover, they call for support in estimating damping capacity—currently dependent on expert judgment—and caution against slipping into reductive quantification practices that would undermine FRAM's systemic intent.

A Way Forward: Standardised Reporting to Support Practice

In response to these criticisms, Sujan et al. (2023) have proposed an important idea: the development of a **standardised reporting system** that retains the interpretive richness of FRAM while delivering actionable summaries for decision-makers. Such a report would not aim to simplify the model's complexity away, but rather to **communicate its insights clearly and consistently**. This could help analysts "tell the system story" in a way that is both faithful to the FRAM philosophy and useful to operational stakeholders. However, they stress the need for flexibility, warning against overly prescriptive formats that would dilute the nuance of FRAM's systemic view.

At present, existing tools such as **myFRAM** and **FRAMalyse (**Grabbe 2025) export FRAM models into conventional di graph structures—nodes and edges that can then be manipulated using network theory or matrix algebra. The latest **FRAMifier** software takes this further by building digraphs labelled with parameters, suggesting a trend towards formalizing and even automating aspects of FRAM. But these efforts often export the model away from its native emergent oriented form in the FRAM Model Visualiser (FMV), potentially sacrificing some of its interpretive potential.

Building It into the FMV: A Live Reporting System

Rather than exporting the model into an external framework, we propose leveraging the capabilities of the **FMV itself** to generate a dynamic, metadata-based reporting system. After each simulation run (instantiation cycle), the FMV could update a structured spreadsheet of KEY:VALUE data, recording for each function:

- Frequency of successful involvement
- Frequency and context of failure or absence
- Numerical values for input/output variability, amplification, and damping
- Time taken per function and per full instantiation

By aggregating these rows over, say, 10,000 Monte Carlo cycles, the system could produce empirical **histograms, summary tables, and anomaly detection visuals**—providing a rapid, intuitive overview of system behaviour. This approach would effectively transform FRAM into a

semi-quantitative simulation engine while maintaining its core strength: making variability and emergence visible without simplifying the system.

Such a tool would **not require changing the FRAM model**—only enriching it with metadata handling and enabling real-time tracking. It would allow practitioners to experiment with interventions, assess the robustness of different configurations, and detect weak points without leaving the FRAM ecosystem. The result would be a **practice-friendly, evidence-informed, and interpretation-respecting standard output format**—one that supports both story and structure.

Conclusion: Time to Formalise Without Fossilising

The proposal for a standardised FRAM reporting system is not a call for reductionism. Rather, it is a call for **consistency in how we translate complex models into meaningful insights**. By embedding such a system within the existing FMV framework, we can build on a decade of community practice and software development. The reporting tool would act as a bridge between the epistemological traditions of FRAM—between realism and phenomenology, between modeling and meaning-making.

In doing so, we may finally address the persistent barriers to wider FRAM adoption. We can equip practitioners not just to model complexity but to **share it, explain it, and act on it**.

The tools are largely already available. The challenge now is to assemble them into something usable, repeatable, and communicable—a reporting standard that reflects the spirit, not just the structure, of FRAM.

REFERENCES

- Hollnagel, E. (2012). *FRAM: The Functional Resonance Analysis Method—Modelling Complex Socio-technical Systems*. Farnham, UK: Ashgate.
- Herrera, I. A., & Woltjer, R. (2010). *Comparing Functional Modelling Approaches: The Functional Resonance Analysis Method for Aviation Safety*. 3rd International Symposium on Resilient Control Systems.
- Kumar, D., Hansen, J. P., Skogstad, M. R., & Woltjer, R. (2024). *Quantitative Modelling of Functional Variability in Safety-Critical Systems Using FRAM*. Safety Science, 172.
- Sujan, M., Franklin, B. D., & Hollnagel, E. (2023). *Learning from everyday work: bridging the gap between Safety I and Safety II*. BMJ Quality & Safety, 32(2), 128–134.
- Underwood, P., & Waterson, P. (2013). *Systemic accident analysis: Examining the gap between research and practice*. Accident Analysis & Prevention, 55, 154–164.
- Grabbe, N. & Du, Y. (2025). *FRAMalyse: an open tool to quantitatively analyze and evaluate the characteristics of models derived by the Functional Resonance Analysis Method.* Proceedings of the 17th International FRAMily Workshop, Delft.
