Chapter 7
Precursor Resilience in Practice – An Organizational Response to Weak Signals

Kenneth Pettersen Gould

Abstract This chapter looks at resilience from the descriptions of organizational strategies and practices in a regional airline operating regular commercial flights at short runway airports. Like many organizations facing environmental changes and intensive operational demands, the airline faces cascades of disturbances and friction in putting plans into place, requiring the ability to extend performance. This study demonstrates that different types of resilience exist and that precursor resilience is more about the organizational expansion of expectancies than individuals or groups managing the unexpected. This clarification adds depth to the understanding of resilience in aviation and similar organizational contexts, and the chapter takes issue in discussing how resilience varies and is different according to level in organizations or systems, place, time, resources, and competencies. This extends ongoing research efforts identifying specific types of resilience and their requirements based on a closer grounding of the concept in empirical studies.

Keywords Precursor resilience · Weak signals · Organization · High reliability Management

7.1 Introduction

Resilience is seen by many as an answer to organizational survival in a more complex and uncertain world [1–9]. Previous work to develop a theory on organizational resilience has anchored resilience in two suggested beliefs [8]. First, resilient organizations possess an "intelligent wariness" [10]. They treat successes lightly and are leery of the potential of the unexpected [11]. Second, resilient organizations strive for operational perfection under chronic unease. They operate under the belief that they are imperfect but can over time learn through events and near events [8].

While adding to our understanding of modern organizations, resilience as theory has become highly generalized and abstracted [12]. The identification of what makes

K. Pettersen Gould (✉)
University of Stavanger, Stavanger, Norway
e-mail: kenneth.a.pettersen@uis.no

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resilience in organizations has, to a limited degree, been clarified by theoretical development and individual empirical cases [9, 12, 13]. Organizational resilience has been viewed as the result of beliefs in organizations as well as emotional, behavioral, and cognitive processes that enable organizations to cope successfully with and learn from unexpected events [8].

Previous researchers argued that empirical evidence gathered from studying organizations running high-risk systems, such as nuclear power and aviation, suggested that resilience has quite different forms in organizations and quite different—if not contradictory—requirements [12, 14]. Resilience varies and differs according to levels in organizations or systems, time, resources, and competencies. These different types of resilience include *precursor resilience*, which relates to monitoring and keeping operations within a bandwidth of conditions and acting to restore these conditions quickly as a way of managing risk. Previous research has shown that the accumulation of small interruptions can compromise the safety of a system just as readily as a larger event [8, 15]. Important in this respect is the possibility that resilient organizations notice relevant weak signals more quickly. In addition, *restoration resilience* consists of rapid actions to resume operations after a disruption whereas *recovery resilience* puts damaged systems back together to establish a new normal that is at least as reliable and robust as before—if not improved. Previous research has provided more material on how personnel and cognitive challenges associated with each differ [14]. Preparation and training for restoration resilience, for example, may diminish attention to prior structures and competencies for precursor resilience.

The failure to pare out and empirically ground the concept of resilience into different types has led to misleading perceptions of the concept. Its generalized treatment may have also discouraged the development of more specific findings of use to organizations themselves in promoting various kinds of resilience [16]. These generalizations are particularly problematic in terms of the importance of resilience as a topic on the safety research agenda, such as our understanding of organizations that must carefully manage high-risk systems that—if mismanaged—could lead to catastrophic failures and cost many lives. Previously, the combination of discourses on complexity and resilience has led to distorted depictions of high reliability organizations (HROs) [12]. In HROs, the generalized promotion of resilience threatens to undermine our ability to distinguish localized adaptations to unpredictable situations from conditions where localized adaptations actually become a negative development in relation to the pursuit of larger reliability and safety goals.

This chapter offers some additional insights into precursor resilience. A key issue is the organizational, meso-level strategies for resilience relied on within the airline, which include other resources than the individual/group level accounts of resilience often promoted within the safety domain [17]. In fact, the precursor resilience we witnessed took advantage of elaborate structures of planning, organizational factors, and competencies that are often critiqued as anticipatory planning [11] and bureaucratic approaches to safety [18] working against resilience. Our findings suggest a relationship between anticipation and certain types of resilience in HROs; furthermore, structures of planning do not have to stand in the way of successful adaptation in high-risk systems. In addition, what a quick and rapid response constitutes in pre-

cursor resilience should be viewed in relation to the type of weak signals to which actions respond. In relation to the time needed to analyze and respond, these events are also different than the more serious disruptions or accidents.

The chapter is written based on the study of a regional airline operating regular commercial flights at short runway airports. These airports have runways between 800 and 1500 m and with few systems for instrument-based approach, landing, and takeoff. The study included data collection over several periods in 2013, consisting of interviews with airline managers and safety management personnel. In addition, two research stays were completed at the airline headquarters in 2013 and 2014, as well as visits to two airline base stations.

7.2 An Organizational Strategy for Precursor Resilience

The airline operated scheduled short runway flights under smaller safety margins, yet with reliability standards and a safety performance equivalent to commercial civil aviation in general [12]. Responding to societal demands for service regularity on a network of 26 short runway airports servicing Norway's most remote coastal regions, the airline developed a specialized strategy for high reliability to fit with societal demands. The airline had a strategy to deal with high input variability related to challenging topography, diverse infrastructure, and changing weather conditions. These conditions required a higher degree of pilot judgment compared to commercial civil aviation in general. The role of pilot judgment could well lead to actions away from accepted standards by individual pilots under pressure to provide service to otherwise isolated rural communities or by pilot temperament to accept higher risks as part of their self-confidence in their own skills [12]. In this unusual setting and in the face of flight conditions one would not think acceptable within the context of HROs, the airline took advantage of precursor resilience and kept operations within a bandwidth of conditions.

As summarized by [17], the common use of the resilience concept relates to the ability of an organization or a system to return to its normal condition or functioning after an event has disturbed its regular state. Thus, the resilience literature often refers to dynamic capabilities, adaptive capacities, and performance variations as key topics. Broadly, there is no order in the application of resilience as it is seen to be related to unplanned, unpredictable, and largely undirectable aspects of emergent properties of complex systems [19, 20]. The resilience identified in this study is different from the "rebound from failure" resilience or the process of "managing the unexpected" described in earlier literature discussing HRO research [11]. By using strategies for system monitoring and the analysis of interruptions and departures from baseline performance, the airline was able to take into account uncertainties and act on identified early warnings. These strategies included the careful and continuous monitoring of flight operations, in relation to both the airline's internal operations and environment. This acting to keep or restore operations within a bandwidth of

conditions could involve a network of internal and external actors, demonstrating that resilience in the context of high reliability can be structured and require coordinated alterations of action.

7.3 Precursor Resilience in Practice: An Example

Operating well-understood aircraft technology and having elaborate systems for planning, the airline shared key conditions for high reliability with commercial civil aviation in general. The organization relied on an extensive framework of analytic and experiential knowledge detailed in maps, formalized flight limitations, and procedures—in many cases, specific for each of the short runway airports. Keeping operations uniform to their level of reliability meant flying in and out of airports where precursor conditions could be specific to the individual airport and current flight conditions. However, as seen in earlier studies of HROs, the formalization of tasks did not support the centralization of authority [21]. In fact, much of the formalization related to documenting and reinforcing the elaborate organizing that being resilient required. In the domain of safety, for example, a Safety Service Office (SSO) was available for advice and guidance on safety-related matters to all nominated safety personnel across levels and departments. Organized by the airline's safety manager, the SSO monitored the performance of management systems in the area of safety and was responsible for the delivery of safety services to the other departments in the organization. In addition to the SSO, a number of cross-departmental groups and functions were available. For example, a Safety and Compliance Review Board (SCRB) headed by the CEO was responsible for interactions between safety and compliance, as well as other major issues of flight safety connected to operations. A local safety management group (SCAG) for flight operations worked across procedures, practices, and people. In addition, the airline chose to establish a health and safety advisory group (HSAG) meeting. According to the airline's safety manager, the idea was to have representatives from frontline personnel look into their areas of operation, together with safety coordinators and the safety manager. The mandate for the HSAG was to evaluate past events and practices in order to identify lessons learned, while also making proactive plans to avoid reoccurrences. The group gave HSE-strategic advice to SCRB and advised the local safety management groups (i.e., SCAG and FSAG) on HSE-related issues that should be considered in their action plan, ultimately issuing recommendations. The HSE advisory group also acted as a working group for SCRB on rising safety issues and could be asked to give detailed information on such issues. One example of precursor resilience emerged in the work processes of the flight data monitoring group (FDMG). FDMG regularly conducted overviews and analyses of flight data monitoring (FDM) data. FDM data was gathered from across flight operations, including all takeoffs and landings, on a routine basis. It was mandatory for the airline to report FDM discrepancies of a serious nature, but the information could also provide systemic insights into even small changes in relation to established operational limitations, quality, and

reliability criteria. In the work of the FDMG, we found cases where the group had identified systemic departures from operational limitations and initiated processes within the airline to respond to these early warnings.

The FDMG routinized a form of watchfulness, which was a quality nurtured by the airline's safety management. In relation to safety management practices within the airline, watchfulness can be described as the continuous monitoring, analysis, and questioning of one's knowledge of operations at the many different airports operated by the airline and the discrete risks that flying to and from them may present. Short runway operations required a sensitivity to operations [11], a recognition of diversity, and an attention to detail. Although most of the airline's management personnel had many years of experience from operations in the cockpit, maintenance, or ground handling, they did not rely on existing patterns of action as being sufficient for reliability and safety.

A full process of precursor resilience, where operations were restored within bandwidth boundaries, was identified related to the analysis of a relatively high number of unstabilized approaches and excessive bank on approach. These incidents were individually not serious events, in the sense of representing an accident risk. However, viewed as a pattern in the analysis, they were interpreted as early warnings at several of the short runway airports.

The frequency of these events raised concerns that there may be precursor conditions causing the trends. During interviews, we were informed of how the safety manager and the FDMG had engaged in a process of abductive analysis [22], creating a hypothesis of what could be causing the trends. At three airport's, incident trends were associated with pilots repeatedly adapting their landing approaches to a combination of technological changes and constraints in the airports infrastructure and support systems. In other words, the planes were getting bigger and flying faster than the existing airport infrastructure and systems were designed for. As technology and infrastructure are systemic issues involving the infrastructure owner and civil aviation authority, the airline itself had only limited influence on restoring conditions within acceptable bandwidths, and a quick response required a shared understanding of the risk and response across organizations. By sharing the analysis with other stakeholders and communicating risk, the systemic issues were agreed upon as precursor conditions causing the airlines pilots to adapt. Because of this process, investments in new technology and changes in airport inflight procedures were made at three short runway airports.

Following these changes, the airline experienced a 26–40% decrease in incident trends. An interesting illustration from this process is a picture of FDM data imported into Google Earth maps, providing a rich description of systemic aircraft movements (see Fig. 7.1). In the figure, each yellow and red triangle represents an excessive bank on approach. Using such maps in consultations with the owner of the airport infrastructure and the national aviation authorities, the airline could communicate their analysis of risk based on a richer graphical representation, not just numbers in a table.

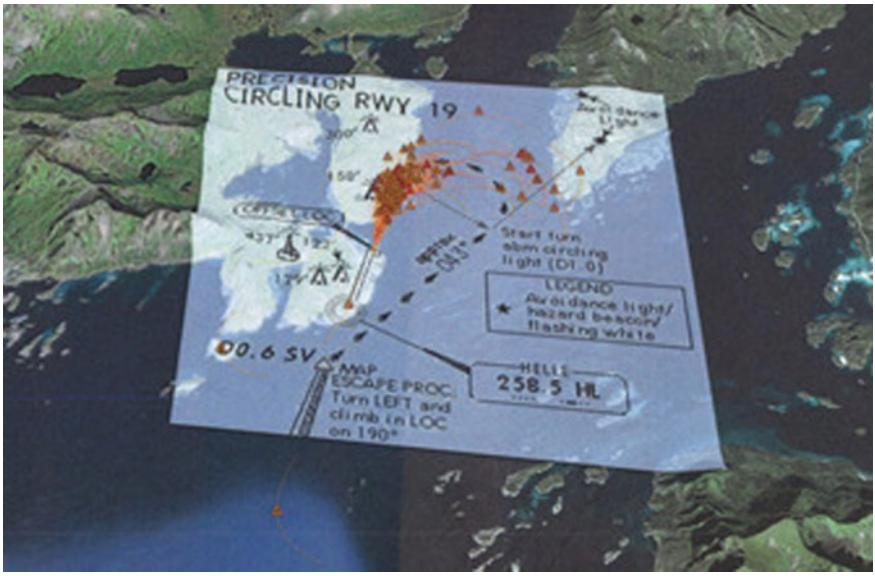

Fig. 7.1 FDM data of excessive bank events at airport

7.4 Concluding Remarks

We recognize that precursor resilience was an addition to other features of high reliability in the airline. These include acting based on extensive and detailed procedural systems. This is comparable to the role of resilience described in other research on high reliability management and HROs [12, 14, 21–23]. During the interviews, airline management representatives underscored the importance of a successful merger between best practice with planning and procedures. However, in this study, the margins or bandwidths of operations that people had to accept were more differentiated than we have seen in civil aviation and perhaps other HROs in general [23].

The type of resilience described in this paper is covered by Aaron Wildavsky's broad definition of being resilient as vitally prepared for adversities that requires "improvement in overall capability, i.e., a generalized capacity to investigate, to learn, and to act, without knowing in advance, what one will be called to act upon" [9]. Yet within this broad definition, resilience has to be treated differently. Our research indicated that promoting precursor resilience relies on strategies at organizational and system levels—in this case, including structures for collecting system-wide data, planning, and coordinated action. Although resilience in general is an ability to respond quickly, the events to which precursor resilience responds are not major disruptions or accidents. This gives an organization more time to act, as weak signals require time to analyze as well as coordinate responses. The latter is of particular importance within the context of high-risk systems, where localized adaptions can become negative development in relation to larger reliability and safety goals. In

fact, in association with precursor resilience, organizational strategies and structures seem to be a prerequisite for detecting both early warnings and responsive capacities to act when high reliability is key for the organization.

This research supports the idea that resilient organizations, through their updated and nuanced picture of ongoing operations, are able to "[…] parlay that understanding into more targeted and timely investments in tolls or actions that can defuse emerging vulnerabilities and risks before harm results" [11]. The type of resilience identified here, in association with high reliability, is also of a specific type [12] and different from more generalized accounts of resilience in HROs [11]. In addition, it is important to note that the precursor resilience we have described is safety oriented and related to a specific, but not limited, set of events and early warnings, which are defined as relevant by their association to the risks the airline has as their key concerns (i.e., a serious event or accident with an aircraft). Thus, no claims can be made that the airline as an HRO can identify and restore all types of adversities [24], nor can we claim that the resilience we have documented can be retained or provide protection against the rigidness and dangers of proceduralization.

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