

RULES – SOMETIMES LESS IS MORE

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ABSTRACT

The Aviation industry is ultra-safe. Rules and procedures have been attributed as a contributory factor for attaining this high level of safety. The complexity of the aviation system has risen dramatically in the last few decades due to the development and introduction of modern aircraft and on-board technological innovations. Every day pilots encounter situations they did not expect. During those situations, they make many decisions that result in safe outcomes. But how are the rules integrated into their decision-making process? Do the rules help or hinder them? Do they consider the rules, and if so, how, and why? This thesis explores these questions using qualitative case study methodology to provide a better understanding of how, or even if, rules and procedures help pilots make decisions in difficult and challenging situations.

According to the literature, 75% to 80% of aviation accidents are caused by human error. A common reaction to this attribution is the development and publication of new rules and procedures to make sure these “human errors” do not happen again. However, in industries with increasing complexity, such as aviation, unknown, unusual, and unexpected situations may arise at any time. It is not possible for the rule writer to envision every situation that a pilot may encounter. This study reveals when there is a gap between the work as imagined by the rule writer and the work as done by the pilots, pilots must use more than just rules and procedures to make decisions and solve problems – they must rely on their knowledge and experience.

This study suggests that organizations would be well-served to invest in the development and implementation of a rule management process that allows them to monitor the gaps that exist between their procedures and the situations the pilots face. This study submits that the pilots must be an integral part of this process. Developing an understanding of the gap could contribute to organizational knowledge which in turn could help the pilots improve their skills at adapting to the challenging and difficult situations they face.

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TABLE OF CONTENTS

Contents

Abstract.....	ii
Acknowledgements.....	iii
Table of Contents.....	iv
List of Figures and Tables.....	vi
1 Introduction.....	1
1.1 Background.....	1
1.2 Research Focus and Objectives.....	2
2 Literature Review.....	4
2.1 Introduction.....	4
2.2 Development and Implementation of Rules and Procedures in Aviation.....	4
2.2.1 History.....	4
2.2.2 A shift in thinking about accident causation and preventive actions.....	6
2.2.3 Have things really changed?.....	9
2.3 Gaps Between Work as Imagined and Work as Done.....	12
2.3.1 Who makes the rules and for whom do they make them?.....	12
2.3.2 Rules as resources for action.....	14
2.3.3 Monitoring and exploring the gap.....	16
2.4 Summary and Need for Empirical Research.....	19
2.4.1 Review of research objectives fulfilled by literature review.....	19
2.4.2 Empirical research needs.....	19
3 Research Methodology.....	20
3.1 Introduction.....	20
3.2 Research Strategy.....	21
3.2.1 Choosing the method.....	21
3.2.2 Designing the research.....	21
3.3 Data Collection.....	23
3.4 Reliability and Validity.....	24
3.5 Limitations, Challenges, and Ethical Considerations.....	26
3.6 Framework for Data Analysis.....	28
4 Research Findings: Description, Analysis, and Synthesis.....	30
4.1 Introduction.....	30
4.2 Initial findings.....	30
4.2.1 What do rules mean in the respondent's daily work? (thoughts about rules in general).....	30
4.2.2 Are rules considered in challenging and difficult situations? If so, how?.....	32
4.2.3 Initial findings summary.....	37
4.3 Theme development.....	38
4.4 Analysis and Synthesis.....	40
4.4.1 Theme 1: No rules for rapidly changing situations.....	40
4.4.2 Theme 2: Rules and professional identity.....	41
4.4.3 Theme 3: Even when rules exist, they might not apply to the situation.....	44
4.4.4 Theme 4: The purpose of the rule.....	45
4.4.5 Analysis summary.....	48

5	Discussion.....	49
5.1	<i>Introduction.....</i>	<i>49</i>
5.2	<i>Exploring and Monitoring the Gap</i>	<i>50</i>
5.2.1	Rule management process.....	50
5.2.2	Transfer of knowledge	52
5.3	<i>Discussion Summary.....</i>	<i>52</i>
6	Conclusion	53
	References.....	54
	Appendix 1	59
	Appendix 2	60

LIST OF FIGURES AND TABLES

Table 1 Main Steps in the Aviation Safety Paradigm Shift.....	7
Table 2 Two Safety Philosophies	10
Table 3 Summary of Main Strengths and Weaknesses of Models 1 and 2	16
Table 4 Rule Management Framework	22
Figure 1 Final Themes.....	39
Figure 2 Dynamic Safety Model.....	46
Figure 3 Rule management framework.....	50

1 INTRODUCTION

1.1 Background

There are over 100,000 commercial airline flights around the world every day and over 1,000,000 passengers in the skies at any one time (NPR, 2016.) This global aviation network is perhaps one of the most complex socio-technical systems in the world. Yet, using accident and fatality statistics, it is also one of the safest. The International Civil Aviation Organization (ICAO) 2016 Safety Report (ICAO, 2016) states that “the global accident rate involving scheduled commercial operations decreased by 7%, from 3.0 accidents per million departures in 2014 to 2.8 accidents per million departures in 2015.” The number of fatal accidents decreased in 2015 to 6 – the lowest in five years. It would appear from these statistics that the commercial aviation system is not only complex but also ultra-safe¹.

Commercial aviation has not always been this safe. It is generally accepted that the evolution of aviation safety has evolved through three identifiable eras: the technical era, the human factors era, and the organizational era (ICAO, 2013). The technical era (mid-20th century through the late 1960s) focused on technical solutions to safety – better and more reliable equipment, transition to jet aircraft, etc. The human factors era (from about the early 1970s through the mid-90s) saw a significant reduction in accidents that could be attributed primarily to the technical improvements of earlier years. It was during this time, however, that when accidents occurred, the causes were likely to be attributed to human error – with a primary focus on the individual (Reason, 1990). The organizational era evolved in the mid-90s and continues to the present. It was during this time that the concept of looking at safety from an organizational systems perspective began to take hold (Dekker, 2005; Dismukes, Berman, & Loukopoulos, 2007; Leveson, 2011; Maurino, Reason, Johnston, & Lee, 1995).

As aviation has transitioned through the eras discussed above, there have been many contributory factors to the current level of safety in the aviation industry. One common thread attributed to increased safety in aviation, regardless of the era, is the development and publishing of rules and procedures². Human error has been attributed

¹ Risk of disaster is below one accident per 1,000,000 events (Amalberti, 2001).

² In this thesis, rules and procedures are not distinguished.

as the cause for 75% to 80% of commercial aviation accidents (Wiegmann & Shappell, 2001, p. 7). Common reactions to address these human errors (if that is what they are) have been to add automation, implement regulations, and add more procedures (Amalberti, 2001, p. 111). Amalberti specifically noted, “the rate of production of new guidance materials and rules in the European Joint Aviation Regulations is significantly increasing while global aviation safety remains for years on a plateau at 10^{-6} (over 200 new policies/guidance/rules per year.)”

Commercial aviation is extremely safe. Actions to mitigate or eliminate risk by adding more rules and procedures (in hopes of eliminating human error) have contributed to safety in the past but may no longer be appropriate for increasing safety levels beyond what they are today. Future accidents will be accidents “where the regulations were in place to prevent the problem or perhaps no-one made an identifiable error and no system truly broke down” (Amalberti, 2013, p. vii). Amalberti adds, “the safety of the system will have staked everything on reassuring procedures” (p. vii).

1.2 Research Focus and Objectives

Rules and procedures have been part of aviation from almost the very beginning. Pilots are trained to learn and follow procedures from the day they are hired until they retire. This approach made sense given that “everybody shared the same idea that safety would be guaranteed if pilots were selected and trained to strictly apply procedures” (Pélegrin, 2013, p. 14)

Safety rule development and implementation is commonly done by “experts”, e.g. regulator, aircraft manufacturer, or company management; the thinking being that they best understand the risks associated with various tasks. This approach is viewed as a form of organizational control intended to ensure errors are not made and safety will be maintained (Weichbrodt, 2015).

In recent years, as the aviation system has become increasingly complex, another view of rules has evolved. This view considers the expert may not be the regulator or company management but the operator (pilot in this case) who is doing the work. This view looks at rules as support and guidance, as resources for action if you will, to be

used by the sharp end operator who has the best local knowledge of the situation (Dekker, 2003; Hale & Borys, 2013ba).

The aim of this research is to better understand how, or even if, rules and procedures help pilots make decisions in difficult and challenging situations. This understanding will be developed by reviewing pertinent literature and by collecting and analysing empirical data. The Research Methodology section of this thesis discusses the research strategy and data collection approach used to collect the empirical data.

The objectives of this research are to:

1. *Discuss* the development and implementation of rules and procedures in aviation.
2. *Critically evaluate* gaps that may exist between work as imagined and work as done.
3. *Analyse* how rules impact a pilot's decision-making in difficult and challenging situations by using existing literature and empirical data research (thematic analysis.)
4. *Propose* possible methods to explore the gaps identified in Objective 2 and expand the capacity of the system to adapt.

The objectives listed above are clearly interwoven. They are stated to give focus to the research task. By meeting these objectives, the overall research aim will be achieved.

2 LITERATURE REVIEW

2.1 Introduction

Do rules guarantee safety? Will the precise following of procedures eliminate human error? Are rule violations always bad? Safety literature that explores these questions is abundant and it proved very challenging to determine how to narrow the literature review to that which most contributed to achieving our research aim. Biggam (2015) asserts “you carry out a review of literature to find out who is saying what about the things you are interested in . . .” (p. 50). To that end, this review focuses on objectives 1 and 2 (listed above) by examining how rules and procedures have evolved in the aviation industry and reasons behind this evolution. The third objective will be met by collecting and analysing empirical data. Objective 4 will be synthesized from the findings and analysis of objectives 1, 2, and 3.

2.2 Development and Implementation of Rules and Procedures in Aviation

2.2.1 *History*

Aviation didn't always have rules. They didn't need them at the very beginning when the designer, engineer, and pilot were the same person (Pélegrin, 2013). Rules came quickly however. The United States enacted the Air Commerce Act of 1926 in response to the emergence of commercial aviation, most notably when air mail service, previously provided by the government, was turned over to private contractors. This act gave the Department of Commerce the authority to regulate aircraft and airmen (mechanics and pilots) and established penalties when those regulations were violated. It also mandated that the Department “investigate, record, and make public the causes of accidents in civil air navigation in the United States” (“Air Commerce Act of 1926,” 1926, p. 569). One outcome of this act was the formation of an Aeronautics Branch within the Department of Commerce. One of the branch's first initiatives was the development and publication of the Air Commerce Regulations in December 1926. The totality of the rules addressing licensing of aircraft, operations of aircraft, licensing of airmen, and air traffic, was contained in a 45-page document. As a comparison, today's federal aviation regulations in the United States are comprised of close to 4,000 pages.

Civil aviation regulations evolved slightly earlier in Great Britain with the publishing of the Aerial Navigation Act of 1911. Not long after, with the outbreak of World War I, civil aviation was banned in the U.K. After the war, the Department of Civil Aviation became responsible for developing and publishing regulations. Rules were introduced prohibiting passengers from commercial aircraft cockpits to eliminate the risk of interfering with the controls. It became a requirement to have a crew of two on board any aircraft that could carry more than ten passengers. If dual controls didn't exist, then the rule required that the two crew members must be able to change places quickly. The primary task of the second crewmember was not to fly the aircraft, but to operate the "wireless" (Chaplin, 2011, p. 79).

Early to mid-20th century aviation accident investigations often attributed the cause to human error; pilot error to be precise. In an analysis of 355 accidents occurring between 1926 and 1933 in the U.K., 258, or 72.3%, were classified as Category A, i.e. accidents in which no part of the aircraft or engine was in any way at fault. Out of these 258 accidents, 177 were attributed solely to errors of airmanship. The committee who performed the analysis concluded "the failure of the pilot is by far the most potential source of accidents in flying" (Chaplin, 2011, pp. 84-85).

Aviation accidents, especially when fatalities are involved, lead the public as well as elected officials to question safety. Politicians, to appease their constituents, conduct investigations that sometimes result in new rules. The expectation is that these new rules will prevent the accident from happening again. This was the case in the United States in 1946 after a series of 7 fatal airline accidents. Congressional committees were formed; investigations were held; and more rules were implemented (Hansen, McAndrews, & Berkeley, 2008). Pilots felt that rule adherence, not safety was the primary goal. One pilot testified that, when facing a serious weather problem, his thought process had become, "Is it legal? If I break this rule will I be able to justify it later so I won't be grounded or fined? Will I have to write a letter of explanation? Will I have to attend a hearing" (Hansen et al., 2008, p. 10)? Only then did he wonder if it was safe. The co-researchers of this thesis are curious about whether today's pilots have these same thoughts when they decide to deviate from a rule or procedure. The review of the literature did not reveal any answers to this question.

2.2.2 *A shift in thinking about accident causation and preventive actions*

Commercial aviation continued to grow after World War II and accidents continued to occur. During this time, the thinking about what caused these accidents and what to do about it evolved. Pariès and Amalberti (2000) discuss this evolution in terms of a safety paradigm shift; “a set of fundamental rules and principles that people believe to be both the definition of and the conditions for safety” (p. 259). They ascribe the change in thinking to three elements in particular: the *time scale* involved in searching for the cause of an accident (investigations are much longer now); the *system size scale*, e.g. the pilot, the crew, the airline, and even the entire socio-technical system; and finally, the *depth of explanation* or the level “at which people are satisfied that they understand the (human factors) ‘cause’ of an event” (p. 260). Table 1 on the following page illustrates this shift in thinking about causes (from individual pilots to entire organizations) and about actions (solutions) by airlines and manufacturers. Note that the airline focus evolves around training, selecting the right people, establishing and enhancing crew resource management; the manufacturer initially focuses on designing better and more reliable aircraft and then adds redundant systems. As time goes on, more automation is added to reduce crew workload and protect against undetected errors.

Table 1
Main Steps in the Aviation Safety Paradigm Shift

<i>Period</i>	<i>Perceived Accident Main Causality</i>	<i>Focus of Airline Safety Efforts</i>	<i>Focus of Manufacturer's Safety Efforts</i>
1960s	Accidents result from individual pilot error, mainly attributed to a lack of basic flying skills.	Selection of appropriate psychomotor skills. Handling training oriented toward handling proficiency, particularly in failure situations and critical areas of flight envelope.	Designing more reliable and easy to fly aircraft.
1970s	Accidents result from individual pilot error, mainly attributed to a lack of technical proficiency.	Selection of appropriate psychomotor and cognitive skills Handling training oriented toward normal and abnormal procedures and drills. Stress on procedures. Intense use of simulators.	Designing more reliable and easy to fly aircraft. Built in redundancy; fail safe and fail operational concepts. More automation assistance to flight control (AP, FD, ATHR); more instruments. Focus on crew workload.
1980s	Accidents result from cockpit crew errors mainly attributed to team synergy failures and to a poor management of resources available in the cockpit.	Selection of "right stuff" with proper cooperation skills. Crew resource management training Line Oriented Flight Training (LOFT) simulation	Reducing pilot involvement in direct flight control actions (fly-by-wire stability, more and more autoflight capabilities, FMS); providing for more and more error protections (GPWS, flight envelope protections). Providing for situation awareness augmentation and decision aids (Nav Display, Centralized Monitoring, ECAM procedures).
1990s	"Every accident is a failure of the organization" (Prof. K.R. Andrews). Front line operator behaviour is strongly (even if not totally) determined by systemic forces (selection, training, procedures, cultures, work conditions, organization structures). Human error is not a failure per se, but an intrinsic component of cognitive processes. Accidents result from a loss of control of the crew (and the larger team) on their error management processes.	Fourth and fifth generation CRM training: <ul style="list-style-type: none"> • Situation awareness augmentation, error management strategies, and facilitation of metacognition. • Company Resource Management 	More automatic protections against consequences of undetected errors: EGPWs, TCAS, MSAW. Closer communication with airlines: <ul style="list-style-type: none"> • Prevention strategies. • Incident reporting systems. More air-ground links (Data Link, Mode S radar, ACARS). Human Centered Automation design concept.

(Pariès & Amalberti, 2000, p. 261)

In the early 2000s, a French sponsored research project conducted a series of seminars involving several disciplines such as sociology, political science, psychology, cognitive science, and others to better understand the conditions and organizational factors existing in companies that experienced accidents and disasters. In reviewing this and other research, Gilbert, Amalberti, Laroche, and Paries (2007) noted that the view of safety held primarily by those in charge of higher risk activities still relied heavily on rules and procedures. This dominant safety paradigm implies that “safety stems primarily from compliance with all the norms, rules, and procedures” (p. 962).

Gilbert et al. (2007) argue that there is a shift in safety paradigms, especially with regards to errors and failures. They point out that errors are a part of normal operations; that they “are a price to pay, a necessity for adjustment, mere symptoms of good cognitive functioning” (p. 968). They argue that a new, adaptive strategy is evolving – one that doesn’t seek perfection but strives for the “constant surveillance of the safety margins and levels of risk taken” (p. 969).

The literature references this “paradigm shift” in other complex high-risk industries (besides aviation.) This shift has been described in the medical industry where patient safety is a focus, as a difference between the “First Story of ‘human error’ and the Second Story of systematic vulnerabilities” (Cook, Woods, & Miller, 1998, p. viii). Woods, Dekker, Cook, Johannesen, and Sarter (2010) also refer to the “first story” and “second story” when they discuss the complexity of the human contribution to safety by noting that:

“One way to discover this complexity is to make a shift from what we call the ‘first story,’ where human error is the cause, to a second, deeper story, in which the normal, predictable actions and assessments (which some call ‘human error’ after the fact) are the product of systematic processes inside of the cognitive, operational and organizational world in which people work” (p. 1).

Second stories show that people, whether they are at the blunt end (regulators, policy makers, technology manufacturers, etc.) of these complex systems or they are sharp end practitioners (pilots, nuclear power plant operators, or surgeons), all have an interest in safe outcomes. These stories also illustrate how those at the sharp end

manage to adapt to the allocation of resources and implementation of rules and constraints thrust upon them by those at the blunt end. Sometimes the adaptation results in failure. These failures don't represent human failures, but "breakdowns in adaptations directed at coping with complexity" (Woods et al., 2010, p. 1).

This "first story" and "second story" perspective is similar to what Pariès and Amalberti (2000) refer to as two safety philosophies (Table 2 on the following page illustrates these philosophies). One philosophy, like the "first story", asserts that everything (about the operational environment) can be known; therefore, all responses to those operations (normal or abnormal) can be predetermined and implemented through training, rules, and procedures. If nobody deviates from the standard solution, safety will be guaranteed.

The second philosophy aligns more closely with the "second story." It conveys a more flexible, adaptive strategy; one that expects random operational variations and expects the sharp end practitioner to monitor and adapt as needed to keep control of the deviations and maintain safe operations.

2.2.3 *Have things really changed?*

In aviation, like other high-risk industries, many disciplines and organizational levels have a role to play in managing risk. Since aviation's beginning over a century ago, this system has used laws, rules, and procedures to control human behaviour. In aviation's early days, as equipment and technology were evolving at rapid rates, this approach was more effective – fatal accidents, once routine, were reduced to extremely low levels. Today, new automation and aircraft manufacturing technologies introduce even more complexity into the system. New air traffic control systems and airborne navigation technologies have been deployed to improve efficiency, reduce costs, and make the aviation transportation system even safer.

Table 2
Two Safety Philosophies

Philosophy 1	Philosophy 2
Aviation operations can be entirely specified through standardized procedures, programs, schedules, rules, nominal tasks, certification, selection, norms, etc.	Aviation operations cannot be entirely specified through standardized procedures, programs, and the like. One reason is that it includes humans.
Safety Improvement will result from more specification (more extensive, comprehensive, and detailed procedures . . .) and more discipline from the operators.	Safety improvement will result from a better respect of the “ecology” of the system and a better acknowledgement of its self-protection mechanisms.
Deviations from nominal operation are both a cause of lower performance, and the main threat for safety.	Deviations from nominal operation are both a necessity for adaptation to random dimension of real life, and a potential threat for safety.
Human operators are ultimately the only unpredictable and unspecifiable components of the system. They are the main source of deviation.	Human operators are up to now the only intelligent, flexible, and real-time adaptable component of the system. They are a deposit and source of safety.
Automation, whenever feasible and reliable, will decrease deviation rate and therefore improve both performance and safety.	Automation will increase reliability, improve performance, make the operation more rigid. As long as humans are kept in the system, automation will also make their environment more complex, and create new problems in man-machine coupling.
Errors are non-intentional but regrettable deviations from standard actions. Errors are unfortunately inevitable.	Errors are deviations from operator’s intentions, but at the same time they are part of the normal process of achieving intentions. Errors are necessary.
Errors are just as negative for safety as any other deviation. Every effort should be made to reduce the number of errors.	Uncorrected errors may be a threat for safety. However, self-error awareness is a critical governor of operator’s behaviour and food for risk management processes (regulator of confidence level.)
The human operator is one more “black box” coupled through inputs (perceived data) that are transformed into outputs (actions) according to specified targets (goals) using adequate transfer functions (procedures, skills, . . .).	Human operators are auto-organized structures, coupled through recursive processes of self-regulation, and ultimately governed by their internal intentions.
(conditioning paradigm)	(freedom paradigm)

(Pariès & Amalberti, 2000, p. 263)

The literature has identified old and new safety paradigms; old and new safety philosophies; and first and second stories. It has placed the blame on humans for accidents and looked at organizations and systems as contributors. It has referred to accidents as “normal” accidents (Perrow, 1984). It has identified a need to transition from a blame strategy to an adaptive strategy. Human error remains a predominant causal factor in aviation accidents. A review of National Transportation Safety Board (NTSB) accident reports between 2001 and 2013 shows there were 15 fatal commercial aviation accidents in the United States (excluding 4 accidents caused by terrorist attacks on 9/11/2001). All the reports identified the probable cause as a failure of a human to do something; typically to follow established procedures. This was true whether it was a crewmember, a mechanic, or a ramp worker. Consistent with “first story” thinking, recommendations usually included one or more of the following: creating more procedures, revising existing procedures, conducting more government inspections, revising guidance material (FAA), and conducting more training for sharp end practitioners.

2.3 Gaps Between Work as Imagined and Work as Done

2.3.1 *Who makes the rules and for whom do they make them?*

The previous section discussed the development of rules and procedures in aviation. Views about safety in high-risk industries such as aviation have moved from the idea that the system can be defined by a set of standards (rules and procedures) and if those standards are adhered to by sharp end practitioners, safety will be guaranteed, to the understanding that it is not just the sharp end that has safety responsibilities, but those at the blunt end as well (Bourrier & Bieder, 2013; Dekker, 2015; Hollnagel, 2004, 2014; Reason, 1990). Despite safety research dating back several decades that identifies the importance of system and organizational factors in maintaining safety performance, the human at the sharp end continues to be held accountable in most commercial aviation accidents. And when that happens, new rules and procedures are imposed.

There is a profusion of rules and procedures in aviation. The intent of these rules, whether in the form of operating procedures, normal checklists, or abnormal checklists, is to promote standardization and ultimately to ensure safety (Bourrier & Bieder, 2013). At least that is the intent of those who develop and implement the rules. Rules are seen as risk controls to eliminate or mitigate risks associated with identified hazards. They are usually designed by “experts” and are “intended to influence and control human behaviour” (Weichbrodt, 2015, p. 221). Dekker (2005) is credited with formalizing this rule model, sometimes referred to as “model 1”. In this model, rules are seen “as the embodiment of the one best way to carry out activities, covering all known contingencies” (Hale & Borys, 2013b, p. 210). Experts design these rules to:

“Guard against the errors and mistakes of fallible human operators at the sharp end, who are more limited than the experts in their competence and experience, and/or in the time necessary, in the heat of operations, to work out that one best way” (p. 210).

But who are these “experts” and what guides or motivates them to design and implement new rules? In some cases, these rule designers may be experts in one field or another but not in risk and task analysis. An example illustrates this point: on February 12, 2009, Colgan Air Flight 3407 crashed while making an instrument approach to Buffalo-Niagara International Airport in Buffalo, New York after the

aircraft stalled and the crew did not recover. Forty-nine people perished. The NTSB determined that the probable cause of the accident was the captain's "inappropriate" response to the stick shaker. Other contributing factors were the crew's failure to adhere to sterile cockpit procedures and the captain's failure to effectively manage the flight (NTSB, 2010). Rule changes came quickly. The "expert" in this case was the U.S. Congress who mandated that the FAA promulgate a new rule that established new standards for First Officers who are now required to have an Airline Transport Pilot certificate instead of a Commercial certificate. New pilot flight, duty, and rest time rules also resulted from this accident. There was no rigid risk analysis performed. Richard Collins, a long-time pilot and author, called the regulatory actions:

"The all-time most egregious case of smoke and flames rulemaking by the FAA. It was dictated by Congress, it makes no sense, and it will have a lasting, deleterious effect on air service to smaller cities and on airline flying as a profession" (Collins, 2014).

Rasmussen (1997) points out that "many levels of politicians, managers, safety officers, and work planners are involved in the control of safety by means of laws, rules, and instructions . . ." (p. 184). However, the example makes it clear that those "many levels" don't coordinate with each other but act in their own interests. Rule writing is attractive; even seductive. In the case above, it appears to be a quick political fix to a complex problem (Weichbrodt, 2015).

There are other aviation communities besides regulators who have an interest in developing standards (rules and procedures) for users (pilots) to follow. Aircraft manufacturers design standard operating procedures (SOPs) for their equipment. They believe they "have anticipated every problem and provided an easy-to-follow solution" (Wright & McCarthy, 2003, p. 697). The airlines may modify these SOPs to meet their specific operational needs and provide them to their pilots in the form of handbooks and checklists (Wright, Pocock, & Fields, 1998). Wright et al. use the term boundary objects (*Boundary Objects and Beyond - Working with Leigh Star*, 2015) to explain the grouping of these SOPs that are used by different communities. Star used the term boundary object "to refer to representational artefacts that are used to co-ordinate the work of different communities involved in joint projects" (p. 4). In the case of SOPs,

each community has a slightly different interpretation as to the meaning of the procedures. The pilot views SOPs as tasks that should or must be done, depending on the situation in which they are used. For everyone outside the cockpit (the other communities), “the SOPs have a meaning in terms of *what ought to have been* done in order to avoid an accident or incident” (p. 4). This concept of viewing SOPs as boundary objects illustrates the gap between work as imagined (by the regulator, the manufacturer, and the airline) and the work as done (by the pilot.) It creates a dilemma for pilots should they find themselves in situations where they believe a deviation from SOP is necessary to maintain safety. If things turn out bad, will they be blamed? Given the number of aviation accidents attributed to the pilot’s “failure to follow procedures”, it is likely that they will.

2.3.2 *Rules as resources for action*

Pilots are trained both in classroom settings and in simulators to follow rules and procedures and never deviate from them. Yet we know from many accident investigations and reports that deviations occur. What is harder to discern is why this happens. Is the procedure hard to understand and follow? Hutchins (1995) argues that “in order to use a written procedure as a guide to action, the task performer must coordinate with both the written procedure and the environment in which the actions are to be taken” (p. 295). In other words, specific cognitive tasks must be undertaken to read the procedure, understand what it means, and take an appropriate action. The rule designer, far removed from the actual “work” in the cockpit could not have imagined every environment or situation a pilot could encounter. It may be that the situation (that the rule designer could not have imagined) requires the pilot take some different action or deviate from the procedure to assure a safe outcome. In this case, experience may require the pilot to think of the procedure as guidance material; a resource to aid in making the best decision at the time. Other literature supports this view. Suchman (1987) in her book *Plans and situated actions*, argues that plans are representations of actions. It follows then, that a procedure (or plan) is simply a representation of a desired action to be taken. However, given the plan designer could not know the specific desired action necessary for every situation the pilot encounters, the procedure can only be an incomplete specification at best. Wright and McCarthy (2003) conclude that procedures “are resources for action that have to be made sense

of afresh in each new situation” (p. 681) after explaining Suchman’s perspective in the following way:

“Procedures are designed to be contextually independent, yet, like utterances in a conversation, procedures have to be interpreted with respect to the particulars of the situation in which they are used . . . This means that, in practice, procedures are often adapted, modified, and circumvented on the basis of the operator’s appraisal of the local situation” (p. 680).

Standard Operating Procedures are important in airline cockpits. Airline crews can change frequently during a given work period. For example, a Captain and First Officer may start the day together and end up paired with someone else before the day has ended. As such, it is necessary to expect each other to be aware of specific policies, rules, and procedures so that operations can be conducted efficiently and safely. SOPs provide standardization for these types of operations. But it is also important not to “over-proceduralize” and remember the importance of the “intelligent operator who is ‘on the scene’” (Degani & Wiener, 1997, p. 302).

Dekker (2005) in his second model on safety rules (referred to as “model 2”), also concludes that procedures are *resources for action* and by themselves, can not guarantee safety. He posits, similar to Degani and Wiener, that “safety results from people being skilful at judging when and how (and when not) to adapt procedures to local circumstances” (p. 139). Model 1 and model 2 are reflected in what Hollnagel (2014) calls Safety I and Safety II:

“Safety I assumes that things go well because people simply follow the procedures and work as imagined (model 1.) Safety II assumes that things go well because people always make what they consider sensible adjustments to cope with current and future situational demands (model 2)” (p. 149).

2.3.3 Monitoring and exploring the gap

The co-researchers have referenced contrasting paradigms, philosophies, and models that are identified, discussed, and analysed throughout the safety literature. While differences exist between the two versions of each (Safety I vs Safety II, Model 1 vs Model 2, etc.), they are not mutually exclusive. Hale and Borys (2013a) in “Working to Rule or Working Safely? Part 2: The Management of Safety Rules and Procedures”, illustrate Model 1 and 2’s strengths and weaknesses in the table below:

Table 3
Summary of main strengths and weakness of models 1 and 2

Model 1	Model 2
<p><i>Strengths</i></p> <ul style="list-style-type: none"> • Makes rule making explicit and easy to audit • Makes consequences of rule violation explicit • Emphasizes competence in rule-making and role of subject experts • Logical, rational, engineering approach • Works well for novices • Proven effectiveness for simple, ‘golden rules’ • Emphasises the role of organizational complicity in rule violation <p><i>Weaknesses</i></p> <ul style="list-style-type: none"> • Sees operators as robots, lacking competence and social motivation, and needing imposed rules. • Encourages a blame culture and negative view of rules and violations • Sees rule-making as a one-off, static process, until accidents trigger rule modification • Fails to deal adequately with exceptions except as triggers for rule book growth • Tendency to bureaucracy and gap between rules and reality 	<p><i>Strengths</i></p> <ul style="list-style-type: none"> • Recognizes operators as experts central to rule-making • Recognizes social processes as key to rule use • Sees rule-making as a continuous, dynamic process • Links rules to the crystallised competence of organizational memory • Recognizes the importance of managing exceptions and their link to violations • Recognizes the centrality of experience <p><i>Weaknesses</i></p> <ul style="list-style-type: none"> • Rule-making and modification process lacks transparency for auditing and for novice learning skills • Undervalues the need for the organization to explicitly manage rule development • Hides differences of interpretation and competence

(Hale & Borys, 2013a)

Hale and Borys suggest a picture emerges from the literature (summarized in the above table) that shows:

“a gap between the reality of work and its routines and the abstraction of the . . . rules that are supposed to govern it and guide behaviour to carry out that work safely” (p. 223).

They acknowledge the value of having the sharp end operators involved in the rule-making process (model 2), but at the same time, see the need for a transparency in rule-making (model 1) “so that it is clear to both rule users and supervisors, and to auditors what the current agreed set of rules is” (p. 223). Hale and Borys further argue that good rules and procedures should be enforced but if workers have to develop “work-arounds” that create “informal” rules that (as model 2 suggests) “routinely violate procedures, it is more likely that the procedures are in need of change” (p. 224). To do this requires monitoring – not to find non-compliances or violations (a model 1 view) but to learn what rules need to be changed or identify situations that might require ways of coping that allow the rules to be used as a resource or as guidance but not necessarily followed to the letter.

How can organizations become more aware of the gap between work as imagined and work as done? Safety science literature provides insight to the answer. The ability of systems and organizations to adapt, i.e. become resilient, is key (Bergström et al., 2009; Dekker, 2006; Hollnagel, 2006; Weick & Sutcliffe, 2007). Generally, resilience is thought of as the ability to bounce back; to recover. It reasons that if something goes wrong, it is easier to “recover” the sooner action is taken. The sooner the adjustment is made, the greater the probability of a successful recovery. Resilience, in the safety sense, is defined by Hollnagel (2006) as “the ability of a system or an organization to react to and recover from disturbances at an early stage, with minimal effect on the dynamic stability” (p. 16); in other words, adapt.

To adapt, organizations must learn about and understand gaps that exist between the procedures and how the work is done (Dekker, 2003). How do they do this? In the Federal Aviation Administration (FAA), collecting and analysing incident reports is a common practice used in hopes that precursors to accidents can be identified. Once identified, barriers, in the form of rules, advisory circulars, and policy changes can be developed to minimize these precursors from happening and being part of an accident chain. From the FAA’s perspective, this action closes the gap, i.e. ensures that the work (as they imagine it) will be done that way by the operators (because it is a rule). One of the co-researchers, a former FAA safety inspector, spent many years on the development of a risk-based oversight system used by all FAA inspectors. A primary premise of this system was that the data collected would enable analysts to identify

these precursors and suggest appropriate action to mitigate or eliminate them. This approach is not much different from how it has always been done. The difference is that now, with the aid of technology, more data can be collected. But in complex systems like aviation, there is little quantifiable benefit to this approach (Dekker, 2006). Dekker asserts that “accidents in very safe systems seem to emerge from (what looks to everybody like) normal people doing normal work in normal organizations” (p. 79).

This example (provided by the co-researcher referred to above) supports Dekker’s perspective: In 1996, a ValuJet Airlines DC-9 crashed in the Florida Everglades killing all 100 persons on board. This accident was the catalyst in the FAA’s taking a different approach to regulating safety. The accident investigation identified numerous deficiencies – both in the airline and the FAA’s oversight. There was a 90-day stand-down during which time, the FAA conducted an internal in-depth look at themselves to figure out how they missed so much. Senior executives retired or were transferred. Safety inspectors were reassigned. System safety training was provided to all inspectors with an emphasis on hazard identification and risk management. Plans were put in place to pursue the development of a new risk-based oversight system based on methodologies used by the nuclear power industry. Shortly after the accident, existing incident reports and inspector surveillance data involving ValuJet was reviewed. Analysts concluded that based on the data, it was no wonder there was an accident; high-risk indicators were plentiful; it’s all here; why didn’t anyone do anything? But this conclusion was only available after the accident. Prior to the accident, it was normal people doing normal work. As Dekker submits, “in safe systems, it is not human errors or failure events that lead to accidents. Normal work does” (p. 80).

Amalberti (2001) describes ultra-safe systems (like commercial aviation) as aging, over-regulated, and highly unadaptive. He asserts that when accidents occur, there are usually no serious system breakdowns or errors. They (the accidents) result from the system’s complexity. Methods to identify accident precursors and eliminate them (incident reporting, issuing violations for non-compliance, making more rules), while arguably effective in less safe systems, do not work in ultra-safe systems. So can safety be improved beyond these ultra-safe levels? If what worked before doesn’t work now, what can be done?

We know there is a gap between rules and procedures and the actions pilots take when facing challenging or difficult situations. We know that “it is the artfulness of the intelligent worker that fills the gap between abstractions of work and its practice” (Wright et al., 1998, p. 5). To improve safety, organizations (regulators, airlines, manufacturers) must explore and understand this gap. Even though one of the characteristics of aviation (as an ultra-safe system) is that it is “highly-unadaptive”, it is critical that every effort is expended to increase the system’s capacity to adapt. Organizations and people must become skilful at knowing when and how to adapt (Dekker, 2003). They must become resilient (Dekker & Lundström, 2006).

2.4 Summary and Need for Empirical Research

2.4.1 Review of research objectives fulfilled by literature review

Chapter 1 specifies four objectives of this Master’s research thesis. Objectives 1 and 2 were met in this literature review. We highlighted literature that explores the history of rule development in aviation and presented evolving views on aviation safety, accident causality, and human error. The literature identifies two views of rules: 1) rules and procedures as a set of standards that provide actions for every situation and that, if those standards are followed, safety is guaranteed; and 2) rules and standards as a set of guidelines or “resources for action”, to be used by the sharp end operators as the situation (that could have not been imagined by the rule maker) dictates. Failure to follow procedure remains a primary causal factor in aviation accidents.

2.4.2 Empirical research needs

Despite the abundance of safety science literature on rules and procedures, there is very little that examines how, or even if, rules and procedures help pilots make decisions in difficult and challenging situations. Our research aim is to answer that question, or at least develop a better understanding about rules and the pilot’s use of them when making decisions in unexpected or unplanned situations. To gain that understanding, empirical research in the form of a thematic analysis that draws on case study methodology will be conducted. This empirical research and its analysis, together with the literature review conducted and discussed in this chapter meets our third research objective. The next chapter, Research Methodology, will detail the strategy and methodology that will be used to conduct the empirical research.

3 RESEARCH METHODOLOGY

3.1 Introduction

We noted in the previous chapter that while there is an abundance of safety science literature on rules and procedures, there is very little research about how, or even if, pilots use these rules and procedures when making decisions in challenging or difficult situations. Accident and incident analysis data are commonly used sources that provide empirical data from undesired situations. These sources provide constructed, hindsight information about situations that were handled unsuccessfully, leading to negative outcomes.

For this thesis, the aim is not to explore statistical data, but to get something different; a more in-depth understanding of how (or if) pilots use rules when making decisions in challenging situations. Contrary to statistics from incidents and accidents, which represent only a small number of flights, interviewing the pilots provides stories from a broader, more personal perspective. The pilot's perspective can provide a more complete story about how pilots do their normal work. This perspective provides insight into how they assess risk, how they adapt when the procedures do not exactly match the way a situation needs to be handled, how they anticipate situations that arise, and how they handle surprise and unusual situations. It tells how work as done differs from work as imagined (Hollnagel, 2006).

Using a pilot's story provides a clearer picture; one where the pilots get the opportunity to talk about cognitive processes; to describe how they think and why they act the way they do. None of the pilots from the interviews for this thesis have experienced an accident. This is not surprising given that there are very few pilots who ever experience a serious incident or accident during their careers. The respondents' accounts are about actions taken and decisions made in difficult situations. Their stories may provide more learning material than one might think, simply because there are so many of them.

At the beginning of this research project, the co-researchers were interested in exploring the gap between work as imagined and work as done from the pilot's perspective. Our initial research aim was to better understand the role rules and procedures played in the daily life of a commercial aviation pilot. It became clear during our first few interviews

that asking pilots about their use of rules and procedures in a general sense, i.e. routine situations, may not provide the type of interesting data we were seeking. Based on that insight, we modified our research aim to explore whether rules and procedures helped pilots make decisions in difficult and challenging situations and if so, how. This modification was invaluable in helping collect useful, analysable data. Difficult situations provide a better source for knowledge than simple, routine situations. Not only are difficult situations more interesting, pilots are also much more aware of what they choose to do and why, than during routine tasks (Hoffman, 1987; Hoffman, Crandall, & Shadbolt, 1998).

3.2 Research Strategy

3.2.1 *Choosing the method*

“Qualitative research is a situated activity that locates the observer in the world” (Denzin & Lincoln, 2000, p. 3). This type of approach was used to gain an understanding of how pilots work with procedures and rules in their own environment. We drew on case study methodology and used thematic analysis to conduct this qualitative research study. The literature revealed that there is a difference between how rules are designed (from the perspective of work as imagined) and how they are interpreted and used by sharp end operators (pilots). Case study methodology “supports deeper and more detailed investigation of the type that is normally necessary to answer how and why questions” (Rowley, 2002, p. 17).

3.2.2 *Designing the research*

Establishing the scope: The target population for the interviews were pilots from four different segments of the Norwegian aviation industry. The Norwegian aviation industry was chosen because one of the co-researchers is a Norwegian commercial pilot with knowledge of aviation operations in Norway. He has access to former and current colleagues who know and trust him which facilitated attracting pilots willing to discuss situations where they may have deviated from rules to ensure (from their perspective) safety. Choosing different segments of the industry was an important factor. We wanted to learn about possible differences and similarities in the pilots’ stories related to the segment they served, i.e. regional airline, traditional or legacy air carrier, low-cost airline, and off-shore helicopter operations. Different segments of the industry face different

kinds of challenges and different levels of risk. Some segments are more standardized and regulated than others, some experience more commercial pressure than others, and it is likely their company cultures differ as well (Cento, 2009).

Selecting the respondents: The respondents were picked non-randomly using active and selective recruitment. There was a need to find pilots willing to share their story, openly and truthfully, without worrying about their judgements being questioned. This turned out to be quite easy. While we did not ask the specific thesis research question during our interviews, we did explain to them that the aim of our research was to gain an understanding about whether rules helped them make decisions in difficult or challenging situations. This triggered their curiosity. As one pilot expressed it: “It is nice to see science projects, where the main focus lies with the front-line operators and their views. It is nice to be given the opportunity to share my thoughts on this.” This approach provided an exploratory aspect of the study in raising the possibility that we may find insights and ideas that lead to other, more detailed representative research (Biggam, 2015).

The respondents represent different types of operators as listed in the table below:

Table 4
Aviation Segments Represented by Respondents

Pilot's Position	Regional Airline	Traditional Airline	Low-Cost Airline	Off-shore Rotor Wing
Captain	6	2	1	3
First Officer	2	1	1	
Instructor/Supervisor	3 Captains are Supervisors			2 Captains are Instructors

Conducting the interview: Interviews were conducted using a semi-structured approach to ensure a conversational environment that would give the co-researchers the opportunity to probe deeper into the respondents' answers.

3.3 Data Collection

Sixteen interviews were conducted (15 face-to-face and 1 using Skype with video). Face-to-face was an important setting for several reasons. It created a relaxed, non-threatening environment that was conducive to a conversational, almost social setting. It also gave the respondent an opportunity to sketch on a piece of paper when explaining the difficult and challenging situation they wanted to discuss. This reduced ambiguity and contributed to richer data, helping the co-researchers understand how and why they made the decisions they did.

Except for two interviews conducted in English, all others were conducted in the respondent's native Norwegian language. The interviews were semi-structured with three basic questions. These basic questions and possible sub-questions were provided to the respondents prior to the interview (see Interview Invitation Letter in Appendix 1). Sub-questions were used to "further specify the central question into some areas for inquiry" (Creswell & Poth, 2017, p. 140). The basic questions and sub-questions were:

1. What do rules mean to you during daily work?
 - a. What rules regulate your daily work?
 - b. [Thoughts on] rules vs procedures vs techniques vs policies.
 - c. How do you think about rules during various situations?
 - d. When and how do you apply rules?
2. What is the most challenging or difficult situation you have faced as a pilot? Alternatively, what is a difficult situation you regularly face?
 - a. What strategies do you use?
3. What about the rules? (did they help in these difficult situations?)
 - a. Would more rules help increase safety – either in this situation or in general?

The respondents were told in the Interview Invitation Letter (see Appendix 1) that these questions would be used as guidance and they could vary depending on their responses during the interview. The respondents' answers were followed up with open-ended "how" and "why" questions to follow related leads when new or interesting issues arose, and to encourage meaningful responses (Patton, 1990). Closed-ended questions, such as "Do the rules pertaining to this situation help you solve the problem?" were used to provide the researchers with a better understanding as to what

the respondent thought about the relevancy of a rule to the challenge the pilot had described.

The interviews were not recorded. We believed that recording the details of situations where the respondent intentionally ignored or violated a rule or procedure could have created an environment that suppressed the complete story (Blaxter, Hughes, & Tight, 2010). Detailed notes were taken during each interview and translated from Norwegian to English. Two interviews were conducted in English and did not require translation. The translated version of the draft notes was discussed and finalized with the respondent over the phone or by email. This discussion occurred anywhere from a few days to a few weeks after the initial interview due primarily to the challenges associated with finding a time suitable to both the researchers and the respondent. The delay provided an unexpected benefit. In some cases, the respondent had thought more about their responses and was able to clarify different points as well as confirm that the translation reflected what he or she had said.

3.4 Reliability and Validity

“Central to reliable research is the concept of trust: can your results be trusted?” (Biggam, 2015, p. 173). There will always be a question of reliability (or trust) when asking pilots directly about how they think about, use, and apply rules while doing their job. To get the data we were seeking, i.e. the data that would help understand how pilots used rules when making decisions in difficult or challenging situations; required a relaxed and open atmosphere; one where the pilots felt safe to speak honestly and frankly about what they think and do without concern for consequences.

Creating this environment was challenging. Seven of the respondents knew one of the researchers professionally and personally. It is possible that some may have felt the need to please and give “textbook” answers that elicited approval. To counter this, the respondents were presented with a short description of the research project including how the information they provided would be used and how identifying information would be removed before publication. Norwegian aviation is a small world, so this “guarantee of protecting the sources” could have been perceived as weak. To strengthen the trust and the guarantee, the respondents were told that they could

withdraw from the project at any time and that, if they desired, restricted access could be given to the final thesis.

We are confident the interview environment we constructed resulted in collecting reliable research data. The evidence for this confidence lies in the fact that during the interviews, follow-up sessions, and post-translation review discussions, the respondents expressed a desire for their stories to be made public, rather than suppressing them. Norwegian aviation is largely non-punitive. This likely had a positive effect on the data collection aspect of the research. None of the respondents asked for any of the information given during the interviews to be restricted.

Biggam (2015) identifies valid research “as research that is acceptable to the research community” (p. 173). Our interest in this study was to gain insight into the decision-making processes used by pilots when they were confronted with difficult or challenging situations. As they determined actions to take, did they consider if they should follow the procedure verbatim or could they deviate if they thought that was the better choice? We drew on the case study methodology, a methodology supported by the research community to use when you want to dig deeper and ask “how” and “why” questions. Creswell and Poth (2017) view validation as:

“a distinct strength of qualitative research in that the account made through extensive time spent in the field, the detailed thick description, and the closeness of the researcher to participants in the study all add to the value or accuracy of a study” (p. 259).

While our research was not to the scope and breadth Creswell and Poth were thinking when writing their book, it did possess some characteristics. A very important and exciting aspect of our project has been the enthusiasm exhibited by our respondents. They have been excited to be part of this work and look forward to reading the final report.

3.5 Limitations, Challenges, and Ethical Considerations

Lack of familiarity with research process: The co-researchers had not conducted qualitative research study previously. The fact that our respondents were selected and interviewed very early in the research process without consideration given to how the data would be analysed is indicative of this lack of experience.

Respondent's interpretation of "challenging or difficult" situations: As explained in the introduction to this chapter, we asked the respondents to discuss their thoughts and actions related to "challenging or difficult" situations expecting that all would recall a single event. We did not, however, attempt to guide the respondents as to how "challenging or difficult" was defined – we wanted to leave that to them. It became clear as the interviews progressed that not everyone had experienced a single "challenging or difficult" event – or at least one they wanted to discuss. We adjusted the question and asked them to consider not just a single event but difficult situations they face regularly. That proved to be an effective adjustment in terms of providing data that allowed the exploration of how rules affected the pilot's decision-making in specific, single situations as well as situations (of a similar nature) they regularly faced. We labelled these two categories Specific Situations and General Situations. This adjustment broadened the types of experiences our respondents provided. This provided an excellent opportunity to learn, which "is of primary importance" (Stake, 2000, p. 447).

Respondent and researcher bias and objectivity: We accept that the respondents and co-researchers have biases. It is not our goal to eliminate bias but to recognize and reflect on it – a self-reflection that "creates an open and honest narrative that will resonate well with readers" (Creswell, 2013, p. 202). Similarly, it is impossible to remain completely objective when many of the respondents are colleagues of a co-researcher in the sense they work for the same company. Fifty percent (8 out of 16) of the total respondents in this study worked for the same airline as one of the co-researchers. Two strategies were used to raise the level of objectivity and help ensure the respondents influenced the data more than the co-researchers. The first was to minimize the number of pilots interviewed that were assigned to the same base as the co-researcher (2 out of 8). The second strategy was to review the interview notes in depth with the other co-researcher who had no personal connection with any of the respondents. This

in-depth review had another benefit – to help identify and resolve biases of the second co-researcher who worked as a civil aviation authority inspector for more than 25 years. While we would like to say, we pre-planned our co-research effort to include a regulator and a regulatee to minimize the biases held by either, that was not the case.

Ethical considerations: All the respondents were invited to participate in our research study. The interview invitation letter (see Appendix 1) explains that identifiable information will be removed and that if, at any time, the respondent wanted to withdraw from the study, he or she could do so and all data would be deleted. Christians (2000) tells us:

“Consistent with its commitment to individual autonomy, social science in the Mill and Weber tradition insists that research subjects have the right to be informed about the nature and consequences of experiments in which they are involved” (p. 138).

While our respondents were not involved in an “experiment” in the same sense intended by Mill and Weber, the notion of informed consent is still valid. As such, in addition to the invitation letter discussed above, for those respondents who agreed to participate, they were provided with an informed consent form (see Appendix 2.) This form clarifies that their participation is voluntary and they can withdraw from the research study at any time. Finally, for those respondents who worked for the same company as one of the co-researchers, the co-researcher sought and received approval from company management to interview those respondents.

Stake (2000) establishes that “qualitative researchers are guests in the private spaces of the world” (p. 447). Keeping that in mind, we were alert for indications of any harm caused by asking the respondents to tell their stories – especially stories that may have been traumatic in nature. We were prepared to stop the interview had that happened. But it did not.

3.6 Framework for Data Analysis

Background: One of our research objectives was to use the empirical data we collected to analyse how rules impacted a pilot's decision-making in challenging and difficult situations. As noted earlier, not everyone experienced a specific "challenging or difficult situation." In this section, the emphasis is on the framework for our data analysis. The actual analysis is reported in Chapter 4.

Our approach: Ultimately, we decided to use thematic analysis to describe and analyse our data. We generally followed the guide described by Braun and Clarke (2006) consisting of the following phases:

1. *Familiarizing yourself with the data.* This involved actively and repeatedly reading the raw data from the sixteen interviews and searching for patterns and meanings with regards to our interview questions. We were trying to get a sense from each respondent's story as to: 1) how they felt about rules in general and 2) do they consider them when making decisions in difficult or challenging situations and if so, do they help? Notes were taken during this phase highlighting specific comments, phrases, and concepts expressed by the respondents. Our notes included any thoughts or ideas we had that could prove useful in other phases of the analysis. We will highlight these findings in the Initial Findings section in Chapter 4.
2. *Generating initial codes (categories)* The notes we had from phase 1 provided a list of ideas and items of interest that we could use to break down the data into more specific categories. In this phase, we focused on the difficult or challenging situations described by each respondent to understand if rules helped them make decisions in those situations as well as why or why not. This work was done on flip chart paper to make it easier to review in subsequent phases.
3. *Searching for themes.* In this phase, we reviewed the raw data, our notes from phase 1, and the categories we developed in phase 2. We transferred the data from the flip chart (gathered in phase 2) to an Excel spreadsheet. Each row (1-16) in the spreadsheet represented a respondent. A second spreadsheet was added to the Excel workbook identifying possible themes. For each theme, we entered the appropriate respondent code that fit the theme. For example, theme X might

have 4,6,9, reflecting that the data from respondents 4, 6, and 9 could be attributed to theme X. Respondent codes could fit in more than one theme.

4. *Reviewing themes.* At the end of phase 3, we had six possible themes. In this phase, we reviewed the themes in conjunction with the notes, tables, and data generated in the previous phases. Our goal here was to identify possible theme overlap; themes that were too broad or not broad enough; and themes that, while interesting, did not fit in the scope of our research.
5. *Defining and naming themes.* The thematic analysis approach is very iterative and in this phase, we again reviewed data from previous phases and further refined the themes to “identify the ‘essence’ of what each theme is about” (Braun & Clarke, 2006, p. 22). This process involved the further consolidation of themes identified in phase 4 resulting in a small group of four themes and ten related sub-themes. The themes from phase 4 were renamed to be more concise and clear.
6. *Producing the report.* The final phase in thematic analysis is producing the report, which, if done well, will “tell the complicated story of your data in a way which convinces the reader of the merit and validity of your analysis” (Braun & Clarke, 2006, p. 23). The next chapter tells this story. You, the reader, must determine its “merit and validity.”

4 RESEARCH FINDINGS: DESCRIPTION, ANALYSIS, AND SYNTHESIS

4.1 Introduction

This chapter focuses on describing and analysing the empirical data in accordance with the data analysis framework discussed in the previous chapter. The sixteen respondents are referenced in this chapter using a code consisting of a number from 1 to 16 followed by two letters. The first letter denotes the aviation segment represented by the respondent, i.e., R-Regional, T-Traditional, L-Low cost, O-Offshore. The second letter is the pilot's position, i.e. C-Captain or F-First Officer.

4.2 Initial findings

This section will discuss the findings that surfaced during Phases 1 and 2 of our thematic analysis as we tried to understand how the respondents thought about and used rules in their daily work as well as in specific or general difficult and challenging situations. These findings were subsequently used to develop the themes for our analysis.

4.2.1 *What do rules mean in the respondent's daily work? (thoughts about rules in general)*

The responses provided were very similar. Six of the sixteen respondents described rules as the structure or framework in which they operated. All but one of these worked for the large regional airline. One respondent (2RC) stated that rules form the structure for all the work that he does. Another (3RC) stated that the rules provide “a frame of operation that provides a safety margin.” He added, “they provide structure, uniformity, and predictability in the cockpit.” Another respondent (4RC) referenced the rules in the company manuals as a frame. This respondent, a captain, noted that if you work “outside the frame, you are on your own.” A first officer (7RF) told us the rules provide him with a framework “that he always aims to remain within.” He added, “as long as they are relevant and reasonable regarding safety and efficiency.” He explained this idea of “relevancy and reasonableness” with the following scenario:

You are in take-off position. The runway is in reality bare and dry. However, technically, it is contaminated because there is a narrow strip of snow along the edges. So, to stay within the rules we have calculated the take-off as if the runway is contaminated even though the surface is not. When the actual crosswind for a contaminated runway exceeds the limit by one knot, we delay our take-off. A few second later the tower reports the wind as calmed slightly so we can now legally take off. But we [the pilots] are well aware that this has no impact on safety. Taking off was outside the limits a few seconds ago but the conditions and our real risk has not changed one bit; especially since the runway is in fact, bare and dry. In other words, the regulations do not reflect what we need to consider (7RF).

Four of the sixteen respondents (who also worked for the large regional airline) described the rules as everything that was contained in the company manuals. One captain (4RC) said the rules cover everything he does and are described in company manuals OM-A and OM-B. Another captain (5RC) described the company manuals and EASA rules as “what runs his work day.” A third captain (6RC) also described the rules as those from EASA, the national authority, and the company. He said that “pretty much everything we do is based on rules.” He added, “the rules are not enough to ensure safety” and that “as a pilot, you must be able to identify the situations where the rules are not suitable to ensure safety.” This respondent further stated that it is important to understand the reason behind the rules and that “you cannot just demand a person to do something without explaining the reason for it.” The importance of understanding the rules was emphasized by another respondent (2RC) who told us that the “trainers need to understand the rules well enough to talk about them in a way that makes sense.” He further stated that the pilots need to understand the entire system and how the rules fit. A legacy carrier captain (10TC) sees rules as an “anchoring point in everything he does” but also says “rules should make sense.” He says he is responsible for maintaining safety of flight – “even if it means breaking the rules.” Decisions, he says, are sometimes not based on rules “but on experience.”

As noted by the responses in the paragraph above, other notable findings began to emerge. The idea that one needs to identify situations where rules are not suitable to ensure safety implies the respondent is aware that there is a gap between work as

imagined and work as done. Other respondents noticed this as well. For example, a supervisor for the regional airline (2RC) told us “there is a gap between the rules and procedures on one side and the various situations and tasks we handle on the other.” A captain (4RC), when discussing the use of rules during his work day said, “sometimes the rules are on one side and you are on the other – the situation emerges in the middle.” In these situations, he stated that he uses the rules “as well as possible and for what they are worth.” Another implication of a gap was implied by a captain (1RC) who told us, “some pilots are very good at following procedures but may be less skilled when they need to handle an unusual situation” (implying the situation wasn’t addressed by a rule or procedure.) Sometimes procedures are skipped when the crew decides they are not necessary. For example, one respondent (5RC) told us he sometimes flies into the same airport several times a day. In good weather, when the conditions have not changed since the last time they flew into the airport that day, they may skip parts of the procedure for briefing the approach. He says, “we don’t want to bother each other with a briefing that is not relevant anymore.” He stated they brief the highlights and skip the obvious. The logic behind this, he says, is repeating the same briefing tires “our ability to stay focused on what counts.” He referred to this as an unwritten rule.

4.2.2 Are rules considered in challenging and difficult situations? If so, how?

As we noted in Chapter 3, in the discussion about limitations and challenges, our initial expectation was that each pilot would tell us about a single challenging situation that each had experienced in their career but this was not the case. When, in our third interview, the respondent could not (or did not want to) discuss a specific situation, we asked if there were any difficult or challenging situations he regularly faced. This proved to be an effective adjustment that we used throughout the interview process. As we progressed through the phases of the thematic analysis, we determined that of the sixteen respondents, six described and discussed a specific challenging situation they had experienced. Eight respondents described difficult situations that they regularly faced. We categorized these as general situations. The remaining two respondents described general situations they faced regularly and provided specific examples to illustrate and describe the situations. Interestingly, all six of the respondents who recalled a specific challenging situation worked for the regional airline. To suggest why this might be the case, would be speculation. Our objective as we searched for patterns and meanings in the raw data was to get a sense of how pilots considered or used rules

and procedures when making decisions in both specific and general difficult or challenging situations.

Specific situations. Three of the six specific challenging situations discussed by the respondents had one thing in common – the situations evolved quickly and required rapid assessments and decision-making. The pilots reported that there was very little time to think about rules and when there was, it was determined that rules did not address the dynamic, quickly evolving situations they had encountered. In one case, following a rule (company recommendation) made the situation worse.

Specific situation 1. Respondent (1RC) described an approach he was making into a small regional airport in Northern Norway. The airport runway is short (871 m) and the airport is surrounded by high terrain. During this night approach in bad weather (an approach the pilot had made many times), the weather deteriorated, reducing go-around options due to the terrain. The crew encountered unexpected weather-related situations during the approach but was able to make a successful landing. When asked about the rules that were applicable to his situation and how he considered them during the approach, he said he did not break any rules but as the situation evolved, he was right on the edge of being in non-compliance with some rules. After landing, he debriefed the approach and landing with his first officer and in hindsight, they recognized that even though they did not break any rules, they came close. This “coming close” in several instances constituted small warning flags, but there was not any “one flag that contributed to a clear no-go decision.” He said he has made many landings at that airport at night in adverse weather conditions and was “initially comfortable” with the situation. But as the situation evolved, it slowly became “something slightly different.” Finally, it was no longer the same situation he experienced before but “something different that you have to figure out how to deal with.”

Specific situation 2. When asked about rules and their impact in challenging situations, a second respondent (2RC) began his story by telling the researcher that the Captain’s training course at his company has “little focus” on how to handle situations that are not covered by the rules. He then recounted an approach into a coastal airport in Norway at night in bad weather. The weather was at or below minimums at the landing airport as well as several possible alternate airports. The respondent, although a captain,

was sitting in the right seat (acting as first officer on this flight) and was the Pilot Not Flying (PNF). When they reached the missed approach point, they did not have the required visual reference and initiated a missed approach (rule compliance). As they were executing the missed approach, they became clear of the clouds and had the airport and surrounding terrain in sight. At this point, the crew decided to abandon the missed approach and execute a visual approach. However, when they turned onto the final approach, they encountered low clouds and had to take an evasive manoeuvre that resulted in an unusual flight attitude and abrupt flight control corrections. The aircraft eventually landed at another airport. Like the first situation, the respondent told us no rules were broken but when the clouds were encountered, rules were not considered – the only consideration was getting out of the clouds and back to a safe operating environment. The captain concluded by telling the researcher that to him, this was “an example of how rules and procedures are not sufficient barriers to prevent undesired situations.”

Specific situation 3. Respondent (5RC) described a situation that involved an in-flight emergency. During the enroute portion of the flight, a fire developed in one of the aircraft’s Air Data Computers. All instruments were lost on the first officer’s panel as well as the right autopilot, yaw damper, and ground proximity warning system. Aural and visual warnings were numerous. At this point, the flight crew did not know there was a fire. The respondent remembers that “it was difficult to sort things out and think straight.” He said the design of the aircraft advisory system was not helpful in that when you cancel a warning or caution, you can’t bring them back up to see in what order they appeared. That made it difficult to know what emergency procedure to use. At that point, a cabin attendant called the flight deck on the intercom and reported the smell of smoke or fire – she wasn’t sure which. The flight crew donned their oxygen masks and declared an emergency to air traffic control. The company recommends that in an emergency, the pilot should normally use the same radio frequency they had been using. They followed this recommendation and it turned out to significantly decrease the chances for a successful outcome. The radio channel they were using was congested at the time and the pilot interpreted several instructions for other aircraft as instructions for him. He reset the aircraft heading and changed the navigation radio to another frequency thinking he was being vectored to another runway. There were several indications things were not right but he decided air traffic must have a plan for him.

When he broke out of the clouds on the wrong heading he saw the airport but it was not where he expected. He recovered and landed safely. This was a case, he says, where following the rule (company recommendation) almost resulted in a catastrophic outcome.

General situations. One element that was a major factor in the specific situations was missing in the stories from the ten respondents who discussed general situations they regularly faced. That element was time. In other words, events were not unfolding rapidly requiring pilots to quickly make decisions. In these situations, rules were much more likely to be considered, but their usefulness was still questioned. The following stories help illustrate why this is the case.

General situation 1. One respondent, 10TC, talked about the challenges of winter operations. He called it the “most complicated part of my job.” Ever-changing weather influences such things as runway braking action, stopping distance calculations, effects of cross wind, and the amount of fuel you can carry. This, coupled with the topographical conditions near Norwegian airports “reduce the safety margins and trigger the need for comprehensive risk assessment.” His strategy is to take what he refers to as a “Big Picture” approach. He checks the weather the night before a flight to get a mental picture about the conditions he is likely to face. He checks again in the morning to update that picture. He does this on his own time – not because the rules require it, but to be better prepared. By the time he gets to the airport to fly, he has a very good idea about the challenges he will be facing that day. His preparation is based on experience; experience that tells him, “he is operating near the safety margin boundary.” His decision-making is based on this experience and “not on the rules.” The rules, he states, don’t address many of the complexities in winter operations. One reason is the “bodies that make the rules don’t always interact with the front-line practitioners.” The rules “guide” how he operates and they “help him decide” what to do, but they “cannot cover all aspects and situations.”

General situation 2. Each specific and general situation described up to this point is the story of one respondent. This example is different. As we were actively reading the interview notes in search of patterns and meaning, we noticed that three of the respondents (11TF, 12LC, 13LF) had similar stories. Their stories revolved around the

pressures they felt to adhere to their flight schedules (stay on time) and do it efficiently (use the minimum amount of fuel). These pressures, they told us, increase fatigue and stress.

One respondent (11TF) flies for a legacy airline, but his previous position was with a low-cost airline. He believes that the low-cost airline philosophy has affected the way traditional airlines have refined their policies and standard operating procedures to stay competitive. An outcome of this, according to him, is that the “safety margins have been reduced and it is the pilot’s responsibility to provide their own margins.” An area of major confusion, he states, exists with regards to the recently (2016) published revision to EASA Flight and Duty Time Limitation and Rest Requirement rules. This revision is so difficult to understand that his company says, “if a pilot inadvertently violates the rule, he will not be held accountable.” He believes, however, that if something happened, the regulator would hold him accountable and he would be blamed. Not only is the rule hard to understand, “it benefits the airline, not the pilots.” The respondent feels pressure to not call in when he is fatigued or expects to be fatigued during his duty day (although the company’s fatigue management policy requires him to do so), but he knows that to be safe, he must avoid fatigue whenever possible. One approach he uses to manage the stress is to look at each day’s flight schedule and if he sees a day with many flights scheduled, he does not think about whether it is too much but says to himself, “let’s see what the day brings.” In other words, if he gets tired, he will deal with it then.

Respondents 12LC and 13LF work for a low-cost airline and each acknowledges pressure to fly as much and as efficiently as possible. 12LC states, “the rule benefits the airline, not the pilot.” 13LF feels there is an economic pressure to maximize efficiency with little regard to operational considerations. As evidence of this, she points to a decision made by the airline to shorten the scheduled time for a route from 55 to 50 minutes. At the same time, the cost index ³ was also reduced. The respondent referred to this as a “classic double bind.” She says this pressure causes stress but “there is no rule for a strategy to handle stress and time pressure.” Both respondents believe that there is a cultural aspect in their airline with regards to flying when you are fatigued.

³ Cost index – a number entered into the aircraft’s Flight Management System – the lower the number, the less fuel is used and the slower the aircraft flies.

12LC said that while he sometimes does call in “not fit for flight”, he does not do it as often as he should. He recalled one flight when, prior to departure, 4 out of the 6 crew members (2 flight deck and 4 cabin) said they expected to become fatigued during the day but did not call in (company policy requires they call in not only when they are fatigued but if they expect to become fatigued during their duty period.) At the end of the day, they agreed that it was not a good decision and that “the rules did not help them that day.” This is an interesting observation by the respondent, given that the rules were in place to help them – the crew chose not to follow them. 13LF talked about the many procedures and policies the airline has so that schedules and efficiencies are maintained. The company employees follow those procedures and policies even though it causes stress because this is the way things are done.

4.2.3 Initial findings summary

Recall that the research aim of this thesis is to better understand how, or if, rules and procedures help pilots make decisions in difficult and challenging situations. In this section, we take the first step in fulfilling that aim by reviewing and describing findings revealed by actively reading the interview notes and searching for patterns and meanings. We describe how the respondents thought about rules in a general sense. The notion that rules serve as a framework or structure that within which, the pilots conduct their daily work was one we heard often. Several also describe the rules as everything that was contained in their manuals. We describe findings as they related to how, or if, rules are considered in the specific and general situations discussed by the respondents. We found that the element of time is a critical factor with regards to considering rules in specific situations. As the situations became more complex with the addition of new events or factors, decisions had to be made quickly. The focus became, not on the rules, but on restoring safe operations. Time, in the sense that decisions had to be made quickly, is not a factor in the general situations described by the respondents. Rules were much more likely to be considered (but not necessarily followed) in these situations. In the next section, the focus shifts to the refinement of the findings associated with the respondents’ interaction with rules in the specific and general situations and to the development of the themes in accordance with the Framework for Data Analysis described in Chapter 3.

4.3 Theme development

Initial theme development. As we progressed through the phases identified in the Framework for Data Analysis, we began to identify commonalities in the data, several which are described and discussed in the previous section. This was done by drawing a table on a flip chart that summarized each respondent's situation, the action each took, and the reason they took it. We reviewed this table and compared it with the interview raw data and interview notes which resulted in the initial set of themes below:

- **Understanding the reason for rules** – four of the respondents discussed the importance of understanding the rules to help make decisions.
- **No rules for dynamic situations** – three of the respondents involved in specific situations found that rules did not help when situations quickly evolved.
- **Both rules and experience are needed to be safe** – three respondents talked about this concept. One (3RC) told us that to be safe “we need to learn the art of combining our rules with experience.”
- **Awareness of gap (between work as imagined and work as done) and resources for action** – seven respondents provided examples of how rules did not fit the situation and times when they used the rules as “suggestions” (resources for action.)
- **Rule perspective** – three respondents described situations where the rule(s) didn't work for the situation they were in. This led us to consider (in our analysis) whose perspective influenced the development of the rule.
- **Drift to danger** – this initial theme is related to the rule perspective above. In the previous section, we discussed situations three of the respondents regularly faced. Company policies to stay on schedule and operate efficiently pushed them closer to the safety margin.

For example, our flip-chart table showed the theme Rule Perspective is associated with respondents 5RC, 8RF, and 16OC. The table illustrated respondent 5RC's discussion of a rule that limits operations based on specific wind conditions. He said the rule is very difficult to apply because it so “poorly written.” He explained the rule was developed and published following two wind-related accidents. This finding led the researchers to consider from whose perspective was this rule written – hence, the relationship to the rule perspective theme.

The next step in developing the themes involved reviewing the initial themes and then defining and naming the final themes in accordance with phases 4 and 5 of Braun and

Clarke’s guide to thematic analysis. We were looking for what Braun and Clarke (2006) describe as the “essence” of the themes, i.e. what was their fundamental characteristic? To do this, we re-read the interview notes, sorted the data using flip charts and spreadsheets, and reviewed the data gathered in previous phases of the process. This resulted in consolidating and renaming the initial themes into four final themes. The themes and related sub-themes are illustrated in Figure 1.

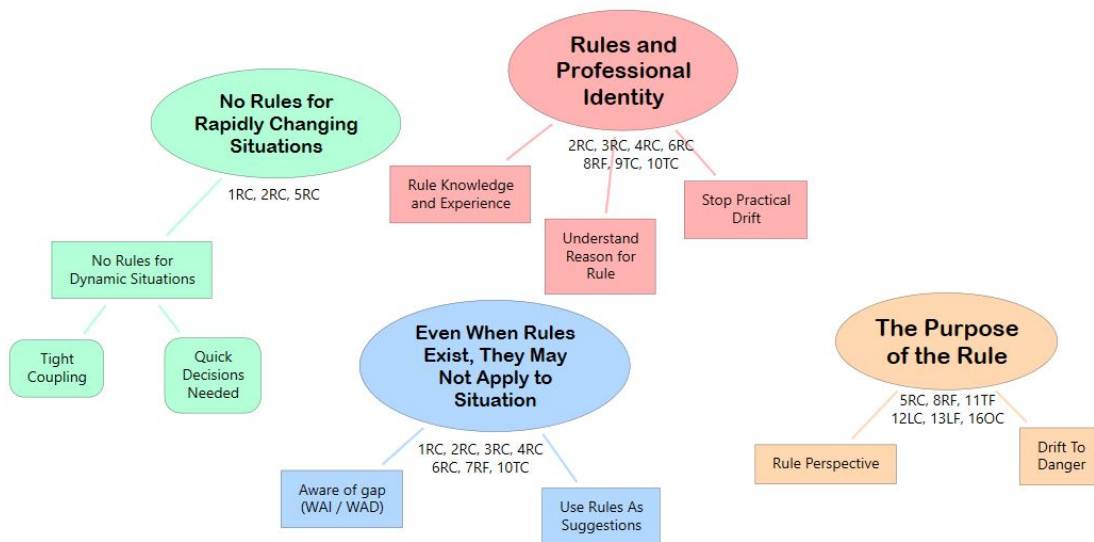


Figure 1 Final Themes

The themes are called out in the larger, oval shapes and are:

- **No rules for rapidly changing situations** – this theme evolved from the stories the respondents told about specific situations they were involved in where very little time was available to make decisions.
- **Rules and professional identity** – this theme emanated from the responses the respondents gave when asked about how they and their colleagues thought about and used rules in their daily work as commercial aviation pilots.
- **Even when rules exist, they may not apply to the situation** – many of the respondents noticed the gap between work as imagined and work as done and talked about how, in instances when the gap existed, they used the rules as guidelines or suggestions.
- **The purpose of the rule** – this theme captures the respondents’ stories with regards to rules that appeared to be written not for their benefit, but for someone else’s.

This section describes and illustrates how the final themes were developed using the guide provided by Braun and Clarke. Phase 6 of this guide, *Producing the Report*, remains. That report, our analysis and synthesis, is presented in the next section.

4.4 Analysis and Synthesis

The objective of this section is to go beyond simply describing the respondents' stories but to look deeper; to get a sense of how their experiences influence not only how they consider and use the numerous rules and procedures that are part of their everyday lives as professional pilots but also how, or if, these rules help them make decisions in challenging or difficult situations. To meet the objective, empirical data extracts related to the themes identified in the previous section will be analysed, discussed, and synthesized in context with the research question and pertinent literature reviewed in Chapter 2. It is important to note that while the themes are separately discussed, they are related and interwoven with each other.

4.4.1 *Theme 1: No rules for rapidly changing situations*

Perrow (1984) describes tightly coupled systems as those which have more time-dependent processes. The less time that is available to act and take corrective action when a system behaves in a way that is unexpected, the more tightly coupled that system is. This concept can be applied to the rapidly changing situations shared by three of the respondents in this study. Their stories illustrate that the rules did not help them make decisions as the situations quickly evolved. One respondent (2RC) said that “the way we work is different from the regulations.” Another (1RC) described the situation as one that seemed routine – until it didn't. It began as something he had experienced before but became “something different.” He had to adapt and make sense of the new situation (Suchman, 1987; Wright & McCarthy, 2003). Two safety philosophies, Philosophy 1 (safety through invariance) and Philosophy 2 (safety through adaptation), were developed by Pariès and Amalberti (2000). The rules for the rapidly changing situations faced by the respondents are characterized by Philosophy 1: “Aviation operations can be entirely specified through standardized procedures, programs, schedules, rules, nominal tasks, certification, selection, norms, etc.” The pilots' perspective, on the other hand, is characterized by Philosophy 2: “Aviation operations cannot be entirely specified through standardized procedures, programs, and the like” (Pariès & Amalberti, 2000, p. 263).

Like Safety Philosophy 1, Dekker's Model 1 of safety rules “sees rules . . . as the embodiment of the one best way to carry out activities, covering all known

contingencies” (Hale & Borys, 2013b, p. 210). This was not the case for one respondent (5RC) when he chose to follow company recommendations during an in-flight fire emergency. This situation, discussed in Section 4.2.2 of this chapter (specific situation 3), describes how the respondent remained on the air traffic control radio frequency he was using when he declared an emergency instead of requesting a change to a less congested frequency. Remaining on the same frequency was the company recommendation. However, remaining on the same frequency resulted in the pilot misunderstanding several ATC instructions. The respondent stated he misunderstood the instructions because of the congestion on the frequency. These misunderstandings nearly resulted in a catastrophic outcome when the aircraft emerged from the clouds and the airport was not where the pilot expected it to be. However, after quickly scanning the horizon, he saw the runway, adjusted his flight path, and landed the aircraft safely. This decision by the respondent is indicative of what Woods and Shattuck (2000) call a Type A problem where “rote rule following persisted in the face of challenging circumstances that demanded adaptable responses” (p. 242) and lends credence to the importance of organizations developing ways to “support people’s skill at judging when and how to adapt” (Dekker, 2003, p. 235).

4.4.2 Theme 2: Rules and professional identity

To better understand how pilots use rules to help them make decisions in difficult or challenging situations, the researchers believed it was important to first develop a sense of what the respondents thought about rules in general. The first interview question and related conversations provide a foundation that contributes to the understanding of how and why rules are used in specific or general challenging situations. An example better illustrates this: one respondent, a captain, stressed that the trainers need to understand the rules better so they could talk about them in ways that made sense “because the rule’s intentions aren’t always evident.” He felt that without knowing the intent of the rule, it is difficult to understand the rule’s purpose and its relationship to “the entire system” (2RC). During his discussion about rules as they applied to the difficult situation he spoke about (specific situation 2 in Section 4.2.2), he reflected on this issue again by saying, “in the Captain’s training course, there is little focus on how to handle situations that aren’t covered by the rules.” This respondent’s desire to understand the rules is reflected in the literature where a captain explained the

annotations and notes he made in his company's Quick Reference Handbook (Wright & McCarthy, 2003). It was important to understand the intentions behind some of the actions specified in the document. He put it this way: "when you're reading it through, you want to know why things are being done this way, and if you know why a certain check is being done, it makes more sense" (p. 691). It is important to know what rules are trying to achieve (Hale & Borys, 2013b). Another respondent (6RC), also a captain, has a similar perspective. His years of experience convince him that "as a pilot, you must be able to identify the situations where the rules are not suitable to ensure safety." To do that, one needs to understand the rule. Knowing the "why" also helps pilots take rules seriously and know the risks of deviating from them. 6RC has a concern that many of his colleagues do not take the rules, SOPs in particular, seriously, and while they still follow them, they do so differently than specified. He explains this "drift" away from explicitly following the procedures as something he "really does not like."

An improved training program could mitigate the concerns of both these respondents. Weichbrodt (2015) supports this analysis by concluding:

"Training can be understood as a management tool to strengthen the 'correct' organizational knowledge. Well-trained employees are thus not only schooled in the formal rules and the ideas behind them, they are also better equipped to deal with unexpected situations, when new solutions need to be created out of existing individual and organizational knowledge. Training, understood as more than simple instruction on how to perform tasks, can then be a resource to workers for better rule-following as well as for better individual decision-making" (p. 228).

Experience was also identified by the respondents as a key aspect of their ability to use the rules and stay safe. One respondent (3RC) describes it this way: "we need to learn the art of combining our rules with experience." Another (9TC) described how routine but unexpected situations present challenges with regards to decision-making. It is not uncommon, while waiting for pushback at the terminal gate, to be offered a new departure clearance from the air traffic controller that could expedite their departure. Sometimes the pilot must decide to either keep the original clearance or accept the new one – usually accepting the new one will allow her to pushback, taxi, take-off, and reach

her destination sooner. The problem, however, is that the aircraft Flight Management System has been configured, take-off distances have been calculated, and the departure has been briefed. Now, the flight crew, if they choose to accept the new clearance, must start over – and they must do so quickly. The dilemma the pilot faces is: do I accept this new clearance that will allow me to depart sooner? Is there enough time to make all the required adjustments? Or is it too risky? Should I just stay with the original clearance? I may be late but I won't have to make any adjustments and risk forgetting or missing something. 9TC said he bases his decision “entirely on experience and whether he has done it successfully before.” He admits he also considers his first officer's experience and their interpersonal relationship, but experience is the key factor. It is this experience that allows sharp end practitioners to become experts – whether deciding to accept a last minute departure or reacting to unexpected situations (Dekker & Lundström, 2006).

One group of respondents we interviewed had a different perspective about rules. These three respondents, all who worked for an off-shore helicopter operator believe the rules are adequate and help keep them safe. One respondent (15OC) said that “rules and procedures, if followed, make the industry safer.” All three respondents spoke about the importance of complying with rules and believed they were safer by doing so. Deeper probing revealed there was more to it than that. They all talked about the importance of attitude, personal relationships, and communications. Their company's culture, one told us, “depends on the standards they set for themselves” (15OC). He said it (the culture) is something they “constantly work on.” He further stated, “we train the way we fly and we fly the way we train” implying there is little or no gap between work as designed and work as accomplished. Off-shore helicopter operators have a much different mission than the other commercial, passenger-carrying airlines in our study. This operator has contracts with oil companies that require them to safely transport their (the oil companies') employees in a timely manner to and from off-shore vessels and oil platforms in the Norwegian Sea. The stories told by the respondents emphasized their customer's requirement of “safe” transportation. This prioritization of safety is a characteristic of high-reliability organizations. Rochlin (1999) states that “part of the construction of safety in these organizations is a tendency to put a negative connotation on any aspect that emphasizes responding through individual action

instead of adapting through collective agency” (p. 1551). Based on the respondents’ stories, this is how their company operates.

4.4.3 Theme 3: Even when rules exist, they might not apply to the situation

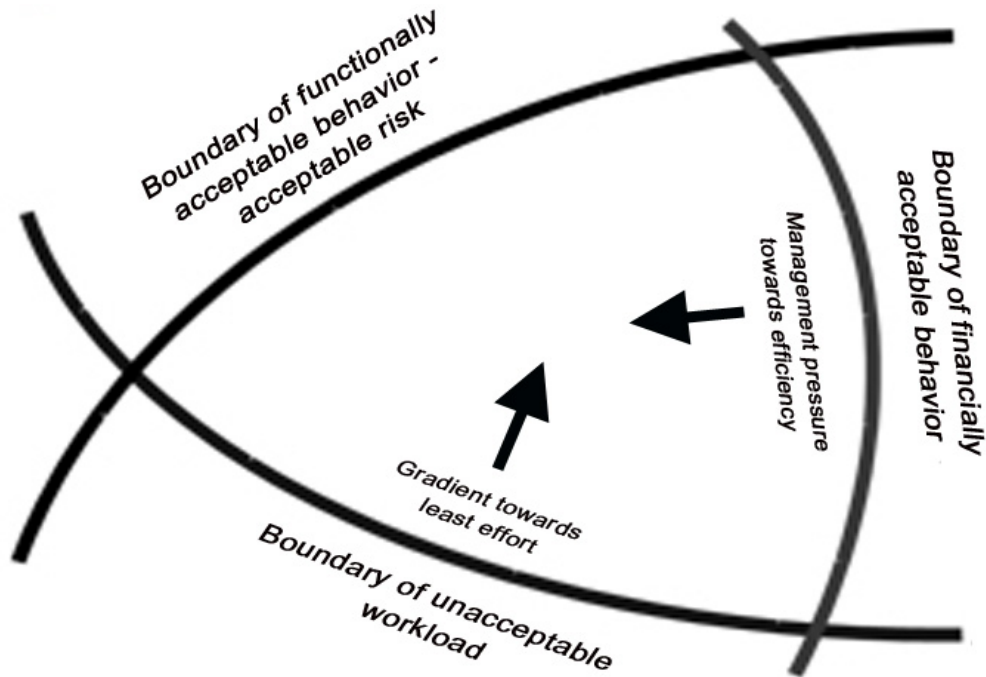
The data provided by the respondents in this study show rules and procedures may not be helpful when making decisions in difficult and challenging situations. In some cases, the respondents expressed that rules existed but they did not apply to the situation in which they found themselves. They evaluated their situations and used the rules as guidance to make decisions that resulted in safe outcomes. Much of the literature referenced in this thesis supports this view (Dekker, 2005; Hutchins, 1995; Suchman, 1987).

One respondent (1RC), when describing the situation he faced, recalled that as the situation evolved, he “had to figure out how to deal with it.” Another respondent (2RC) contended the “rules and procedures were not sufficient barriers to prevent undesired situations” such as the one he found himself in. He further stated that in his normal work environment (northern Norway), operations are very challenging and he frequently notices a “gap between the rules and procedures” and the “various situations and tasks we handle.” He frequently has to adapt the procedures based on his appraisal of the local situation (Woods & Shattuck, 2000; Wright & McCarthy, 2003). Another respondent (3RC) describes a situation where he feels a company policy does not provide an adequate barrier, so he adapts and operates the aircraft differently; in a way that increases the safety margin. The company does not want the pilots to use reverse power during landings on their turbo-prop aircraft unless it is needed. The respondent believes that by the time you know it is needed, it may be too late. His approach is to always apply it when landing on slippery runways and then disable it if it is not needed. He believes that the focus should not be on the rules during these critical phases of flight. This policy and the pilot’s approach to using it are supported by Degani and Wiener (1997) who argue that over-procedurization (or under in this case) “fails to exploit one of the most valuable assets in the system, the intelligent operator who is ‘on the scene’” (p. 302). Another respondent (4RC) said rules do not cover the many situations he faces. He says, “I can use the rules as suggestions but I have to find a solution.” Respondent (7RF) had a similar perspective. He reflected that rules create

boundaries but that he “always relates the rules to the current conditions and environment.” A similar observation was noted by a legacy airline captain (10TC) who explained, “rules guide how I operate but they cannot cover all aspects and situations.” Rules are adapted and used as suggestions based on the evaluation of local situations. For these respondents, the rules “provide guidance to the pilots to ensure a safe, logical, efficient, and predictable means of carrying out the objectives of the job” (Degani & Wiener, 1997, p. 302).

4.4.4 Theme 4: The purpose of the rule

There are many reasons and sources for rules and procedures. Rules are suggested and even mandated by politicians following serious accidents; aircraft manufacturers develop rules and procedures to follow when operating and maintaining their aircraft; and airlines write and implement standard operating procedures, checklists, and policies for their employees to use. All of these entities desire safety in aviation and use rules and procedures as a formalized way of controlling it (Rasmussen, 1997). Pilots often are not participants in the rule making process. Leaving the pilot out of this process can contribute to rules that address situations as imagined by the rule writers instead of how the work is actually done by the sharp end practitioners. The theme 3 analysis discussed how this gap impacted some of the respondents’ use of rules in certain challenging situations. This section will discuss how rules and policies developed from the perspective of work as imagined, impact the pilots who do the work. To help explain this impact, a simplified version of Rasmussen’s dynamic safety model, shown on the following page, is used (Rasmussen, 1997).



Rasmussen, J. (1997). Risk management in a dynamic society. A modelling problem. *Safety Science*. 27(2-3), 183-213.

Figure 2 Dynamic Safety Model

In this simplified model, the boundary of functionally acceptable behaviour on the upper-left side of the figure constitutes the safety boundary. Inward pressure that moves operations towards the safety boundary is exerted from the other boundaries. The boundary of financially acceptable behaviour on the right of the figure moves to the left as airline procedures and policies to reduce costs and increase efficiency are implemented by management, exerting pressure that causes daily operations to move closer and closer to the safety boundary. The boundary of unacceptable workload also causes operations to move closer to the safety margin as the pilots cope with stress and fatigue.

Four respondents in our study were impacted by management decisions to operate more efficiently. Three of their stories are described in Section 4.2.2 under General situation 2. These three stories describe the impact of fatigue and associated stress experienced by the respondents. They all suggest that competition in the airline industry has forced their companies to maximize the use of their human resources to remain economically viable. Rules are written by EASA with input from civil aviation authorities. Airlines use those rules as the basis for scheduling flights and assigning

crews to operate them. The respondents strongly believe the Flight and Duty Time Limitation (FDTL) rules that govern the development of their work schedules benefit the airline and give little consideration to operational conditions. In 2013, prior to the adoption and publication of the current FDTL rules, the European Commission released a memo in the form of a press release accentuating the positive aspects of the yet to be adopted rules. The memo emphasized that if the European Parliament decided to block the draft regulation, it would have “negative effects on safety” (EASA, 2013). The memo concluded that if the new regulation is adopted, “Europe will have one of the safest and modern flight duty regimes in the world” (p. 7). The stories told by the respondents in our study do not bear this out. They tell about difficulties in understanding the rule, how following the rule does not consider the environments they work in, and how the fatigue and the stress it causes are a regular part of their lives as professional pilots. To understand why EASA and the airlines believe the rules provide the pilots with a safer work environment and the respondents in our study feel the opposite, is beyond the scope of this study. It is clear, however, that the respondents believe that while the airlines they work for are following the rules, they are doing it in a way that benefits them and not the pilots. Their implementation of the rule causes an inward movement of the boundary of financially acceptable behaviour and the boundary of unacceptable workload that pushes the pilots against the safety margin. What is not clear is why the pilots fail to regularly report when they feel fatigued or expect to feel fatigued before their duty day ends. Each airline has a fatigue management program that requires this be done, yet it is not. The respondents believe there is an unwillingness among the pilot community to admit you are fatigued. They say it is just not done. A large gap exists between the work as designed by the airlines and the work as performed by the pilots. This gap must be explored, monitored, and acted on to maintain adequate safety margins.

The last respondent interviewed was one of the three respondents who worked for the off-shore helicopter operator. As the interview was ending, the co-researchers mentioned that his story was very similar to those told by his colleagues. We observed that unlike other types of operations, off-shore operations like his company appeared to be more compliant and have less commercial pressure. The interview continued when the respondent told us “we have commercial pressures too.” The respondent explained to us that some of the contracts they have with the oil companies have cost

penalties for being late and says, “that does not contribute to safety” (16OC). The respondent says this penalty puts additional pressures on both pilots and technicians. The economic pressure, as in the previous example, pushes operations closer to the safety margin.

4.4.5 *Analysis summary*

This section discussed, analysed, and synthesized the stories shared by the respondents in our study. Four themes were used to focus on the “essence” or fundamental characteristics of the empirical data as they related to the aim of this research – to better understand how pilots use procedures and rules to make decisions in challenging or difficult situations. In theme 1, *No rules for rapidly changing situations*, the data reveal that the way pilots work “is different from the regulations” (2RC). The data in theme 2, *Rules and professional identity*, illustrate the importance of understanding the intent of the rules and the experience of the pilots when faced with critical decisions in challenging and unexpected situations. In theme 3, *Even when rules exist, they may not apply to the situation*, the data infer that rules are used as suggestions based on the respondents’ evaluations of their situations. Lastly, the data in theme 4, *The purpose of the rule*, show the effect of how rules can exert pressures on pilots that result in operating closer and closer to the safety margin. As stated at the beginning of this section, all the themes are interwoven. Experience, for example, is an important concept discussed in theme 2. It is also a key aspect of theme 3. Experience helps keep the pilots safe but it also is a factor of how and when the rules are used.

5 DISCUSSION

5.1 Introduction

In Chapter 4, we described, discussed, and analysed the respondents' stories. The empirical data revealed that rules frame the daily lives of the pilots in the study. These pilots, representing four distinct segments of passenger carrying, commercial aviation operations, had similar stories about how they considered and used rules not only in the daily routine aspects of their work but also when making decisions in challenging or difficult situations. In some cases, there were no rules for the situations they faced. In other cases, rules existed, but they did not match the situation. The pilots adapted – they considered and used the rules as suggestions or resources for action based on how they evaluated and made sense of their particular and sometimes unexpected situation. These findings confirm what the literature presents – applying rules and procedures in aviation's already complex socio-technical system is even more complex. Those practitioners, who operate at the sharp end of the system must adapt using strategies that could mean the difference between catastrophic outcomes or arriving safely at their destinations. The gap that exists between how work is perceived by the rule writer and how the work is done by the rule user is an important reason for why they must adapt.

When this research journey began, we were aware of this gap due to our familiarity with the literature and our personal experiences in the industry. One of our original research objectives was to propose possible methods to “reduce” the gaps identified by the empirical data. Over the many hours spent conducting interviews, re-reading the literature, describing and analysing the data, our objective changed. The gaps between work as imagined and work as done will always exist. As Suchman (1987) argued years ago, rules and procedures describe desired actions to be taken but the rule authors cannot know the actions necessary for every specific situation that might be encountered. It makes more sense (to us) not to think so much about how to reduce the gap (although that is important) but about ways in which the gap can be monitored and explored (Patterson, Cook, Woods, Render, & Bogner, 2006). Organizations need to understand why the gap exists and use that knowledge to help their airlines and pilots develop the skills they need to “judge when and how to adapt” (Dekker, 2003, p. 236). Unless this gap is monitored and understood, it will be “impossible for the organization

to calibrate its understanding or model of itself and thereby undermine processes of learning and improvement” (Hollnagel & Woods, 2006, p. 357)

5.2 Exploring and Monitoring the Gap

5.2.1 Rule management process

While the respondents in our study describe and discuss how rules and procedures do not always apply to the situations they encounter, they are not aware of any formal process to change this. One respondent (2RC), whose situation we described in Chapter 4, discussed an internal investigation of the incident he spoke about, and said “the incident report made little sense and they missed an opportunity to learn.” In other words, a gap was noticed (by the respondent) but an opportunity to learn about why it existed and share this knowledge with other pilots was missed. Dekker (2003) contends that to make progress on safety “organizations must monitor and understand the reasons behind the gap between procedures and practice” (p. 235). One way to do this is to develop a rule management framework (Hale & Borys, 2013a; Larsen & Hale, 2004). The framework they developed is illustrated below and discussed on the following page.

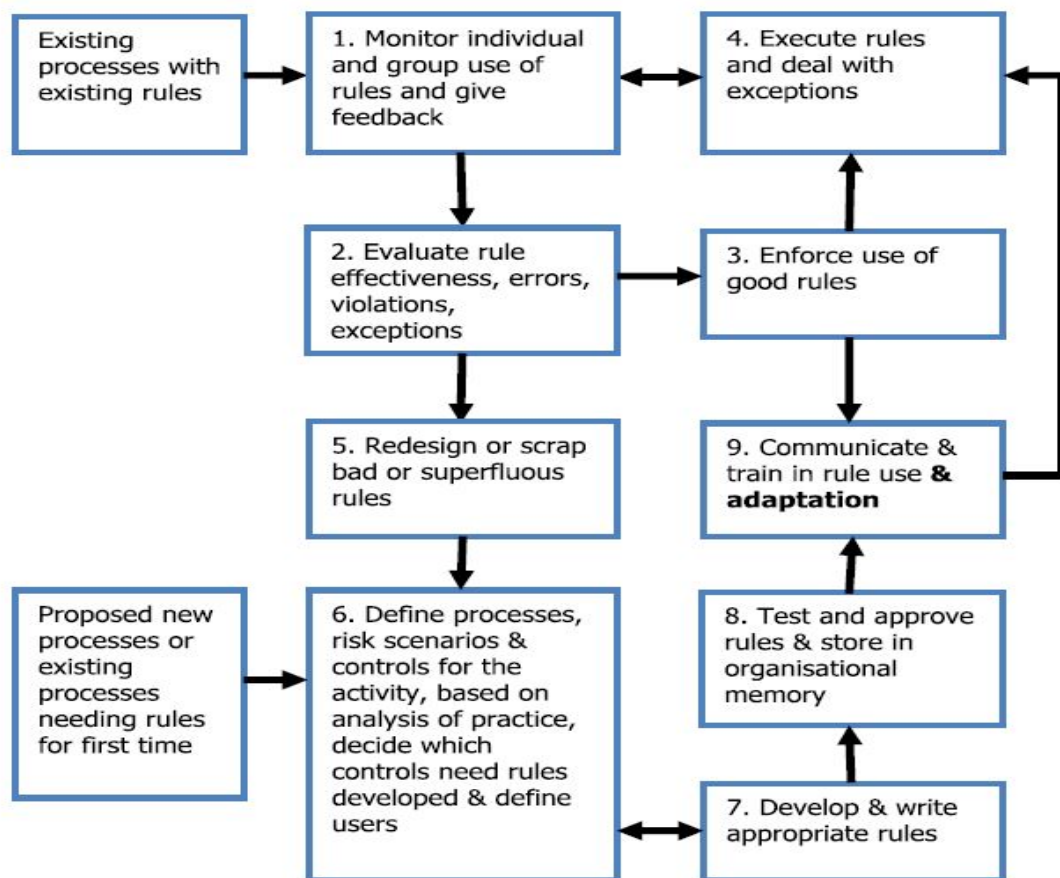


Figure 3 Rule management framework
Hale and Borys. Adapted from Larsen & Hale. (2004)

In their paper, Hale and Borys focus on boxes 2, 3, and 5 of the framework with regards to monitoring and feedback. They refer to this as the “learning and change part of the rule management cycle” (p. 224). This process would help the airlines who the respondents in our study work for explore and monitor the gaps. The literature supports this approach by emphasizing the need to regularly monitor the gap between the rules and the pilot’s work so organizations can adapt their procedures to the local situations their pilots encounter (Antonsen, 2008; Dekker, 2005). Many airlines are audited internally and by third-party auditors, but the focus of this type of monitoring is more to examine specific behaviours and is compliance oriented. The type of monitoring we are suggesting here relates in part to “self-monitoring and reporting of deviations and surprises” (Hale & Borys, 2013a, p. 225). These are the types of situations described by the respondents in our study.

As the gaps are monitored and identified, the organizations become aware of those situations where there is a mismatch between the rules and procedures used by the pilots and the work situations they regularly or unexpectedly encounter. This knowledge can be used to eliminate or revise existing rules and procedures based on data provided by the pilots, thus resulting in informal or tacit rules being made explicit and increasing the adaptive capacity of not just the sharp end operators but the entire system. Collecting this data could prove challenging. A non-punitive culture must exist to encourage pilots to report gaps they find during normal work. A voluntary reporting system modelled after a program like the Aviation Safety Action Program in the United States is one option. The anonymous reporting feature that is part of some Safety Management System software programs is another. Exploring and monitoring the gap using a process like the one described by Hale and Borys can increase the organization’s adaptive capacity by giving them the “ability to respond to events, to monitor ongoing developments, to anticipate future threats and opportunities, and to learn from past failures and successes” (Hollnagel, 2011, p. xxix).

Developing new rules and procedures and revising existing ones are key steps in the process once the organization understands their needs. This requires identifying how much flexibility the rules should include as well as how much flexibility users should be given with regards to following the rules. Are they (the procedures) to be used as resources, or must they be precisely followed? One thing is clear in the literature, the

rule users must participate in this development/revision process (Antonsen, 2008; Dekker, 2005; Wright & McCarthy, 2003). Participation, the literature argues, does not mean the rule users want to write the rule but they want to be consulted and have a say in how they are adapted (Hale & Borys, 2013a).

5.2.2 *Transfer of knowledge*

Once new or revised rules have been developed by the organization, their intent and use requirements must be communicated to the pilots. Knowing what the rules are trying to achieve is a key aspect of using the rules as several respondents in our study reported. Understanding the rule's intent helps them understand how the rule fits into the system (2RC). Training is a key aspect of sharing this organizational knowledge with the pilots. Training is the vehicle used to convert the "tacit" knowledge that makes up the informal rules used by the pilots into more "explicit" rules that are explained and communicated by the training departments (see Weichbrodt's (2015) assertion in the theme 2 discussion in Chapter 4.)

5.3 Discussion Summary

By referring to the literature and the respondents' stories in our study, this chapter has demonstrated the importance of identifying, exploring, monitoring, and understanding the gap between procedures as they are written and how they are used in practice. The empirical data collected in this study not only acknowledges the gap between the rules and the situations the respondents face but also emphasizes the value of understanding the gap and using that understanding to develop an organizational knowledge that can be used to increase safety.

This study has some limitations. All the respondents are part of the Norwegian aviation system so it is not possible to know how findings might be different with a broader representation of pilots. Opportunities for future research could include interviewing respondents from other countries including those outside the EASA regulatory community. The interviews were not recorded. This allowed for an open and trusting interview environment where the respondents could talk about situations where they may not have followed the rules. Detailed notes were taken but important nuances in their stories may have been missed. The researcher's inexperience with interviews is also a limitation. Case study methodology allows the researcher to "dig deeper" by

asking more how and why questions. At times during the data analysis segment of the research, we found ourselves wondering, “what did they mean by that” or “why did they say that.”

6 CONCLUSION

The aim of this research is to develop a better understanding of how, or even if, rules and procedures help pilots make decisions in difficult and challenging situations. Findings indicated that while rules provide structure and predictability in the cockpit, not all are used as specific prescriptions for problem-solving but as resources in the decision-making process. In quickly evolving, difficult situations, the collection of rules at the pilots’ disposal does not match their situation. In those situations, the pilots indicated rules were important, but they relied on their knowledge and experience to do work. The findings coincided with existing literature by identifying that rules and procedures are considered as suggestions or as resources for action. The study also found that respondents are aware of the gap between the rules and procedures as designed for the rule maker’s vision of work vs the dynamic, event-driven situations faced by pilots. This finding implies that organizations would be well-served to invest resources into identifying, exploring, monitoring, and understanding this gap. This study confirms that pilots will adapt to the situations they confront. After all, what alternative do they have? But rather than leave it up to each pilot to decide when and how to adapt, a formal process developed and implemented by the organization could provide a common structure that increases the resilience and adaptive capacity of the system, giving pilots ample discretionary space and the degrees of freedom necessary to make decisions.

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APPENDIX 1

Interview Invitation Letter

We, Richard Abbott (former regulator FAA) and Espen de Lange, Airline pilot Widerøe, are students at the University of Lund, attending a Master Program in Human Factors and Systems Safety.

First of all, we would like to thank you for devoting your time to helping us gathering data for our Master Thesis.

We will be interviewing pilots from four Scandinavian air operators.

The theme for our thesis is about rules and how they are used by pilots in difficult or challenging situations.

We want to explore your views, not the content of the rules, meaning, we want to get a picture of the daily work of the pilot, the way you experience it.

It is therefore vital that the interview is held in a relaxed and open atmosphere. You can feel free to speak your mind. Traceable information will be removed, to the extent possible. Any information given, will be restricted, if you at a later stage wish we do so. You can at any time withdraw from the project, and all the data would then be deleted. During the interview, we will make notes in Norwegian. You will receive a Norwegian and English version of the interview per mail for editing and approval.

The questions below are for guidance. They may vary, during the interview, depending on what we choose to focus on. This will enable us to pursue issues of interest.

Basic questions

- What do rules mean to you during daily work?
Support questions:
 - What rules regulate your daily work?
 - [Thoughts on] rules vs procedures vs techniques vs policies.
 - How do you think about the rules during various stages and situations?
 - When and how do you apply rules?
- What is the most challenging or difficult situation you have faced as a pilot?
Alternatively, what is a difficult situation you regularly face?
Support question: What strategies do you use?
- What about the rules? (did they help in these difficult situations?)
Support question: Would more rules help increase safety – either in this situation or in general?

Mvh Espen de Lange
Capt DHC-8 Widerøe
Mob 9933 7736

APPENDIX 2

Informed Consent Form

Contact Information about this Thesis Work:

Lund University / Johan Bergstöm, Associated Professor
Tel: +46 705563369 / E-mail: johan.bergstrom@risk.lth.se

Risks/Benefits:

There are no known risks or benefits to participating in this research.

Consent:

Your participation in this research project is entirely voluntary. You may refuse to participate or withdraw from the research at any time.

Your signature indicates that you have received a copy of this consent form for your own records and that you consent to participate in this research.

I, _____ agree
to participate as outlined above. My participation is voluntary and I understand I can
withdraw at any time.

Participant's Signature

Date

Student Investigator Signature

Date

