

Do Large-Scale Agile Frameworks Encode Socio-Technical Resilience?

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Abstract

Large-Scale Agile Frameworks (LSAFs) are widely used to coordinate agile transformation beyond individual teams. They are often associated with organisational adaptability, yet whether their formal guidance encodes the capabilities associated with socio-technical resilience (STR) is unclear. Drawing on Hollnagel's resilience potentials, this vision paper presents observations from an initial investigation of how resilience-relevant capabilities are represented in formal LSAF guidance. These observations indicate a potential resilience blind spot in LSAFs. The paper identifies opportunities for further empirical work on LSAFs and resilience, and on how organisations supplement LSAFs with resilience-oriented practices.

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1 Introduction

In practitioner and academic discourse, agility and resilience are frequently treated implicitly as closely related or even equivalent organisational qualities [15]. The ability to respond quickly to change, learn from experience, and continuously improve are presented as hallmarks of both agile and resilient organisations [8, 13] but this assumed equivalence lacks systematic scrutiny. Is being agile sufficient to ensure resilience? Furthermore, what does “being resilient” mean in practice?

Our work aims to clarify these issues, and is informed by cases we have encountered in earlier research. For example, AgileCo [1] is a large video game developer with around 3000 employees. The company had been built on agile principles and used agile practices across

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the organisation from the beginning. However, when they wanted to introduce new games, they recognised that a perspective that went beyond agile’s “responding to change” mantra was required if they were to stay competitive. Taking this wider perspective led to some functions being centralised, which prompted changes in process and communication practices. In this case, being resilient required a wider perspective than team-based agility, and being agile was not sufficient to ensure resilience.

To understand resilience in this case, it is necessary to consider organisational capabilities that go beyond iterative delivery, continuous feedback, and team learning. Drawing upon Resilience Engineering (ResE), resilience in the organisation was achieved through dynamic adjustments that involved people, processes, and governance structures in combination [14].

This vision paper proposes that ResE can be combined with LSAFs, which aim to provide an organisation-wide perspective on agility. The ResE approach to identifying resilience presents a fruitful direction for future empirical software engineering research and the paper envisions an agenda for such research. To support our proposal, we present initial observations from a document-based analysis that applies a ResE framework to analyse LSAF guidance.

2 Background

Resilience matters to software teams and to individual developers because the social and technical processes that support software development impact team and individual wellbeing and productivity [17]. Large-scale agile frameworks shape the environment within which software is developed and hence they have the potential to influence whether or not socio-technical resilience can flourish.

2.1 Socio-Technical Resilience and Resilient Performance

Resilience refers to a system’s capacity to absorb disturbances, adapt to change, and continue functioning or transform under stress [20]. In software engineering research, resilience has traditionally been associated with fault tolerance, redundancy, and continuity of service. The focus on technical capability cannot account for social and technical factors that contribute to performance outcomes [11]. ResE counters this view, treating resilience as a dynamic and ongoing aspect of socio-technical performance that involves operational tasks, organisational processes, and the design and production of technologies that are used in work [14].

Working within this approach, Hollnagel [7] developed a conceptual framework for examining resilience through four potentials (i.e. capabilities that enable resilience). The first, Anticipate, concerns a system’s ability to foresee, prepare for, and respond to potential disruptions before they occur, including the capacity to reason about future operating conditions and emerging risks. The second, Monitor, concerns the ongoing observation of system performance, the detection of early warning signals, and the use of indicators to track changing conditions. The third, Respond, addresses the capability to act promptly and adaptively when disturbances arise, including the ability to identify triggers, verify readiness, and return to regular operation. The fourth, Learn, concerns the capacity to reflect on experience, collect and analyse operational data, and integrate understanding from successes and failures into future practice.

Within ResE, resilience is not a product of technical design, but is evident in the performance of individuals and teams as situated within organisational processes, technologies, and structures [6]. This perspective is especially relevant to software engineering organisations, where outcomes depend on complex interactions among development teams, delivery pipelines, governance structures, customer relationships, and technological ecosystems [20].

2.2 Large-Scale Agile Frameworks

LSAFs emerged as a response to the challenge of extending agile principles and practices beyond individual teams to address the coordination demands of organisations, including interdependent teams, multiple product streams, and alignment with strategic business goals [4]. LSAFs provide structured guidance across these multi-level settings, enabling improved collaboration, adaptability, and faster value delivery at scale [10]. As examples, five LSAFs that are widely recognised in practice and have been discussed in comparative LSAF research [5] are: the Scaled Agile Framework (SAFe), Large-Scale Scrum (LeSS), Scrum@Scale, Disciplined Agile (DA) and the Spotify Model.

SAFe provides a comprehensive, prescriptive model spanning team, programme, and portfolio levels, with strong emphasis on planning cadences, role definitions, and portfolio governance [18]. LeSS takes a contrasting approach, scaling Scrum with minimal additional structure while emphasising simplicity and empirical process control [12]. Scrum@Scale extends Scrum's core mechanisms to networks of teams through a lightweight coordination model [19]. DA provides a process decision framework that allows organisations to choose and tailor their ways of working from a toolkit of practices [16]. The Spotify Model, originally an internal engineering culture initiative, emphasises team autonomy, alignment through shared culture, and informal coordination through squads, tribes, chapters, and guilds [9].

However, no single framework covers all areas of organisational operations, and there is an absence of a unified basis for assessing frameworks against broader organisational goals [5]. Socio-technical resilience, as a distinct conceptual lens informed by ResE, has received limited attention in LSAF literature.

3 An initial investigation

This initial investigation used document analysis [3] to examine whether the formal guidance of five widely recognised LSAFs (SAFe, LeSS, Scrum@Scale, Disciplined Agile, and the Spotify Model) encodes capabilities associated with socio-technical resilience. The analysis considered the official framework guides and documentation referenced in Section 2.2, as these represent the primary sources through which each framework communicates its principles, practices, governance structures, and recommended ways of working. The unit of analysis was individual statements describing framework practices, roles, events, coordination mechanisms, metrics, and organisational guidance relevant to large-scale agile development.

The analysis adopted a deductive coding approach [2] using Hollnagel's four potentials [7] as the analytical framework. This provided a structured vocabulary for asking whether LSAF guidance makes resilience capabilities visible. Each statement was examined to determine whether its guidance supported any of the resilience potentials. The focus was on identifying evidence of resilience-related capabilities rather than measuring frequency or strength. The results were synthesised to identify areas of convergence, where LSAFs reflected resilience engineering concepts, and areas of divergence, where resilience capabilities appeared to be weakly represented or absent. This exploratory analysis resulted in an initial conceptual comparison between LSAFs and ResE rather than a quantitative evaluation.

3.1 Areas of convergence between LSAFs and ResE

From our analysis of the official LSAF documents, there are two areas where LSAF principles overlap with the capabilities associated with ResE.

Agile frameworks, including their large-scale variants, emphasise iterative delivery, retrospection, and continuous improvement as central practices. These principles align naturally with Hollnagel's Learn potential, which concerns the collection and analysis of operational data, learning from both success and failure, and embedding lessons into future practice. Retrospectives in Scrum-based frameworks, Improvement Kata in Lean-influenced approaches, and the culture of experimentation supported in the Spotify Model are mechanisms through which organisations can develop learning-oriented behaviour. The principle that learning is a shared organisational responsibility, rather than the province of management or specialist roles, is also consistent with how ResE frames learning as a distributed and ongoing capacity.

Similarly, the emphasis in LSAFs on metrics, feedback loops, and performance review creates a foundation for monitoring-related resilience capabilities. Frameworks that encourage regular inspection of performance indicators, the communication of results across teams and organisational levels, and the adjustment of practices in response to what indicators reveal are supporting the Monitor potential. The SAFe Lean metrics, LeSS's reliance on empirical process control, and DA's guidance on value stream measurement reflect this orientation. In this respect, the agile emphasis on transparency and inspection is meaningfully compatible with the concern of ResE for ongoing observation of system conditions.

3.2 Areas of divergence between LSAFs and ResE

The analysis identified resilience capabilities that were weakly represented or absent, divergences that reflect a difference in orientation between LSAF and ResE. ResE developed to counter the limitations of root cause analyses. Large-scale agile methods were designed to embrace uncertainty through iteration, feedback, and adaptation at an organisational scale.

The Respond potential goes beyond the agile notion of responsiveness to change. In ResE, this potential involves identifying in advance the classes of situations that may require action, defining triggering criteria for initiating a response, establishing readiness through systematic verification, and specifying when a response should stop. LSAFs, designed primarily to support continuous delivery and team coordination under conditions of manageable uncertainty, do not appear to provide this kind of guidance. Although SAFe includes risk management practices, and DA offers decision tools for process selection, these are oriented toward delivery risk rather than the broader organisational readiness that ResE addresses.

The Anticipate potential surfaces the most significant divergence. In ResE, anticipation goes beyond strategic vision or roadmap planning, and requires organisations to look beyond the next planning increment or programme interval and to reason systematically about conditions that have not yet arisen. LSAFs prefer near-term adaptation over long-range prediction, and are not naturally oriented toward anticipatory reasoning. The emphasis on strategic alignment in SAFe and DA, mainly concerns product and portfolio direction rather than anticipating systemic disruption or operating environment shifts.

These divergences suggest that LSAFs and ResE are compatible but not identical. Combining both requires attention to the capabilities that each one does not naturally emphasise.

4 Avenues for Further Research

4.1 A Potential Resilience Blind Spot

Our analysis suggests that LSAFs, as specified, provide useful foundations for some aspects of STR, particularly learning and monitoring, but other resilience capabilities, especially those associated with responding to disruption and anticipating future conditions, are less

explicitly addressed. This does not mean that organisations using LSAFs lack resilience. As Furniss et al. [6] argue, resilience is a product of ongoing adjustments made by people in practice, not solely of system design. It is possible, and indeed likely, that organisations supplement their use of LSAFs with additional risk management, incident response, and leadership practices that address the gaps identified here. Indeed, AgileCo, the example introduced earlier, illustrates this, and implicitly demonstrates the use of Anticipate and Respond capabilities: they anticipated the need to centralise functions in order to stay competitive, and they responded by creating new practices.

Nevertheless, framework documentation matters. It expresses the design logic of a framework and shapes what organisations and practitioners are encouraged to attend to, institutionalise, and measure. If resilience capabilities such as response readiness, risk threshold definition, and future-oriented modelling are weakly represented in the LSAF guidance, organisations may not recognise these as areas requiring deliberate attention. The connection between large-scale agile practices and STR, while frequently asserted in the practitioner and academic literature [8, 13], has not been examined in sufficient depth to determine whether adopting an LSAF is likely to produce the conditions required for resilient performance across all four potentials.

4.2 Implications for Research and Practice

For researchers, this analysis provides several avenues for future empirical work. First, longitudinal studies of organisations using LSAFs could examine how agile adoption and resilience capabilities manifest in practice, and the correlation between organisational agility and resilience. Second, comparative studies could examine how organisations combine elements from multiple LSAFs and supplementary practices to address the resilience gaps identified here. Third, the relationship between specific LSAF practices and the four potentials could be examined through case studies, providing finer-grained evidence about where the alignment and divergence identified here are most consequential.

For practitioners, the analysis suggests that organisations pursuing LSAFs may benefit from complementing their chosen framework with explicit guidance drawn from ResE or adjacent disciplines. The identification of situations that require readiness, the definition of response thresholds, and the development of anticipatory capacity, including systematic attention to weak signals and alternative futures, are areas where practices beyond standard LSAF guidance may be warranted.

Based on our reflection about the observed divergences, we envision a greater dialogue between ResE and large-scale agile communities. Both are concerned with how organisations sustain performance under uncertainty, but approach it from different theoretical traditions and with different assumptions about the nature and predictability of disruption. A more deliberate integration of these perspectives in research, in framework development, and in organisational practice could contribute to a richer and more complete understanding of what it means for a complex, software-intensive organisation to be both agile and resilient.

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