Introduction: Error management on Everest

“[...] I know the mountain [Everest] is an environment so extreme there is no room for mistakes.”

(Cahil, 1997, p. 245-246).
This dissertation reports on research on organizational error culture. That is, the way organizations deal with errors, the approaches the organizational members have towards errors, and which of those behaviors are encouraged or discouraged by the organization. In short, organizational error culture entails the way organizations “think” errors are best dealt with, and how organizations actually do deal with errors.

In this introductory chapter I will give definitions of errors and related concepts (violations and error consequences), and discuss two approaches for dealing with errors (error prevention and error management). I will discuss what organizational error (management) culture entails. A rationale is given for the importance of research on organizational error culture, and the benefits of organizational error management culture in particular. All will be done by linking the relevant theory to one factual event; the 1996 climb of Mount Everest by the ‘Adventure Consultants’ and ‘Mountain Madness’ expeditions. Further, an overview of the remaining chapters is given.

Over the years, more than 150 climbers (one for every 30 attempting to climb it, or one for every five who have reached the summit) have died on Mount Everest (Coburn, 1997). The leaders of the two expeditions that are discussed here - Adventure Consultant’s founder Rob Hall and Mountain Madness’ founder Scott Fischer- were both highly respected climbers. Yet, the summit bid of the two expeditions, both departing from camp IV around midnight on May 9/10, 1996, have had extremely tragic outcomes: after sunset (the time any climber definitely wants to be back at Camp IV) seventeen climbers were still somewhere high up the mountain. Both expedition leaders, a guide, and two clients died. Three narrowly escaped death.
One client was left for dead twice, but ultimately survived losing an arm and several fingers. What happened? What went wrong? What role did errors and team error culture play? “A few suggested that the tragedy was simply a combination of bad luck, bad weather and bad decision making.” (Cahil, 1997, p. 16). Certainly, more can be said about the antecedents of the disaster.

Mountaineering in general, and the tragedy that struck the two 1996 expeditions in particular, has before inspired academics to analyze the events from a psychological perspective. Loewenstein (1999) has applied and extended utility theory based on mountaineering. For the most part, however, emphasis has been on personality of mountaineers (Jackson, 1967; Magni, Rupolo, Simini, De Leo & Rampazzo, 1985); Elmes & Barry (1999) have applied theory on narcissism to explain the tragedy. Breivik (1997) studied risk taking and sensation seeking among the 1985 Norwegian Mount Everest expedition. Sensation seeking was also studied by Rossi and Cereatti (1993), and Cronin (1991). Stress seeking was investigated by Robinson (1985).

The current chapter takes a different perspective. An attempt is made to apply the theory on error handling approaches and organizational — or in this specific case — team error culture aspects to the events and outcomes of the 1996 summit assault.

The first and foremost goal of the current chapter is to introduce to the reader relevant concepts and theory with respect to errors and error culture, and to provide some rationale for the empirical research described in later chapters. The chapter thus attempts to “smoothen the path”. Further, I will tip on some specific questions: Has the way the teams handled errors contributed to the tragedy? How can the error
cultures of the expeditions be characterized? What role may these team cultures have played in the outcomes following the summit bid?

It is important to note that I do not claim to be giving an exhaustive analysis of the 1996 Everest disaster. For such an attempt, I would have had to gain far more expertise on mountaineering. Further, the number of sources used here is restricted. At times, it may seem to the reader that the Mountain Madness expedition had more problems, and made more errors. Please note that more problems and errors of the Mountain Madness expedition are discussed here, simply because the ‘inside’ source of this expedition is one of the guides (Boukreev & De Walt, 1997), who had insight in the expedition leader’s and guides’ strategies, decisions, and errors. With respect to the Adventure Consultants expedition, in contrast, most of the information is derived from one of the clients (Krakauer, 1997), who may have lacked background information on rationales for decisions made by the leader and guides.

In order to understand and appreciate the role of errors and error culture in high altitude mountaineering, some background has to be provided. In alternating segments I will discuss high altitude mountaineering, and theory on errors and error culture: Background and specifics of the two expeditions are followed by theory on errors, preparations for the summit bid, theory on error culture, before I reach the ‘climax’ of the chapter; the summit bid, its tragic outcomes and the role of error culture.

Of the general factors contributing to a successful (commercial) Mount Everest climb, I will successively discuss expedition staff, equipment, physical and mental health, number of expeditions attempting for the summit in the same season,
and weather. Strengths and weaknesses of both expeditions’ preparations are considered.

*Spring 1996.* Both expeditions had one head guide (Rob Hall/Scott Fischer, see also Table 1), two guides (Mike Groom & Andy Harris/Anatoli Boukreev & Neal Beidleman), a climbing sirdar (leader of the climbing Sherpas; Ang/Lopsang), six or seven climbing Sherpas, a Base Camp doctor, a Base Camp sirdar, a Base Camp Manager and a Base Camp cook. Both expedition leaders had put effort in hiring the best available people, although Fischer’s choice of Lopsang as a climbing sirdar was criticized by outsiders: “Lopsang’s climbing no one would question. But, his leading, I don’t know. [Lopsang being young and lacking leadership experience] is going to make all sorts of mistakes and could well blow it big time” (Henry Todd, expedition leader of “Himalayan Guides” cited in Boukreev & De Walt, 1997). The climbing Sherpas take all the gear and provision up the mountain, build consecutive higher camps, prepare meals up the mountain, and fix ropes. As Rob Hall said to his clients; “The Sherpas we’ve hired are the best in the business. They work incredibly hard for not very much money by Western standards. I want you all to remember we would have absolutely *no* chance of getting to the summit of Everest without their help. I’m going to repeat that: Without the support of our Sherpas none of us has any chance of climbing the mountain.” (Krakauer, 1997, p.53).
Table 1

*Composition of Adventure Consultants and Mountain Madness expeditions*

<table>
<thead>
<tr>
<th>Adventure Consultants</th>
<th>Mountain Madness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rob Hall</td>
<td>Founder &amp; leading guide</td>
</tr>
<tr>
<td>Mike Groom</td>
<td>Head Guide</td>
</tr>
<tr>
<td>Andy Harris</td>
<td>Guide</td>
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<tr>
<td>Ang</td>
<td>Climbing sirdar</td>
</tr>
<tr>
<td>John Krakauer</td>
<td>Journalist/client</td>
</tr>
<tr>
<td>Doug Hansen</td>
<td>Client</td>
</tr>
<tr>
<td>Beck Weathers</td>
<td>Client</td>
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<tr>
<td>Yasuko Namba</td>
<td>Client</td>
</tr>
<tr>
<td>Stuart Hutchison</td>
<td>Client</td>
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<tr>
<td>Frank Fischbeck</td>
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<td>Lou Kasische</td>
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<td>John Taske</td>
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Equipment and supplies such as tents, ropes, ladders, and oxygen have to be made available. Scott Fischer’s expedition had problems in this area. At high altitude, weight matters. As Scott Fischer wanted to maximize the clients’ chances of reaching the summit, he opted for the purchase of proportionally light Poisk’s three-liter oxygen canisters (Boukreev & De Walt, 1997). Scott and Boukreev had engaged in intense negotiations with the Poisk manufacturers. Finally, at a very late time, a compromise was reached. The shipment, however, was mistakenly delayed by Russian customs, and the oxygen arrived only shortly before the climb. There were similar problems with a custom-made tent. Of concern to both expeditions was the
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snow still lingering on sections of the trekking trail to Everest Base Camp, halting the expedition porters and yaks transporting equipment and supplies to Base Camp. These logistical problems caused stress for both expedition leaders.

Besides the obvious importance of physical health, mental health, or ‘positive spirit’, is also crucial for all attempting to climb (Boukreev & De Walt, 1997; Graydon & Hanson, 1997). The expedition leaders were burdened by a competition of establishing and/or maintaining a market share in the commercial expeditions business. Hall had already established a good reputation, and had no trouble finding clients coming up with the 65,000 US dollars he charged. Fischer was, in 1996, new in the commercial Everest market. He desperately wanted to establish his business. Thus Hall and Fischer, although they respected each other and could get along well, were direct competitors. Hall had the advantage of reputation in the business. Fischer had the advantage that his business was based in the US, where about 80% of potential clients are found. Outnumbering the other at clients brought to the summit (and back safely) was what was going to make the difference. Commercial expeditions, however, imply working with clients whose climbing expertise, physical health and ability to cope in extreme situations are unknown. Guiding clients up the mountain, some of whom substantively lack experience, therefore makes any prediction of the success rate nearly impossible.

In the years preceding the 1996 spring expeditions, Everest had become increasingly popular. In 1996 some three hundred people (climbers as well as supporting staff) resided at Base Camp. In total no less than fifteen expeditions, twelve non-commercial and three commercial expeditions, attempted to reach the summit. Although cooperation among expeditions can be mutually beneficial, there is
an optimum in the number of expeditions attempting a summit assault in the same period. This optimum was exceeded, increasing the risk of bottlenecks and delays on the mountain (Coburn, 1997). For this reason an agreement was reached among the 1996 expeditions. Each expedition was assigned a ‘summit day’. For both Adventure Consultants and Mountain Madness it was agreed that they would assault the summit on May 10. As I will discuss later, some expeditions chose to violate the agreement. On May 10 a Taiwanese expedition decided to go for the summit earlier than they were supposed to.

Finally, I want to mention one extremely important factor: weather. The weather does, probably more than anything else, determine the chances of making it to summit and back. It is, at the same time, a factor beyond control. “What the conditions would be on the mountain when [the two expeditions] were finally acclimatized was anybody’s guess. Weather on the mountain, like the people with the hubris to climb it, cannot be predicted with any reasonable degree of accuracy. It was possible that when the climbers were ready, the mountain wouldn’t be […..].” (Boukreev & De Walt, 1997, p.74).

*Acclimatization.* “When confronted with an increase in altitude the human body adjusts in manifold ways, from increasing respiration, to changing the pH of the blood, to radically boosting the number of oxygen-carrying red blood cells — a conversion that takes weeks to complete.” (Krakauer, 1997, p.69). Due to a decrease in oxygen, while increasing altitude, it is not uncommon to experience acute mountain sickness (AMS, Graydon & Hanson, 1997), which in turn, when neglected, can lead to life-threatening conditions of high-altitude pulmonary edema (HAPE; a condition
associated with the lungs) or of high-altitude cerebral edema (HACE; a condition associated with the brain). At Base Camp (5300m/17,500 feet) the air holds half of the oxygen that is available at sea level ("like working on one lung and walking around in a two-martini fog" Boukreev & De Walt, 1997, p.75), the air at the Mount Everest summit (8848m/29,000 feet) only holds one third (Boukreev & De Walt, 1997; Krakauer, 1997). Needless to say that acclimatization is absolutely necessary. Further, the period of acclimatization provides the guides with the additional advantage that they can assess the physical and mental condition of the clients. But even when appropriately acclimatized, one is likely to experience hypoxia, when residing at high altitude. This means that one’s reasoning abilities (for the duration of the stay at high altitude) decrease dramatically, often without even being aware of this effect. The danger as well as the likelihood of hypoxia make high-altitude mountaineers especially error prone.

Near the end of March both expeditions independently trekked up the trail from Lukla (2850m/9,500 feet; Adventure Consultants) and Syanboche (3900m/13,000 feet; Mountain Madness) to Base Camp (5300m/17,500 feet). By flying the clients to Syanboche, Fischer violated the “start below 3040 meters [10,000 feet] and walk up slowly” rule.

In order to allow acclimatization to the altitude, the teams only covered relatively small distances each day, and rested a lot. On April 8 and 9 the expeditions reached Base Camp, and spent some five days recuperating, upon which further acclimatization started. This entails several one day return trips, followed by longer trips to increasingly higher altitudes, higher camps. Although the basics of any two acclimatization schemes will have similar strategies, details may differ between
teams, and even between team members. An example of an acclimatization plan would be: Day 1; helicopter flight from Kathmandu (1400m/4,500 feet) to Lukla (2850m/9,500 feet). Day 1 to 7; trekking to Base Camp (5300m/17,500 feet), scheduling several rest days in between. Day 8 to 13; acclimatization at Base Camp. Day 14; climb to Camp I (6100m/20,000 feet) and return to Base Camp. Day 15 and 16; resting at Base Camp. Day 17; trekking to Camp I were the night is spent. Day 18; returning to Base Camp. Day 19 and 20; resting at Base Camp. Day 21; climbing to Camp I, were the night is spent. Day 22; proceeding to Camp II (6500m/21,500 feet, “advanced Base Camp”, which holds a fully equipped mess tent), spend the night. Day 23; climb up to 6800 meters (22,500 feet), return to Camp II, and descend on to Base Camp. Day 24-26; rest days at Base Camp. Day 27: climb to Camp II, spend the night. Day 28; climb to Camp III (7300m/24,000 feet) and a bit higher, spend the night at Camp III. Day 29; return to Camp II. Day 30; return to Base Camp. Day 31-36; resting before starting the final, full climb.

As soon as acclimatization above Base Camp starts, the clients are presented with a test of physical, mental, and technical preparedness: The Icefall. “No part of the South Col route was feared more by climbers. At around 20,000 feet [6100m, situated between Base Camp and Camp I], where the glacier emerged from the lower end of the Cwm, it pitched abruptly over a precipitous drop. This was the infamous Khumbu Icefall, the most technical demanding section of the entire route. […] Because the climbing route wove under, around an between hundreds of […] unstable towers [“seracs”], each trip through the Icefall was a little like playing Russian roulette: sooner or later any given serac was going to fall over without warning, and you could only hope you weren’t beneath it when it toppled.” (Krakauer, 1997, p.75-
Interconnecting the seracs is a network of fissures ("crevasses"), which can be more than three hundred feet (100m) deep. As they would have to do with respect to other matters as well, the spring 1996 expeditions cooperated. One expedition was elected to take responsibility for preparing the Icefall (and to receive payment from the other expeditions). This entails putting in place more than seventy aluminum ladders to span the crevasses or to ascend vertically. Sometimes four ladders have to be overlapped at their ends and lashed together with climbing rope in order to cover a span.

As some of his clients were not taking the challenges of acclimatization too well, Scott Fischer was forced to make a number of hurried, unplanned excursions between Base Camp and the upper camps escorting clients down. This left Fischer exhausted, and some of his clients poorly acclimatized.

Errors, violations and consequences. In order to address the issues outlined at the beginning of this chapter, I will first define errors, and actions or outcomes that are easily (and often) confused with errors. The concept of errors has, as have most psychological concepts, been defined in different ways. In this dissertation, I focus on action-based definitions of errors. An action is defined as “goal oriented behavior that is organized in specific ways by goals, information integration, plans and feedback and can be regulated consciously or via routines” (Frese & Zapf, 1994, p. 271). Errors, then, are defined as “all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and where these failures cannot be attributed to the intervention of some chance agency” (Reason, 1990, p. 9). Or as Frese and Zapf (1994, p. 288) put it: “Errors only appear in goal-
oriented action, they imply the non-attainment of goals, and [...] should have been potentially avoidable.” At this point, it is important to differentiate (a) between errors and violations, and (b) between errors and error consequences.

In most — if not all — cases, errors do not capture the full range of human contributions to disasters (Reason, 1990). Usually violations are important contributors as well. Errors and violations are similar in the sense that they both involve planned behavior and goals (actions). A violation, however, presumes rules that are disobeyed. Thus, while an error implies a wrong plan or wrong implementation of a plan (hence non-attainment of the goal, hence an error), a violation implies a conscious decision to act in a way that strays from predisposed rules of accepted or safe behavior. Further, an error — as discussed above — by definition implies the non-attainment of a goal. This is not the case for violations. An action that is prohibited by rules of some sort, may still result in goal attainment: Crossing a red traffic light may still be associated with the driver’s goals of quickly going from A to B. To further illustrate the difference between errors and violations, consider the following event: “Kami [a Sherpa], being young and cocky and inexperienced, didn’t think it was really necessary to clip into the rope. One afternoon as he was carrying a load up the Lhotse Face he lost his purchase on the rock-hard ice and fell more than 2,000 feet [600m] to the bottom of the wall.” (Krakauer, 1997, p.53-54). The Sherpa in this example consciously violated the accepted rule of securing oneself onto anchored ropes. The following event, which may seem (as it did to fellow climbers) to be a violation, was actually not; “As I advanced, I realized I had made a mistake that morning by not changing out of my “Snickers” [referring to track shoes with spiked cleats usually worn lower on the
mountain, see p.106], and I was upset at having made such a blunder.” (Boukreev & De Walt, 1997, p. 109). Boukreev — a Mountain Madness guide whose mistake is described here — did not consciously violate the boots-and-crampons rule here (although he did at lower altitude), rather, he had mistakenly put on the wrong shoes (plan is wrongly executed).

A second important distinction is that between errors and their consequences. The erroneous choice of shoes described above did not have negative consequences, but could have. Whether or not errors have (severe) negative consequences tells us nothing about the severity of the error itself. As a matter of fact, there is no such thing as a severe error. The same error may have a variety of — minor or serious — consequences, depending on the situation, or system one is working in. Turning a valve in the wrong direction would, when adjusting one’s heating system at home, not even be considered worth mentioning. Consider, however, the same mistake when a client of the Adventure Consultants expedition has to await ascending climbers before he himself can descend: “Harris [one of Adventure Consultants guides], who’d left the summit shortly after I did, soon pulled up behind me. Wanting to conserve whatever oxygen remained in my tank, I asked him to reach inside my backpack and turn off the valve of my regulator, which he did. For the next few minutes I felt surprisingly good. My head cleared. I actually seemed less tired than I had with the gas turned on. Then, abruptly, I sensed that I was suffocating. My vision dimmed and my head began to spin. I was on the brink of losing consciousness. Instead of turning my oxygen off, Harris, in his hypoxically impaired state, had mistakenly cranked the valve open to full flow, draining the tank.” (Krakauer, 1997, p.8).
That there is no such thing as a severe error does not imply that any one error is similar to the next. Actually, various error taxonomies (e.g. Rasmussen, 1982; Zapf, Brodbeck, Frese, Peters & Prümper, 1992) exist that have helped researchers as well as practitioners at understanding error-prone situations, and develop systems that prevent and/or correct errors.

*Error prevention versus error management.* With the distinction between errors and their consequences, the ground has been laid for discussing two general approaches to errors: error prevention and error management. In principle, both approaches have the same ultimate goal: Avoiding negative error consequences. Error prevention does so by avoiding the error altogether. Error management (Frese, 1991), on the other hand, is based on the understanding that, no matter how hard one tries, one cannot prevent all errors. Further, it is not really the error you want to avoid, but rather its negative consequences. Error management is thus ‘lenient’ in the sense that it accepts error occurrence, yet the approach stresses the importance of taking errors seriously and dealing with them. Error management is aimed at avoiding or reducing negative error consequences, and at learning from errors. The latter is what conceptually links the two approaches: Learning from errors that have occurred (error management) helps preventing errors in the future.

Bringing up an example already described above; Boukreev’s erroneous choice of shoes did not have negative consequences. On the one hand, Boukreev, as he indicates, “had to be deliberate when I placed my feet” (Boukreev & De Walt, 1997, p. 109). Boukreev thus employed error prevention, avoiding making the mistake of slipping on the icy surface. On the other hand, he was “not in a dangerous
situation because I was on fixed ropes” (Boukreev & De Walt, 1997, p. 109), making sure that an error such as a slip on the ice could not yield the negative consequence of falling into a crevasse. Thus, he also employed error management.

Both error prevention and error management are commonly used in daily life, working life as well as in mountaineering. In daily life, for example, traffic signs indicating a sharp curve, are aimed at preventing drivers from making the mistake of driving too fast in an area where doing so is unsafe. In the event that one does make the mistake (or violation!) of speeding, an automatic anti-blocking system of the car will manage this error, and thereby avoid negative consequences. In working life, for example, our computer asks us whether we really want to delete all of our files, preventing us from doing so erroneously. Also, most software allows direct rectification of errors by means of an undo function. In mountaineering, slipping on ice is largely prevented by attaching crampons to one’s boots. Additionally, the consequences of slipping are avoided by securing oneself to anchored ropes.

Errors on Everest. Is Everest a place for error management? “[...] I know the mountain [Everest] is an environment so extreme there is no room for mistakes.” (Cahil, 1997, p. 245-246). This quote indicates that error prevention is advisable. Others have gone so far as to say that error prevention is the only advisable approach and that error management would not work on Everest: “Unlike your routine life, where mistakes can usually be recouped and some kind of compromise patched up, [on Everest] your actions, for however brief a period, are deadly serious.” (Alvarez cited in Krakauer, 1997, p.73). I believe, however, that it is unrealistic, in any environment, in any situation, to think mere reliance on error prevention will be
sufficient. The unexpected error that occurs has to be prepared for and handled, especially in an environment where its consequences can be severe. Much of the preparation for future errors can be done through what has been learned from errors in the past. Proper equipment, physical and technical preparedness help to prevent as well as to manage errors. But it cannot be predicted what exactly will happen high up on the mountain.

*Error culture.* Rybowiak, Garst, Frese, & Batinic (1999) have done research on how individuals tend to deal with occurring errors (“error orientation”). Building on the same line of research, Göbel (1998; Göbel & Frese, 1999) showed that those actions and attitudes that support error management are related to success of small-scale entrepreneurs. In organizations, people not only have their personal goals to focus on. Similarly, on Everest, “The consequences of a poorly tied knot, a stumble, a dislodged rock, or some other careless deed are as likely to be felt by the perpetrator’s colleagues as the perpetrator.” (Krakauer, 1997, p.38). In organizations, as well as in mountaineering, error culture rather than mere individual error orientation, is important.

Given that it is impossible to eradicate errors, it is important for an expedition (or organization) to acquire error-handling strategies. The examples on error prevention and error management in daily life, work, and mountaineering discussed above illustrate that error prevention and error management strategies can be embedded in the system: Although the users decide they ‘do not want to erase all files’ (error prevention), and want to ‘undo’ a dramatic alternation in lay-out (error management), it is actually the computer (the *system*) that was constructed in such a
The organization and its culture can be viewed as a similar system. The error culture, which entails shared beliefs, attitudes and behavioral styles, can be viewed as a system that can support or impede error management. In this introductory chapter, as well as throughout the remaining chapters of this dissertation, I argue that shared beliefs and habits related to error handling affect, through the avoidance of negative error consequences and through the rendering of positive error consequences, organizational (or team) performance.

Preparing for the summit bid. After the acclimatization period had been concluded, the two expeditions stayed at Base Camp for several days to recuperate. On May 6 (Adventure Consultants) and May 7 (Mountain Madness) they headed for their final ascent. In between taking off at Base Camp and the actual summit push, several problems emerged. As Scott Fischer assisted people back to Base Camp several times during acclimatization, he was exhausted by the time he reached Camp IV. Furthermore, several clients of both expeditions were exhausted and/or experiencing (minor) physical problems. Lopsang, Mountain Madness climbing sirdar, had been carrying a satellite phone up the mountain for reporter Sandy Hill Pittman in addition to the other gear he was supposed to carry. As it turned out, the phone did not work at Camp IV, yet carrying it drained Lopsang’s energy, which he needed for safety related tasks. There were delays in roping sections and establishing Camp IV. Two of Fischer’s clients abandoned the summit attempt and returned to Base Camp.

Camp IV marks the beginning of the “Death Zone”, where “[…] any mistake is amplified in the rarefied air […]” (Boukreev & De Walt, 1997, p. 93). In the death way that both error prevention and error management are made easy for the users.
zone people are particularly susceptible to mistakes and death because of severe oxygen deprivation: “Above 26,000 feet [8000 m] […] the line between appropriate zeal and reckless summit fever becomes grievously thin. The slopes of Everest are thus littered with corpses.” (Krakauer, 1997, p.177).

While the two expeditions arrived at Camp IV on May 9 a storm took on, which seriously endangered the summit attempt planned at midnight. At 7:30 p.m., however, the storm eased. There was almost no wind; excellent conditions for a summit bid. The change of weather brought a Taiwanese expedition to decide, against agreements made earlier, to attempt for the summit as well. This meant that no less than a total of thirty-three people would be climbing at the same time, all having to use the exact same route and anchored ropes.

Error culture on Everest. The Adventure Consultants and Mountain Madness expeditions had quite different leadership styles and cultures: “If the name of Hall’s business, Adventure Consultants, mirrored his methodical, fastidious approach to climbing, Mountain Madness was an even more accurate reflection of Scott [Fischer’s] personal style. By his early twenties, he had developed a reputation for a harrowing, damn-the-torpedoes approach to ascent. Throughout his climbing career, but especially during those early years, he survived a number of frightening mishaps that by all rights should have killed him.” (Krakauer, 1997, p.62). Fischer himself said: “[…] I’m gonna make all the right choices. When accidents happen, I think it’s always human error. So that’s what I want to eliminate.” (Fischer cited in Krakauer, 1997, p.65).
Differences in convictions of safe conduct in the inherently dangerous activity of high altitude climbing were at the core of different cultures of the two expeditions:“The differences between Hall’s and Fischer’s philosophies of guiding were emblematic of an ongoing debate between practitioners in the adventure travel industry. The camps of belief can be roughly divided between the “situationalists” and the “legalists”. The situationalists argue that in leading a risky adventure, no system of rules can adequately cover every situation that might arise, and they argue that rules on some occasions should be subordinated to unique demands that present themselves. The legalist, believing that rules can substantially reduce the possibility of bad decision making, ask that personal freedom take a backseat.” (Boukreev & De Walt, 1997, p. 155). The legalist approach to mountaineering most resembles an error prevention approach, where mistakes should be avoided by a thigh system of rules. The situationalist approach, on the other hand, most resembles an error management approach, where one prepares in such a way that the unexpected error is optimally dealt with.

I do not believe that Hall and Fischer were either legalists or situationalists in the strict sense. Yet, Hall leaned more towards the legalist approach, while Fischer was closer to that of the situationalists. This situationalist approach of the Mountain Madness expedition was strengthened by the beliefs of one of its guides: “As a Russian, Boukreev came from a tough, proud, hardscrabble climbing culture that did not believe in coddling the weak. He was quite outspoken in his belief that it was a mistake for guides to pamper their clients. “If client cannot climb Everest without big help from guide,” Boukreev told me, “this client should not be on Everest. Otherwise there can be big problems up high.”.” (Krakauer, 1997, p. 149-150). Boukreev was
disturbed with the way clients were being prepared for the summit bid: “It had been my impression that Scott [Fischer]’s primary interests were in my experience and what I could bring to ensure client safety and success on summit day, and I had been working with that in mind, focusing primarily on details that I thought would bring success and attempting to anticipate the problems that would prevent us from making a bid on the summit. It was not clear to me that equally if not more important was chatting and keeping the clients pleased by focusing on their personal happiness.” (Boukreev & De Walt, 1997, p. 97). Beidleman — Mountain Madness’ other guide — responded to this: “[…] many of our members don’t understand many of the simple things. They want us to hold their hand through everything.” (Boukreev & De Walt, 1997, p. 98). These quotes illustrate the tension between guiding approaches based on the legalist/situationalist distinction and the related issues of error prevention and error management.

How can a system, an expedition culture, employ error prevention? By learning from past experience, by developing methods and rules that will prevent known problematic situations and errors. In an error prevention culture, the importance of following the rules and compliance to the leader’s decisions will be emphasized. This might have some drawbacks: “Personally I looked with concern upon the closely regimented expeditions where the clients performed as tin soldiers. […] I felt it was important to encourage independent action”. (Boukreev & De Walt, 1997, p. 106). Indeed, such an error prevention culture does not allow sufficient preparation for unexpected problems and errors.

How can a system, an expedition culture, prepare for the unexpected error? By preparing in the best possible way for dealing with those errors and problems: By,
for one thing, encouraging self-reliance. Krakauer, a client of the Adventure Consultants, said: “To my mind, the rewards of climbing come from its emphasis on self-reliance, on making critical decisions, and dealing with the consequences. When you become a client, I discovered that you give all that up. For safety’s sake, the guide always calls the shots. (Krakauer, 1996, p. 58).

As I will convey in the following, several problems arose and mistakes were made during the summit bid. I have tried to especially discuss the ways these problems and errors were dealt with, and how the expedition’s cultures contributed to the impact of those errors.

*The summit bid.* Around midnight, the expeditions departed from Camp IV. All members carried two oxygen canisters; a third canister for each of them was stashed at the South Summit to be picked up underway. With normal use, each canister provides oxygen for about six hours. This meant that no one was to return to Camp IV later than 6 p.m.. It is therefore common to set a strict turn-around time. Hall had lectured his clients repeatedly on the importance of a predetermined turn-around time: “With enough determination, any bloody idiot can get up this hill. The trick is to get back down alive.” (Hall cited in Krakauer, 1997, p. 147). The turn-around time of the Adventure Consultants was going to be either 1 p.m. or 2 p.m.. Hall, according to Krakauer, never actually decided on the turn-around time: “We were simply left with a vaguely articulated understanding that Hall would withhold making a final decision until summit day, after assessing the weather and other factors, and would then personally take responsibility for turning everyone around at the proper hour.” (Krakauer, 1997, p. 177). Gammelgaard, a Mountain Madness client, said: “I never
heard anything whatsoever about a turn-around time on summit day.” (Boukreev & De Walt, 1997, p. 168). Indeed, Fischer never set a definite turn-around time either.

“Instead, he had worked out […] a simple strategy, an adaptation of the tactic he’d been using throughout the expedition. His climbing sirdar, Lopsang […], and his guides, Boukreev and Beidleman, would alternately lead; he would bring up the rear, and as he overtook stragglers, he would turn them around. If problems arose, he would establish radio contact with Lopsang […], who, it was assumed, would always be at or near the front of the pack. Neither Beidleman nor Boukreev was issued a radio.” (Boukreev & De Walt, 1997, p. 168).

As it turned out, however, Lopsang was never at the front. For reasons that have not become fully clear even afterwards, he short-roped client Hill Pittman. This tactic, which is something like pulling someone up the mountain, drained his energy. It also meant that he was at the rear and not the front, unable to keep the agreement with Adventure Consultant’s sirdar Ang on cooperatively roping the steeper sections above Camp IV. Ang, who was upset that he, again, would have to make up for Lopsang’s absence (see Krakauer, 1997, p. 175) refused to work on the ropes above the Balcony. Krakauer recalls: “When Ang […] and I first arrived at the Balcony at 5.30 a.m., we were more than an hour in front of the rest of Hall’s group. At that point we could have easily gone ahead to install the ropes. But Rob [Hall] had explicitly forbidden me to go ahead, and Lopsang was still far below, short-roping Pittman, so there was nobody to accompany Ang […].” (Krakauer, 1997, p. 174).

“Whatever motivated him, Lopsang’s decision to tow a client up the mountain didn’t seem like a particularly serious mistake at the time. But it would end up being one of
the many little things — a slow accrual, compounding steadily and imperceptibly toward critical mass.” (Krakauer, 1997, p. 170).

A bottleneck arose. Four of Hall’s clients decided to turn around, figuring that with the fatigue they already experienced and late hour, they would be unable to reach the summit and descend in time. Doug Hansen, also a client of Adventure Consultants, decided to turn around as well. “Then Rob [Hall], who was bringing up the rear, caught up to Doug, and a brief conversation ensued. Nobody overheard the dialogue, so there is no way of knowing what was said, but the upshot was that Doug got back in line and continued his ascent.” (Krakauer, 1997, p. 165).

Lopsang is seen vomiting, which indicates that he was in trouble. The Taiwanese expedition — whose leader had decided, against earlier agreements, to summit on the same day the Adventure Consultants and Mountain Madness expeditions did — had a slow climbing style, climbing really close together, hindering members from the Adventure Consultants and Mountain Madness expeditions to pass them. Just before the Hillary step — one of the most famous pitches in mountaineering, forty feet of near-vertical ice and rock — further delays in rope fixing arose. “Clients huddled restlessly at the base of the rock for nearly an hour while Beidleman — taking over the duties of an absent Lopsang — laboriously ran the rope out. Here, the impatience and inexperience of Hall’s client Yasuko Namba nearly caused a disaster. […] as Beidleman clung precariously to the rock 100 feet above the clients, the overly eager [Adventure Consultant’s client] Yakuso [Namba] clamped her jumar to the dangling rope, before the guide had anchored his end of it. As she was about to put her full body weight on the rope — which would have pulled

When fixing the ropes … “Beidleman [one of the guides for the Mountain Madness expedition] couldn’t find another anchor to tie [the rope] into. Not wanting to leave the unanchored length of rope on the surface of the snow because a climber might clip on thinking it was anchored above him [or her], Beidleman tossed the rope toward Tibet.” (Boukreev & De Walt, 1997, p. 170), thus employing error prevention. Less than half of the intended route to be fixed had been covered… “[...] leaving [...] the most exposed part of the climb where the climbers had to perform a pretty precarious solo traverse were a slip could be fatal” (Martin Adams cited in Boukreev & De Walt, 1997, p. 170), thus leaving the route without proper error management conditions.

Finally, between ten to forty-five minutes after 1 p.m. the first climbers (Boukreev, Krakauer, Harris, Beidleman, and Schoening) reached the summit. Other climbers were still going up well after 2 p.m., some arriving at 2.15 p.m. but only descending after 3.10 p.m., some arriving even later than 3.30 p.m. or 4 p.m., thereby seriously violating turn-around times (had they been set). Most climbers had picked up, and started using, their third canister of oxygen on the way up, arriving at the summit with only a few hours of oxygen left. As guide Boukreev, then still on the way up, recalls: “[...] there on the South Summit, I began to wonder again where Scott [Fischer] was. Here, I thought, maybe it would be necessary to turn some clients around, but there was no Scott to do it. I felt I did not have the right to make this decision. The clients had paid big money and had given Scott that authority, not
me.” (Boukreev & De Walt, 1997, p. 167). As Boukreev was not issued a radio, he could not consult with Fischer.

Krakauer notices ‘wispy clouds’ filling the valleys to the south, obscuring all but the highest peaks. As Krakauer leaves the summit to descend, he runs into Beidleman and Adams. “Adams, [an experienced airplane pilot], later told me that he recognized these innocent-looking puffs of water vapor to be the crowns of robust thunderheads […]” (Krakauer, 1997, p. 185). However, at the time, no one but Adams was worried about the weather, and Adams only expressed his concerns after the expeditions had ended.

Upon the mistake with the valve of the oxygen regulator, described earlier in this chapter, Krakauer had to wait for an hour at the top of the Hillary step before he could descend. When finally reaching the South Summit, he was eager to screw on a new canister of oxygen. Guide Harris, however, stated that all canisters were empty. In reality they were not, it was (as Krakauer learns only after the expedition has ended) merely Harris’ regulator that was frosted, due to which it registered all canisters to be empty. Harris, however, could not be convinced. “In hindsight, Andy [Harris] was acting irrationally and had plainly slipped well beyond routine hypoxia, but I was so mentally impeded at the time myself that it simply didn’t register. […] Given what unfolded over the hours that followed, the ease with which I abdicated responsibility — my utter failure to consider that Andy might be in trouble — was a lapse that’s likely to haunt me for the rest of my life.” (Krakauer, 1997, p. 188). Krakauer gives some indication of Groupthink (Janis, 1972) as an aspect of the expedition’s culture as he says: “My inability to discern the obvious was exaggerated to some degree by the guide-client protocol. Andy and I were very similar in terms of
physical ability and technical expertise; had we been climbing together in a non-guided situation as equal partners, it’s inconceivable to me that I would have neglected to recognize his plight. But on this expedition he had been cast in the role of invincible guide, there to look after me and the other clients; we had been specifically indoctrinated not to question our guide’s judgement.” (Krakauer, 1997, p. 188).

Somewhat lower on the mountain, Krakauer ran into Adventure Consultants client Weathers, who had, due to eye-surgery some years earlier, almost completely lost his vision in the low barometric pressure. Weathers had, several hours earlier, agreed that he would wait on Hall to return from the summit and descend with him. Krakauer offered to lead Weathers to Camp IV, but Weathers declined. A bad decision in retrospect. “Beck [Weathers] was nearly persuaded when I made the mistake of mentioning that Mike Groom [a guide] was on his way down with Yasuko [Namba], a few minutes behind me. In a day of many mistakes, this would turn out one of the larger ones.” (Krakauer, 1997, p. 191).

Only Boukreev, Krakauer, Adams, and of course those who had turned around on the morning of May 10, made it back to Camp IV before 7 p.m.. Daylight had gone and a fierce storm broke loose. At 4.30 p.m. Doug Hansen, the client who had been convinced by Hall to proceed ascending, had collapsed and was in need of oxygen above the South Summit. Hall stayed there to help Hansen. The night was setting in. Hall and Hansen were too high up on the mountain to be rescued, especially during the heavy storm. The people at Base Camp strongly urged Hall over the radio to descend, or to at least descend to the South Summit to pick up extra canisters of oxygen. Guide Andy Harris, however, repeatedly intervened with his
own radio, stating his earlier conviction that all oxygen canisters were empty. This may well have contributed to Hall’s decision not to move. At 4.45 a.m. May 11, Hall radioed that Hansen ‘was gone’. By this time, Hall himself was unable to move. He died on the evening of May 11.

Guide Harris was also somewhere high up on the mountain, as was Fischer. At 8 p.m. the batteries of the Mountain Madness radios ran out. It is unclear what exactly happened to Harris, he never returned. On May 11 Lopsang attempted a courageous rescue for Fischer, but Fischer was too far-gone, not at all responding to oxygen and tea offered. Gau, the Taiwanese expedition leader, was brought down alive.

Meanwhile, during the evening of May 10, several members got lost not far from Camp IV. The storm had severely reduced visibility, and the tracks from the ascent had been erased by the wind. Groom, Namba, Adams, Beidleman, Schoening, Madsen, Fox, Hillman Pitt, Weathers and two Sherpa’s mistakenly wandered east instead of west. The group lost all orientation and got onto the Tibetan (instead of Nepalese) side of the South Col risking falling off the Lhotse Face.

Boukreev, earlier that day, had been one of the first to leave the summit. When he met Fischer, who then was still ascending, he proposed that he would descend quickly, in order to regain strength possibly needed later. Fischer agreed. Several people have criticized Boukreev’s decision to ‘abandon’ his clients. Boukreev’s rationale, however, is persuasive. “I said to Scott [Fischer] that the ascent seemed to be going slowly and that I was concerned that descending climbers could possibly run out of oxygen before their return to Camp IV. I explained I wanted to descend as quickly as possible to Camp IV in order to warm myself and gather a
supply of hot drink and oxygen in the event I might need to go back up the mountain to assist descending climbers. Scott [Fischer], as had Rob Hall immediately before him, said “OK” to this plan. I felt comfortable with the decision, knowing that four Sherpa’s, Neal Beidleman (a guide like me), Rob Hall, and Scott Fischer would be bringing up the rear to sweep the clients to Camp IV.” (Boukreev & De Walt, 1997, p. 249).

As it turned out, Boukreev was the only one who was able to rescue climbers. The clients that had returned were totally exhausted. Some Sherpa’s, who had not summited in order to assist if an emergency would arise, had been incapacitated with carbon monoxide poisoning from cooking in a poorly ventilated tent.

Boukreev’s first rescue attempt was fruitless. He could not locate the wandering climbers. Then, at 0.45 a.m. Beidleman, Groom, Gammelgaard, Schoening and two Sherpa’s arrived at Camp IV. Being lost on the South Col, Schoening [a mountain Madness client] had pulled himself together: “[...] his attitude was, “Okay, no panic, no fear, no disaster. What can we do about the situation?”” (Gammelgaard cited in Boukreev & De Walt, 1997, p. 206). Schoening was able to lead the stronger members of the lost group to Camp IV. Boukreev was given directions on where to find the others. At 4.30 a.m. Boukreev brought back Fox, Madsen and Hill Pittman to Camp IV. Namba and Weathers were (presumed) dead.

On the morning of May 11, after spending a night unconscious lying face-down in the snow, Weathers miraculously walked into Camp IV. “[...] I could see that his pile jacket was open down to his stomach, his eyes were swollen shut, and his arm was locked upright, parallel to his shoulder like a low-budget horror flick. His face was so badly frostbitten that he was unrecognizable. Then I realized it had to be
Beck [Weathers].” (Henry Todd cited in Coburn, 1997, p. 176). The next day, at Camp IV, he is left for death the second time, but again, revived. Upon treatment in a hospital Weathers lost an arm and several fingers, but survived. Looking back, he commented: “I don’t think the doctor that looked at me should be faulted for declaring me dead, or close to dead. It may not have been the best diagnosis, but we all make mistakes at times, even at sea level.” (Beck Weathers cited in Coburn, 1997, p. 200).

“What we can do now is contribute to a clearer understanding of what happened that day on Everest in the hope that the lessons to be learned will reduce the risk of the others who, like us, take on the challenge of the mountains.”


The role of error culture in the tragic outcomes. Several people have offered explanations for the tragedy. I will cite two sources: “Along with friends from other expeditions, the climbers assessed the tragedy, not intending to assign blame to individuals -if this was even possible- but to make sense of the catastrophe and to learn from the mistakes that were made. The tragedy, they agreed, resulted from the confluence of bad luck and poor judgement. The guides and clients together had cut their safety margins too thin.” (Coburn, 1997, p.192). And: “The events of May 10 were not an accident, nor an act of God. [...] They were the end result of people who were making decisions about how and whether to proceed. Unfortunately, not all the guides were really given the leadership or operating protocol for dealing with the
various situations that arose on the mountain. The organization was very loose.” (Jim Williams cited in Coburn, 1997, p.193).

With an inclination towards error prevention (legalist approach), Hall aimed at setting tied rules. He did not allow clients to go far ahead of the rest of the group. He was a leader that usually worked with a tight turn-around time. Referring to another expedition that had, earlier that spring, turned around just an hour before the summit, Hall had said: “To turn around that close to the summit … That showed incredibly good judgement […]. I’m impressed — considerably more impressed, actually, than if he’d continued climbing and made the top.” (Hall cited in Krakauer, 1997, p. 147).

Yet, for the 1996 summit bid, he did not set a turn-around time, he expressed disappointment when some of his clients turned around before reaching the summit, and he even persuaded one client not turn around but to continue for the summit. The reason for his uncharacteristic actions remains unclear. Possibly he wanted to bring more clients to the top than Fischer would. Possibly his thinking was impaired by hypoxia. Possibly both. In any event, his clients had, throughout the previous weeks, been conditioned to rely on rules and the guides rather than on their own judgement. On summit day rules had not been set, or were unclear, guides were absent or impaired with hypoxia, thus clients were on their own.

A client of Mountain Madness ultimately led the stronger of the wandering clients from both expeditions (and an Adventure Consultant guide) back to Camp IV. A Mountain Madness guide — Boukreev — saved those who were left behind. The Mountain Madness sirdar — Lopsang — saved the leader of the Taiwanese expedition. Yet, the Mountain Madness culture, with its inclination towards the situationalist approach, was not perfect either. The expedition was not fully prepared
for dealing with errors and unexpected problems. Both Fischer and Lopsang were already exhausted when the summit bid began. Only two radio’s were issued (to Fischer and Lopsang) leaving the two guides without one. It was therefore impossible to make a proper assertion of the situation and the needs high on the mountain. There was no possibility to communicate strategies between the guides, leading guide and sirdar. It was therefore unnecessarily difficult to adequately deal with problems.

The most explicit choice for an error management approach was Boukreev’s harshly criticized decision (Boukreev & De Walt, 1997; Krakauer, 1997) to descend in front of the others. As described above, this enabled him to assist expedition members who were in trouble. Further, when leading a commercial Everest expedition one year later, he enforced a culture of self-reliance rather than obedience, and of coaching rather than leading. His successful 1997 expedition to Everest was organized in such a way that previous errors could be avoided and unexpected problems could be handled (see Boukreev & De Walt, 1997, epilogue). He used a more intense acclimatization strategy that involved strong commitment from the clients: By climbing consecutive higher mountains (rather than going up and down the same mountain for acclimatization) he was able to (a) ensure proper acclimatization, and (b) to properly assess the clients strengths and weaknesses. He made it very clear that he was willing to serve as a guide, give advice, be a member of a rescue team if so needed, but he stressed that the clients would have to take some responsibility for the hubris of their ambition. Boukreev would act as a coach, not as an authoritan leader. Further, radios were issued to all climbers and guides.

A summation of violations and mistakes contributed to the problems the expeditions encountered on summit day. Neither of the two expeditions had a very
strong or very explicit error culture. Neither of the expeditions turned out to be optimally prepared to prevent problems or to avert its consequences. Adventure Consultants inclination towards an error prevention culture left the team with an inability to deal with the unexpected. Mountain Madness error management oriented culture may have lacked consistent implementation to be effective. Boukreev’s successful approach in 1997 and the expedition’s culture he explicitly enforced may have been the right answer. He may have been able to implement a true error management culture. The issue of error culture raised in this chapter may therefore be an important one.

Overview of the dissertation

This dissertation reports five studies, using various methodologies, aimed at investigating the role (importance, content and dynamics) of organizational error culture.

Chapter 2 describes the precursor of a survey reported in Chapter 3: Teams of managers from a real organization engage in a dynamic simulation in which organizational decisions have to be made (Study 1). The design of this management game is such that errors are likely. It is established that ‘ways of dealing with errors’ can be distinguished at the team level. Three dimensions surface: Mastery orientation, Awareness, and Error Aversion. Team error management culture is measured and linked to team performance. A negative correlation is found between Error Aversion and team performance.
Chapter 3 describes a survey (Study 2) and a qualitative study (Study 3) both investigating the link between organizational error management culture and organizational performance. In 65 Dutch organizations, active in various lines of industries, the three dimensions of error management culture are related to organizational performance. Mastery orientation is found to be correlated with both a ‘subjective’ management assessment of organizational performance as well as ‘objective’ economic measures. In-depth interviews, using the critical incident approach (Flanagan, 1954), confirm the survey findings and further point at the role of leadership styles such as punishment and showing empathy.

Chapter 4 reports on the improvement of the error culture questionnaire. In Study 4 interviews with managers are analyzed in order to determine lacunas in the original questionnaire and to develop new items and scales. In Study 5 the development of new scales is finalized by means of exploratory (half of full sample) and confirmatory (remaining half of sample) factor analysis using structural equation modeling (LISREL). Further, a nomological net is built around error culture.

In Chapter 5, the findings of Chapters 2 to 4 are integrated, conclusions are drawn and directions for future research are discussed.
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Errors and ways of dealing with them form an important topic for all organizations. Managers in hazardous industries are not the only ones who face the challenge of establishing an effective, systematic approach to errors. Hartley (1994) has given examples of how errors have affected organizations in various lines of industry.

This chapter first discusses error prevention and its liabilities. Then an alternative strategy for dealing with errors — error management (Frese, 1991) — is presented. Positive aspects of errors are discussed. The emphasis lies on the role that organizational and team culture may play in avoiding negative error consequences while exploiting positive error consequences. In preparation for research in actual organizations the ideas are tested in a management game.

**Error management: Avoiding negative error consequences.** When dealing with errors, two strategies can be followed: Error prevention and error management. So far, most

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of the emphasis has been on error prevention (Argyris, 1985; Wilpert, 1995). The problem, however, is that total elimination of error occurrence is impossible. “Mistakes are inevitable, given the present state of decision making and the dynamic environment facing organizations” (Hartley, 1994, p. 2). While error prevention may (to a large degree) be effective in a stable environment that enables people to anticipate each possible error, the dynamic environment that organizations encounter makes it impossible to ‘control’ all errors in advance.

In the error management approach, a clear distinction is made between the error itself and its negative consequences. The concept of error management focuses on avoidance of negative error consequences, rather than on errors per se (Frese, 1991). Thus, the error management approach recognizes that it is, in spite of effort put in error avoidance, realistic to take into account that (some) errors will nevertheless occur. More importantly, it is recognized that not errors, but rather their negative consequences are the real ‘threat’ to a system or organization. Therefore, these error consequences form the main focus. Error consequences are avoided by enhancing the ‘error process’. The error process comprises error detection, error explanation, error handling and recovery. In her study on management errors Grefe (1994) found that negative error consequences can, by and large, be avoided through error anticipation, early error detection and quick error handling.

A well-implemented error management approach makes error prevention less crucial. This is important because an error prevention approach may have negative side effects. First, systematic error prevention that has been successfully implemented may elicit an over-reliance on the system to prevent errors. Error anticipation will decrease and actions to cope with errors are rehearsed less frequently
Due to this decrease in skills for detecting and dealing with errors, the inevitable error that slips through every once in a while can cause excessive damage (cf. latent errors; Reason, 1990). Second, organizations that put an emphasis on error prevention typically do not accept errors. Consider the reactions this may evoke; strain caused by errors, covering up of errors, and therefore (again) chances of creating latent failures (Reason, 1990) and a decrease of individual and collective learning from errors (see also below). Thus, while a majority of errors may be avoided through error prevention, this strategy may have the drawback of creating a system that weakens the error process, which in turn may increase the severity of the negative consequences of those errors that are not prevented.

Various researchers have focussed on the possibilities of error recovery and learning from errors (e.g. Edmondson, 1996; Sitkin, 1996), rather than error prevention. Edmondson (1996), for example, has independently developed similar ideas to those embodied in the error management concept. She conducted survey and qualitative studies on errors in a medical setting. One of the focuses of this study was why some work groups are better than others at catching and correcting human errors before they become consequential. Her results show that the combination of high error rates, high error detection and reporting rates, and high error interception (i.e. error recovery) rates is strongly associated with high team performance.

Positive aspects of errors: Learning opportunities, adaptability and innovation. As discussed above, an error prevention approach has drawbacks. Its main goal is to prevent negative error consequences by means of avoiding errors altogether. Errors can, however, besides negative consequences, also evoke an array of opportunities.
By aiming at error prevention, managers will inevitably exclude these positive aspects of errors.

Several scholars have discussed and tested learning opportunities that errors may provide. Kolb, for example, who has conceptualized learning not just as gaining knowledge, but more so as the integration of experience and insight (Kolb, 1976; 1984) puts emphasis on the function of errors in learning. In his view, problems or errors form the starting point, as well as the ‘motor’ for learning. Error training (Frese, Brodbeck, Heinbokel, Mooser, Schleiffenbaum & Thieman, 1991) was built on this presupposed learning scope provided by errors. Error training can be clearly distinguished from the more traditional types of training. While the latter put emphasis on learning things the right way directly and minimizing the amount of errors while doing so, error training focuses on the positive function of errors. Errors are encouraged in error training. Further, it is made clear to the trainees that they should not get upset with errors, but take them as a learning opportunity: Error training teaches trainees effective emotional strategies for dealing with errors. Several studies have demonstrated that performance after error training is higher than after traditional training (Dormann & Frese, 1994; Frese, et. al., 1991; Irmer, Pfeffer, & Frese, 1994; Thieman, 1990). One explanation for these findings may lie in the goals that are encouraged in error training (Heimbeck, 1999).

Dweck and Legget (1988) have distinguished two types of general goals, that can be associated with working on difficult tasks: First, judgement goals which aim at gaining positive and avoiding negative judgements about one’s performance. Second, learning goals, which entail increasing one’s competence irrespective of judgements (Dweck, 1999; Dweck and Legget, 1988). People who have learning goals are likely
to take errors as a challenge that can be mastered. People with judgement goals, on the other hand, are likely to see errors as ‘proof’ of inability. Dweck and colleagues (e.g. Dweck, 1975; Dweck & Reppucci, 1973) demonstrated that learning goals are associated with a mastery orientation, high persistence and performance when confronted with failure. Judgement goals are largely associated with a pattern of helplessness, low persistence and low performance.

The results of the error training studies indicate that errors promote exploration, which in turn seems to foster learning as well as a deeper understanding of the material involved (Dormann & Frese, 1994). Edmondson (1996) has also looked at the learning opportunities that errors may provide. She concludes that openness about errors within the work group contributes to a self-perpetuating cycle of learning.

The positive function of errors has also been recognized in the concept of the learning organization (e.g. Argyris, 1992). Argyris (1991) places emphasis on detecting and correcting errors, and advocates that errors should not be perceived negatively. Further, he proclaims that there is danger in persistent success. People who have only rarely failed, have never learned how to learn from failure. Sitkin (1996) makes a similar argument as he warns that success can go hand in hand with complacency, restricted search and attention, risk-aversion and homogeneity. He promotes the benefits of ‘strategic failure’, which can be described as failure that challenges the status quo, provides adequate feedback, does not conform to expectations and thus requires active, deeper processing. Strategic failure keeps organizations sharp. Furthermore, strategic failure will, in Sitkin’s view, lead to ‘adaptability’ which is the ability to adapt to changing environmental conditions and

*Error orientation and team features for effective error handling.* An error management approach can overcome the drawbacks of an error prevention approach and foster the benefits that errors provide. However, the organization must support error management. At the individual level, attitudes and behavioral styles have been distinguished that support error management (error orientation; Rybowiak, Garst, Frese, & Batinic, 1999). The main concepts of error orientation are: (1) analyzing error occurrences and (2) their communication to colleagues; (3) short term competence at error handling and recovery as well as (4) long term learning from errors; (5) anticipation of errors and (6) adequate risk taking. Together, these concepts enhance a successful error management approach. The last two aspects of error orientation, (7) strain caused by errors and (8) their covering up, impede error management.

Rybowiak and colleagues have developed a questionnaire to measure error orientations (Rybowiak et. al., 1999). This error orientation questionnaire (EOQ) has been validated and has been shown to correlate with performance related traits and characteristics (e.g. self-efficacy, Bandura, 1996 and plan- and action orientation, Frese, Stewart, & Hannover, 1987). Moreover, error orientations of small-scale entrepreneurs have been shown to correlate with success of the company (Göbel, 1998; Göbel & Frese, 1999). Thus, some evidence exists that error orientation, as a
personal trait, is important in organizational settings. In organizations, work processes and performance at higher hierarchical levels such as the team or organization as a whole, rather than just the individual level are crucial. Edmondson’s (1996) results suggest that characteristics such as openness of work teams are related to team performance. From this it follows that team error orientation, rather than the sum of the individual error orientations of team members, should form the object of investigation.

The main goals of the current study are the following. First, to test whether team or organizational error culture exists, that is, to establish whether error related behavioral styles characterize the team; whether there is a distinguishable team feature at work. Second, in order to validate the team error culture aspects, learning and judgement goals are linked to team error culture. I expect that learning goals are positively correlated with error analysis, communication, error recovery, learning from errors, error anticipation and risk taking aspects of team error culture, while error strain and covering up should be positively correlated with judgement goals. Third, I investigate which aspects of team error culture are related to team performance. More specifically, I hypothesize that error analysis, communication, error recovery, learning from errors, error anticipation and risk taking are aspects of error team culture that are positively correlated with team performance. I further hypothesize that error strain and covering up are negatively correlated with team performance.
Methods

*The management game.* A management game that was developed by the Dutch company MCC, served as the setting for the study. MCC has developed several management games that allow practitioners to experiment with management strategies. The goal of these games is ‘simu-learning’: learning by anticipating and reacting to a simulated reality. The management game discussed here focussed on information technology (IT) management of a fictitious company.

Each of the teams in the game had to run a fictitious company that produced an innovative type of car chairs. Due to economic turbulence, the company dealt with increased competition and decreased profit margins. At the start of the game, the company had 240 employees; 155 in production, 25 in sales, 60 in administrative duties and no IT personnel.

The goal of the management team was to make the company more profitable. A fictitious board of directors of the company took some of the decisions for the management team (selling price, production capacity, budget, and negotiations with unions resulting in agreements on wages). The game instructors gave the teams this information from the board of directors at the beginning of year (i.e. decision making round).

At the beginning of each year the teams had to divide the budget between production, marketing and IT, with further differentiation in each (e.g. personnel, research and development). Each team’s decisions were passed on by means of a simulation model. After that, each team received an overview of the results of their decisions. Teams then analyzed these results in order to make optimal decisions for
the next year. Besides company results, the teams also had to deal with developments in the market. Each team’s performance was measured by the company’s cumulative profit.

The game took place on one evening, and lasted for about three hours. The month before the actual game, the teams could practice by means of decision-making rounds sent in by fax. The teams then received feedback (company results) back by fax. During this month they could consult with a special management game helpdesk. Before and during the actual game, the teams could consult their management game manuals. The actual game comprised five decision-making rounds (five company years) with the ultimate company profit as team performance measure.

Participants. Managers from Dutch companies participated as teams in the management competition game. In 44 teams, 145 managers participated (M = 3.3 per team, SD = .83, minimum = 2, maximum = 6).

Procedure. The game comprised five rounds in each of which the team had to make decisions for their fictitious company. After each of the five decision rounds, feedback on the consequences was provided to the teams. Near the end of the game (either between the third and fourth, or fourth and fifth round) all members of participating teams were asked to complete a questionnaire.

Measures. An adaptation of the EOQ (Rybowiak et al., 1999) served as the measure for team error culture. In this adaptation of the EOQ, the items were transformed to the team level and the situation of the game (e.g. “My mistakes have helped me to
improve my work.” is transformed into; “Our mistakes have helped us to improve our decisions in the management game”). The questionnaire comprises eight scales: analyzing errors, communication within the team, error recovery, learning from errors, error anticipation, risk taking, error strain and covering up errors. Besides team error culture, teams filled in the learning and judgement goals scales (Button, Mathieu & Zajac, 1996). Team profit after the fifth and final round served as the dependent variable.

Results

First, it was established whether error culture is a concept that exists at the team level. In order to do so, $\eta^2$’s — a measure of intra-group consensus (James, 1982) — were calculated for each of the eight scales. The discussion on the size of intragroup consensus measures has not been completely resolved yet (James, 1982; Rousseau, 1990). James (1982) reported that in team and organizational research $\eta^2$ values between .00 and .50, with an average of .12 have been found. In our study the $\eta^2$ values ranged from .34 to .48 (see Table 1) thereby exceeding Georgopoulos’ (1986) minimum criterion of .20. It is concluded that error culture exists at the team level. Therefore, all analyses were based on the aggregated data.
Table 1

*Eta*²’s and correlations of Team Error Culture scales

<table>
<thead>
<tr>
<th>Eta²</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tr>
<td></td>
<td>.45**</td>
<td></td>
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<td></td>
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<tr>
<td>1. Analysis</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Learning</td>
<td>.47**</td>
<td>.44**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Recovery</td>
<td>.44*</td>
<td>.50**</td>
<td>.45**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Communication</td>
<td>.37</td>
<td>.60**</td>
<td>.42**</td>
<td>.53**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Anticipation</td>
<td>.45**</td>
<td>.01</td>
<td>.39**</td>
<td>.03</td>
<td>-.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Risk taking</td>
<td>.40</td>
<td>.04</td>
<td>.52**</td>
<td>.12</td>
<td>.10</td>
<td>.73**</td>
<td></td>
</tr>
<tr>
<td>7. Strain</td>
<td>.34</td>
<td>.30</td>
<td>-.15</td>
<td>.08</td>
<td>.01</td>
<td>-.25</td>
<td>-.37*</td>
</tr>
<tr>
<td>8. Covering up</td>
<td>.33</td>
<td>.03</td>
<td>-.20</td>
<td>-.24</td>
<td>-.20</td>
<td>-.17</td>
<td>-.33*</td>
</tr>
</tbody>
</table>

N = 44 teams; * p < .05; ** p < .01, two-tailed tests.

Correlations between scales of team error culture were then investigated (see Table 1). As can be seen in Table 1, low or near zero correlations are found between some scales, while high correlations are found between others. The pattern of correlations suggests clusters of scales that might be explained by underlying dimensions. In order to test if this was the case, a second order factor analysis was conducted.

In the second order factor analysis the eight scales were entered as items. Three factors with eigenvalues greater than one were found. Error analysis, communication, error recovery, and learning from errors all loaded highly on the first factor. Factor loadings are respectively .83, .84, .80 and .60. I refer to this dimension as Mastery orientation; its four aspects relate to error management’s goals of avoiding negative error consequences and learning from errors, aimed at mastering error’s challenges (Dweck, 1999; Dweck and Legget, 1988). Error anticipation and risk taking loaded on the second factor. Factor loadings are respectively .91 and .88. This
dimension is called Awareness; both its aspects point at a team’s readiness for error occurrence and error handling. Error strain and covering up loaded on the third factor (.87 and .89 respectively). I call the third dimensions Error Aversion; both its aspects reflect a negative orientation towards error occurrence.

Mastery team orientation was found to correlate with learning goals, as did the Awareness dimension (see Table 2). Error Aversion was associated with judgement goals. More importantly, Error Aversion was negatively correlated with final score of the teams.

It was hypothesized that the Mastery and Awareness dimensions would correlate positively with team performance. No such correlations were found.

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>Eta²</th>
<th>Alfa</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mastery</td>
<td>3.80</td>
<td>.27</td>
<td>.48**</td>
<td>.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Awareness</td>
<td>3.64</td>
<td>.38</td>
<td>.48**</td>
<td>.84</td>
<td>.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Error Aversion</td>
<td>1.99</td>
<td>.33</td>
<td>.34</td>
<td>.75</td>
<td>-.06</td>
<td>-.33**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Learning goals</td>
<td>4.04</td>
<td>.34</td>
<td>.44</td>
<td>.92</td>
<td>.60**</td>
<td>.40**</td>
<td>-.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Judgement goals</td>
<td>3.26</td>
<td>.29</td>
<td>.45*</td>
<td>.66</td>
<td>.19</td>
<td>-.03</td>
<td>.40**</td>
<td>.24</td>
<td></td>
</tr>
<tr>
<td>6. Team performance</td>
<td>4844</td>
<td>4185</td>
<td>n.a.</td>
<td>n.a.</td>
<td>.04</td>
<td>-.08</td>
<td>-.26</td>
<td>.02</td>
<td>-.06</td>
</tr>
</tbody>
</table>

N = 44 teams; * p < .05; ** p < .01; # p < .10, two-tailed tests. n.a. = not applicable.
Conclusions and discussion. Intra-group consensus on team error culture scales justifies aggregation of data to the team level. This indicates that error orientation does manifest as a team feature. This finding is encouraging for further research on organizational error culture.

The eight facets of error orientation (Rybowiak et al., 1999) seem to work somewhat differently at the team level. Here three dimensions underlie the eight facets. These dimensions are: Mastery orientation — a dimension of team error culture that is aimed at taking on the challenges of error occurrences; Awareness — a general readiness to handle errors; and Error Aversion — negative attitude towards error occurrence.

In accordance with what was hypothesized, Mastery and Awareness are positively related to learning goals, and Error Aversion is positively related to judgement goals. Analyzing errors, communication, error recovery and learning from errors (Mastery dimension) and error anticipation and risk taking (Awareness dimension) thus are associated with the goal of overcoming a difficult situation, with mastering the task at hand. Error strain and covering up errors (Error Aversion dimension) was associated with the goal of gaining positive judgements and avoiding negative judgements when confronted with a difficult task.

Error Aversion was negatively correlated with team performance, as was hypothesized. In disagreement with what was hypothesized, however, neither the Mastery nor Awareness dimension were positively correlated with team performance.

Several explanations may be offered. First, the hypothesized relationships of Mastery and Awareness with team performance do not exist. As has been discussed in the introduction, however, such relationships have been found in individual (small-
scale entrepreneurial) performance. Thus, maybe things work differently with team performance. As Edmondson (1996) has pointed out, however, team or organizational climate is important for dealing with errors effectively. Besides results already discussed here, her study hinted at the importance of an optimal climate for dealing with errors. As she indicated, “In certain units, the leaders may have established a climate of openness that facilitates discussion of error, which is likely to be an important influence on detected error rates.” (Edmondson, 1996, p.17). In her view, such a climate promotes so-called ‘self-correcting performance units’ (Hackman, 1993) that are able to anticipate, catch and correct errors made within the team. Indeed, her results suggest that errors are more often successfully corrected in those units in which members are less concerned about being caught making a mistake.

Another explanation for the lack of relationships might be that, in this setting, the task was complex relative to the low number of decision rounds. The teams only worked together for a three-hour period. In this period their ultimate goal was to make profit, but in order to do so, they had to spent a substantive amount of time at figuring out the ‘rules’ of the environment. That is, they had to explore the system; the way the fictitious market reacted to their decisions. In error training, such exploration is done during the training phase while performance is measured in a transfer task. In this setting, in contrast, the exploration or learning phase coincides with the performance phase.

I would then — cautiously — interpret the findings as follows: While Fear of errors impedes performance, the Mastery and Awareness dimensions of team error culture may, in this specific setting, not have had a chance to have the hypothesized effect on team performance.
References


Error management culture and organizational performance:  
On mastering the challenges of errors

This paper examines organizational error culture in relation to organizational performance. We argue for the importance of an organizational culture that supports effective and productive error handling. We do so by drawing on the literature on errors in general (Reason, 1990), recent organizational approaches (e.g. Total Quality Management; Sitkin, Sutcliffe & Schroeder, 1994), operational safety and high reliability (Rochlin, 1999) and laboratory studies on error training (Frese, 1995). We gather survey and qualitative data on error culture in medium sized organizations and link these data to organizational performance measures.

Practically every organization is confronted with errors. Errors have been defined as “[…] all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some change agency” (Reason, 1990, p. 9).

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Errors have double implications. On the one hand, there is no doubt that errors can contribute to grave consequences — accidents like the one in Chernobyl or the Challenger disaster — on the other hand, most people readily agree that one can learn from errors. Thus, errors are the material that may lead to the insolvency of an organization (e.g. Barings Bank; Rawnsley, 1995) but they may also be the raw material for a learning organization (Argyris, 1992; Sitkin, 1996).

A similar duality has been recognized in Total Quality Management (Sitkin, Sutcliffe & Schroeder, 1994), exploitation versus exploration (March, 1991) and organizational learning (Argyris, 1992; Huber, 1991). Sitkin and colleagues (Sitkin, Sutcliffe, & Schroeder, 1994) have argued that Total Quality Management actually comprises two distinct goals resulting in distinct approaches; Total Quality Control and Total Quality Learning. On the one hand, organizations want to do ‘the things they do’ without errors (Total Quality Control). They want to exploit the methods that have proven their success (March, 1991), and improve them (single-loop learning; Argyris, 1992; March, 1991). This implies controlling and auditing known processes, and focussing on reliability and stability. On the other hand, organizations want to be adaptable and innovative (Total Quality Learning), and explore new ideas and methods (March, 1991), which implies second-loop learning (Argyris, 1992) rather than single-loop learning. In this respect, errors provide organizations with learning opportunities.

Both goals of control and learning are valid and important. It is, however, difficult for organizations to find an optimal balance between the two. A mere focus on exploration leaves an organization with many new ideas lacking necessary refinement. A mere focus on exploitation is likely to leave the organization with
well-developed, but sub-optimal methods (March, 1991). The two approaches require conflicting strategies (e.g. auditing versus risk taking and experimentation), which makes it hard to achieve an optimal balance. Yet, in order to keep competitive advantage, organizations need both reliability and stability associated with control, as well as adaptability and innovativeness associated with learning (March, 1991; Sitkin, 1996; Sitkin, Sutcliffe, & Schroeder, 1994).

Errors may result in both negative (e.g. loss of time, faulty products, accidents) and positive consequences (e.g. learning, innovation and resilience; Sitkin, 1996). The organizational goal of avoiding negative error consequences is conceptually associated with the more general goal of control. The organizational goal of fostering positive error consequences is similarly associated with the more general goal of learning. Organizations would gain most if they adopt a strategy that is able to take on the challenge of both goals of control (avoiding negative error consequences) and learning (fostering positive error consequences) simultaneously or in alignment.

A commonly used approach for avoiding negative error consequences is preventing the error itself (Argyris, 1992; Frese, 1991; Wilpert, 1995). With respect to the duality of errors (or rather their consequences), we propose that error prevention is a strategy not optimally suited for supporting both goals of control and learning.

Error prevention implies a focus on the goal of control. We propose that mere emphasis on error prevention has its limits: total elimination of errors is impossible. The advantages of the human cognitive apparatus (e.g. fast processing in uncertain environments) are the flipside of the fallibility of human reasoning (Reason, 1990). Further, error prevention may create negative side effects. An over-reliance on error
prevention may reduce error detection. When people are convinced that error prevention is successful, a sort of hubris develops which leads to a decrease of error anticipation which, in turn, makes it more difficult to detect those errors that occur nonetheless (Grefe, 1994; Dormann & Frese, 1994; Rochlin, 1999). Skills to deal with errors are affected (Argyris, 1992; Dormann & Frese, 1994; Rochlin, 1999), and an error occurring in spite of error prevention is then more likely to cause excessive damage (Reason, 1990; Frese, 1991). Further, a danger of organizational emphasis on error prevention is that errors are sanctioned severely. This may lead to strain, defensive reactions, covering up of errors, and thereby decrease the likelihood of error correction (Argyris, 1992; Johnston, 1996).

Error prevention does not necessarily allow learning. Organizational learning strategies such as experimentation (Huber, 1991) are in direct conflict with error prevention’s goal of control: Errors are needed for learning from them. This dilemma is recognized in organizational learning strategies such as drawing from near-histories or hypothetical histories (March, Sproull & Tamuz, 1991), where the non-occurrence of errors is dealt with by trying to learn from errors that might have occurred. These strategies are in alliance with error prevention’s goal of control and provide the learning material (hypothetical errors), but have drawbacks associated with artificiality and validity.

The error management approach (Frese, 1991) distinguishes between errors and their consequences. While error prevention aims at avoiding negative error consequences by avoiding the error altogether, the error management approach focuses on error consequences directly. It aims at avoidance of negative error consequences and the promotion of positive error consequences by means of early
error detection, quick and effective correction, error analysis, and long term learning from errors.

With respect to the duality of error consequences, we propose that error management is a strategy well suited for supporting both goals of control and learning. Error management overcomes the inherent conflict in allocating resources between the two. Both goals of control (avoiding negative error consequences) and learning (promoting positive error consequences) are embedded in the approach. Further, since error management does not imply error avoidance, the learning material — occurrence of errors — is available.

We now turn to the empirical evidence supporting the error management approach, which implies that negative error consequences can be avoided without avoiding the error itself (goal of control), and that positive error consequences can be promoted (goal of learning). Edmondson’s (1996) research on errors in a medical setting revealed a positive relationship between the number of detected errors and team performance. It turned out that highly performing teams reported more errors (i.e. made more errors and/or were more willing to report them). Edmondson concluded that these teams had a better error climate, which allowed them to talk about errors, which in turn increased detection and correction. Thus, a distinction was made between an error (wrong medication order) and its negative consequence (harming a patient). Further, the open climate, characterized by a willingness to report and discuss errors, allows learning from errors, and thereby can affect team performance positively (Edmondson, 1996).

Learning from errors has been shown to occur in error training, which leads to higher performance compared to traditional and error-free forms of training (Dormann
& Frese, 1994; Frese, 1995; Frese, Brodbeck, Heinbokel, Mooser, Schleiffenbaum & Thieman, 1991; Gick & McGarry, 1992; Heimbeck, 1999). Errors allow and encourage exploration, which in turn seems to foster learning as well as a deeper understanding of the material involved (Frese, 1995; Kolb, 1984).

Edmondson’s (1996) findings are in line with Rochlin’s (1999) assertion that high performance should not be confused with the absence of errors. As Edmondson (1996, p. 25) has put it: “Given that human error will never disappear from organizational life, an important management issue thus becomes the design and nurture of work environments in which it is possible to learn from mistakes and to collectively avoid making the same ones in the future.” Based on research in high reliability organizations, Rochlin reports the finding that high reliability organizations tend to reward the reporting of errors, and focus on organizational (i.e. shared) responsibility rather than on blaming the direct actor. The organization as a whole, not a single actor, should be the object under investigation. He further stresses that research be directed at the ‘generic subjectivity’ and organizational culture that provides meaning and purpose to the systems and processes that are operated and managed. Safety in high reliability organizations is more than the summation of actions of individual employees, but rather, entails a collective property that emerges from the interaction between parties, based on the social structure, beliefs, rituals and myths of the entire organization (Rochlin, 1999). Similarly, we propose that an error management approach be studied in terms of organizational culture dimensions. Thus, in line with Edmondson and Rochlin we argue that there is a cultural dimension to how organizations deal with errors.
Empirically, our study on error management culture builds on research on individual error management orientation (Rybowiak, Garst, Frese, & Batinic, 1999) where associations between this orientation and success of small-scale entrepreneurs have been established (Göbel, 1998; Göbel & Frese, 1999). Rybowiak et al. (1999) differentiated eight factors: communication about errors; analysis of errors; correction of errors; learning from errors; anticipation of errors; knowledge, acceptance and anticipation of risks; strain caused by errors (negative); and covering up errors (negative). In another study (Van Dyck, 1997; see also chapter 2) we tested whether these error orientation concepts could be translated to the team or organizational level. In the study of Van Dyck (1997; see also chapter 2), high intra-group consensus was found on the error culture scales. It turned out, however, that at the team level three dimensions where underlying the eight original scales used for individual error orientation. These dimensions were labeled mastery, awareness and error aversion.

The three dimensions refer to direct and indirect support and to impediment of error management. Error management is directly supported by a mastery orientation towards errors. We use the term mastery orientation in the sense of Dweck and her colleagues (Dweck & Legget; 1988; Diener & Dweck, 1978; 1980), that is, as an orientation toward developing ability, taking failure as a challenge to be mastered, generating effective strategies and maintaining effective striving under failure. Mastery orientation as an aspect of error culture is similarly focussed at overcoming difficulties associated with errors, and developing better strategies for the future. It entails that members of the organization communicate about errors, analyze errors’ causes, deal with errors actively (i.e. quick and effective recovery), and attempt to learn from errors.
A general example comes from organizations that make errors, correct them in the best possible way and than share the relevant information among their employees, by means of an information system accessible and used by all.

Communication, analysis, correction and learning are all directly related to minimizing negative, and maximizing positive error consequences. As such, the mastery aspect of organizational error culture relates to a (long-term as well as short-term) orientation to overcome errors’ problems and to take on the challenge that errors provide. Further, they entail what Rochlin (1999) labels a ‘positive engagement’, reflexive and interactive learning, and are in line with one of his key factors in high reliability organizations; the free flow of communication. The mastery aspect aims at both control (in the sense of eliminating or reducing negative error consequences) and learning (rendering positive error consequences). We, therefore, expect the mastery aspect of error culture to be positively related to organizational performance.

Anticipation of errors and knowledge, acceptance and anticipation of risks relate to a general awareness of errors. In calculated risk taking the organization accepts that it is sometimes necessary and useful to risk an error (see also Sitkin, 1996). Anticipation of errors is important because it aids the detection of errors. Only errors that are detected can be managed well. Negative error consequences tend to increase when the error remains undetected (Reason, 1990). Early detection can stop this dynamic process: The faster the detection, the better one is able to deal with the negative consequences (Grefe, 1994).

An example of the awareness aspect of error culture relates to recent preparations for the new millennium. The information technology sector had to
anticipate all aspects of their programming that related to the year 2000, read as 00 and misinterpreted as 1900. The organizations had to anticipate all problems related to this bug, as years are often used as variables that change other points in the program. Changing the programs necessitates an ‘awareness’ attitude in the information technology sector. Companies could not rely on simple solutions in their complex programs. They had to anticipate bugs that were overlooked, and test the effectiveness of their efforts in safe environments. A lot of companies organized ‘dress rehearsals’ where the date was artificially changed to 1-1-2000. On ‘D-Day’ the companies still had to be prepared for potential bugs to show up, even after extensive program adaptations and testing.

Error awareness thus relates to a preparedness for the unexpected, a continuous anticipation of future surprises (Rochlin, 1999). In sum, error awareness increases the likelihood of early error detection and prepares the organization for error handling. As such, error awareness indirectly supports error management. We thus expect a positive relationship with organizational performance.

Strain and covering up reflect a negative attitude towards errors, or error aversion. In organizations where employees are (severely) punished for their mistakes, employees are likely to experience strain, and may decide to cover up their errors. Strain and covering up diminish communication, analysis, correction, and learning, and thus, indirectly, hinder error management. Errors that are covered up remain undetected (at least to those who did not cover them up), and therefore run the risk of accumulating negative consequences (Reason, 1990).

An example is the Barings Bank disaster in 1993. Several sources indicate (e.g. Leeson, 1996; Rawnsley, 1995) that a major motivation for Leeson to produce an
unauthorized shadow account was that he was afraid to admit errors. He had been able to hide errors (and violations; cf. Reason, 1990) and their accumulating negative consequences for a long time, while attempting to make up for the errors and to look good without having to admit any of them. Employees who made mistakes or were not successful enough were fired quickly. Thus, the punishing culture of Barings Bank apparently reinforced this attitude (Rawnsley, 1995). Although there were obviously additional problems at Barings Bank, the accumulated consequences of Leeson’s actions resulted in its fall.

With respect to error strain, a recent follow-up on the error training research (Heimbeck, 1999), revealed the crucial role of so-called heuristics (e.g. “Don’t get upset with errors. Take them as a learning opportunity.”) for the success of error training. This effect can be explained from the viewpoint of focussed attention: When errors are considered to be threatening, attention (i.e. cognitive resources) is directed to the self, rather than the task (Kluger & DeNisi, 1996). Translated to the domain at hand, error strain takes away resources needed for error handling. We therefore expect a negative relationship between error aversion and organizational performance.

We propose that error management culture refers to the aggregate incorporation of a mastery orientation, awareness and low error aversion within the organization. Avoiding negative error consequences and fostering positive error consequences should be associated with higher organizational outcomes.

Hypothesis 1: Mastery orientation is positively related to organizational performance.

Hypothesis 2: Error awareness is positively related to organizational performance.

Hypothesis 3: Error aversion is negatively related to organizational performance.
We use two methods to test our hypotheses. A survey is conducted using an adaptation of the error orientation questionnaire (Rybowiak et al., 1999) to measure error management culture and relate it to subjective and objective measures of organizational performance. In addition, interviews are conducted on a sub-sample of the investigated organizations. In these interviews emphasis lies on how errors are generally dealt with in the organization, how managers react to subordinates’ errors, and organizational mission statements and visions with respect to errors. The qualitative data serve two purposes: First, to validate findings of the survey data; second, to explore additional organizational culture dimensions that are not measured by our questionnaire.

Methods

Sample. To minimize the risk of disintegration into several different sub-company sites with their own culture, we sampled mid-sized commercial organizations. We worked with a database from a commercial agency. This organization specializes in setting up and maintaining databases containing addresses of Dutch companies and names of functionaries within them. For our database we requested addresses of a total of 1,000 companies with one hundred to five hundred employees working in the same plant, office or site, and names of two functionaries within them. From this database we approached three hundred organizations. To work against a possible post-hoc explanation that associations between error culture and organizational performance would be restricted to certain sectors (e.g. with low risk activities), we included various sectors in our sample: automation (IT), retail trade, construction,
publishing, wholesale, machine and appliances, transport, insurance, consultancy and banks. Within broad categories for line of industry (see below), the approached companies were randomly selected. The approached companies do not differ from the non-approached companies with respect to the control variables (see below), nor do the participating companies (of those approached) differ from the non-participating companies.

Either one or two managers per company were selected from the database and received ten questionnaires on organizational error management culture. We asked these contact persons to give the questionnaire to their colleague-managers with a view to including as representative a cross-section of management as possible. If necessary - that is if a company had returned some, but not enough questionnaires - we wrote and/or telephoned the contact person asking whether it was possible to attain further participation. Our threshold for including a company in our analyses was three or more returned questionnaires. In exchange for participation, each company received a report with all relevant information and results with respect to their company as well as anonymous comparison data of the other companies.

In all, contact persons from 85 companies participated (producing a 28.3% response rate). In terms of individual participants, 380 questionnaires were returned. Since only organizations with three or more respondents were included in our analyses, this produced a sample of 65 organizations (25% of approached organizations). Of these, eleven organizations returned three completed questionnaires, fifteen organizations sent in four, fifteen sent in five, and twenty-four organizations sent in six to ten questionnaires. The average number of participating managers per organization in our sample is 5.4 (SD = 2.0). In total 297 male and 43
female managers participated, 10 managers did not reveal their gender. On average the participating managers had a position just above mid-level management.

**Measures.** Our questionnaire contained three scales on organizational error management culture, and a self-reported measure of organizational performance. Furthermore, for twenty-four of the organizations we were able to obtain an objective measure of organizational success. All measures other than the control variables form 5-point scales ranging from 1 (not at all / very unsuccessful) to 5 (completely / very successful). More details are given below.

**Error management culture.** Our measure of error management culture was based on the Error Orientation Questionnaire (EOQ) developed and validated for individuals (Rybowiak et al., 1999). We adapted the thirty-seven items of the EOQ in such a way that all items referred to the organizational level (“To which degree does this statement apply to people in your organization in general?”; see appendix for specific items).

In another study (Van Dyck, 1997; see also chapter 2) we specifically tested the generalizability of the error orientation questionnaire to higher levels (i.e. the team level in that case). It turned out that at the team level three dimensions were underlying the eight original scales. In the current study the same three dimensions surfaced. We entered the thirty-seven items in a factor analysis: Three factors had eigenvalues higher than two. Consistent with the other study, items of communication (k=4), analysis (k=5), correction (k=4) and learning (k=4) loaded on the first factor (mastery), items of anticipation (k=5) and risk taking (k=4) loaded on the second factor (awareness). Items of error strain (k=5) and covering up (k=6)
loaded on the third factor (error aversion). For all but three items loadings were .20 or more higher on their respective factor than they were on the other two factors. Thus, three error culture dimensions are formed: Mastery (Chronbach’s alpha = .92), Awareness (Chronbach’s alpha = .71), and Error Aversion (Chronbach’s alpha = .88).

**Subjective organizational performance.** To avoid common method variance, survey data of the respondent with the highest position in a company were used to establish a subjective measure of company performance. In all analyses with subjective measure of organizational performance, only data of the remaining respondents were used to assess error management culture.

We designed the measure of subjective organizational performance in such a way that comparisons between organizations in different industry characteristics were possible. That is, the measure comprises three items on success of the organization relative to its competitors in the same line of business. The items are: “How successful is your organization in comparison to other companies in the same line of industry and of (about) the same size?”; “To what degree has your organization achieved its most important goal in the last year?”; and “How innovative is your organization in comparison to other companies in the same line of industry and of (about) the same size?” (Cronbach’s alpha = .76).

**Objective organizational performance.** Relying on only one type of economic value (e.g. profit) has serious drawbacks. Preferably, we wanted to work with an economic measure that takes into account several general economic values, and that makes comparability over different lines of industry possible. We used a yearly-published
book by a Dutch consultancy agency that describes the performance of a large number of Dutch companies to obtain objective data on company success (De Breed & Partners, 1996). The method for developing these scores is based on Altman’s (1968) model. The model has been refined over the years, and specific (annually updated) models have been developed and updated for separate lines of industry. The nature of annual financial reports is in part dependent on the nature of company activities (line of industry). By developing prediction models separately for each sector this is taken into account and corrected for.

With the use of multiple discriminant analysis, a set of financial ratios was developed that distinguished between annual reports of solvent and insolvent companies (De Breed & Partners, 1996). For each line of business, separate regression models were developed, based on recent data on insolvency in that particular industry. These regression models took into account commonly used economic data, such as profit rate, cash flow, added value and resulted in a score between one (very poor) and five (excellent). A low score meant a high resemblance to companies that had become insolvent in the previous years, while a high score meant a high resemblance to companies that had been successful in the previous years. An advantage of this measure is that it is comparable across lines of business and that it is based on several economic indicators of success.

Only larger Dutch Incorporated companies that had filed recent and detailed annual reports were included in the analyses of De Breed & Partners. Companies active in banking or insurances were not included. These restrictions have consequences for availability of data for the companies in our sample. We were able
to obtain these objective data of organizational performance for twenty-four companies in our sample.

*Control variables.* We used age (M = 49.39, SD = 41.34 years) of the organization (based on founding year of the first office in The Netherlands) and number of employees of the participating office (M = 227.69, SD = 101.95) as control variables in our analyses to test against liability of newness (Brüderl & Schüssler, 1990; Sighn & Lumsden, 1990; Singh, Tucker & House, 1986) and liability of smallness hypotheses (Brüderl, Preisendörfer & Ziegler, 1992; Sighn & Lumsden, 1990).

In addition, line of industry served as a control variable. For this purpose, four broad categories were developed based on industry codes of the participating organization. The first category, ‘production & construction’, comprises nineteen organizations active in production (doors (1), plastics (1), cigarettes (1), wood (1), machines (2), engines (1), and newspapers (2)), and construction (10). The second category, ‘business services’, comprises sixteen organizations (consultancy (3), information technology (6), administration (3), public relations (1), marketing research (2), and transportation (1)). The third category, ‘finances & insurances’, comprises ten organizations of which six are active in insurances, and four are banks. The fourth and final category, ‘trade’, comprises twenty organizations of which eight are active in retail trade and twelve in wholesale. The industry categories are included as three dummy variables in our regression analyses.
Level of Analysis

All our measures referred to the organization as a whole, rather than individual behaviors or attitudes. Eta$^2$ values - a measure of intragroup consensus (James, 1982) — as well as ICC values (Kenny & La Voie, 1985) — a comparison of within and between variance on group measures - were calculated to determine whether aggregation of data to the organizational level was justifiable on methodological grounds. In our study the eta$^2$ values ranged from .24 to .38 ($p < .01$) for mastery, .24 (n.s.) for awareness, .38 ($p < .01$) for error aversion. ICC values are satisfactory for two of the three culture measures (.37 ($p < .01$) for mastery, .05 (n.s.) for awareness, .51 ($p < .01$) for error aversion). Due to the low intra-group consensus values for the awareness dimension, aggregation of data on this dimension is not justified. The awareness dimension is therefore excluded from the analyses.$^2$

Qualitative Data

We conducted in-depth interviews with sixteen managers from eight companies of our sample; one was active in automation, one in administration, one in retail trade, one in construction, two in wholesale, one in insurance, and one in technical consultancy. We used a critical incident approach (Flanagan, 1954), taking into account at least two occurrences of errors. Examples of errors mentioned by the interviewees are: (calculation) errors in offerings for clients, errors in employment contracts, wrong

$^2$ Our analyses as described in the result section yield identical results regardless of whether awareness is included or excluded.
planning and not meeting the deadline for a product presentation, errors in purchases, not being alert on wrong and insufficient information from clients, faulty products, the printing of three million letters, of which the address headings did not fit the envelope windows, and the hiring of seventeen temporary employees from two agencies, where both sent seventeen temps, so that the organization had the double amount of what they needed.

The focus of the interviews was on espoused and enacted (Siehl & Martin, 1990) aspects of the error management culture and on ways in which managers reacted to, and dealt with subordinate’s errors. Further, it was assessed whether an organization had a clear vision and/or mission statement regarding errors. All interviews were administered ‘face-to-face’, audio-recorded and transcribed.

In the first step of the coding process, raters 1 and 2 (other than the authors, but familiar with the theory) independently developed six categories (mastery, awareness and error aversion, as is consistent with survey data; blame, punishment and empathy as new dimensions) from their readings of the transcripts. In the second step, raters 3 and 4 (unfamiliar with hypotheses and theory) independently indicated all those parts of the transcripts related to error culture (Cohen’s Kappa = .86). About half of the total number of words was included in error culture segments, to be further analyzed. The remaining half of transcribed interviews contained general information about the organization, its main activity, responsibilities of the interviewed manager, the manager’s department, and the questions of the interviewer. Before starting the next step in the rating process, the raters 3 and 4 discussed the differences, and decided together on those parts of the transcripts that were indicative of the
organization’s error culture. This resulted in 261 segments to be categorized and scored.

Only in the third step (their second step) were rater 3 and 4 provided with the six categories. They were asked to assign the error culture segments of the transcripts to the six categories (Cohen’s Kappa = .69). The two raters discussed the differences, and decided together on those categories they initially differed on.

Raters 3 and 4 were then asked to assign a score between 1 (low) and 5 (high) to each categorized segment of the transcripts (Cohen’s Kappa = .76). The two raters discussed the differences, and decided on those scores they initially differed on.

On average, 16.1 segments were categorized and scored per interview. Per interview, scores in the same category were averaged, resulting in an overall score on each of the six categories, for each of the interviews. Further, at the end of each interview managers were asked about specific mission statements of their organization regarding errors. Since this entailed a simple and standard question, we did not further code these parts of the interviews. An additional rater (number 5, unfamiliar with our hypotheses) selected illustrating quotes from the interviews.

For each of the six dimensions, correlations between scores of two managers of one company were calculated. These are; .28 for Mastery, .18 for Awareness,.32 for Error Aversion, -.16 for Blame, .48 for Punishment, and .79 for Empathy. Based on these correlations we decided to exclude the Blame variable, and the Awareness (for which we had also found insufficiently high intra-group agreement values for the survey data, see Methods section) from further analyses.
Results

Table 1 shows means, standard deviations, and inter-correlations. Mastery orientation and error aversion have a small and marginally significant correlation with each other. Size was negatively related with mastery orientation and positively with error aversion. Apparently, larger organizations have lower mastery orientation and higher error aversion scores. The correlation between the subjective and objective measures of organizational performance was non-significant, suggesting that the two measures tap different aspects of performance: The subjective measure is related to the achievement of goal developed within the organization, while the objective measure relates to economic indicators.

We tested our hypotheses using correlational (Table 1) and hierarchical (or sequential) regression analyses (Table 2). We entered the control variables size, age, and three dummies for the four industry categories in the first step of a hierarchical regression analysis with the subjective measure of organizational performance as the dependent variable. A similar hierarchical regression analysis was conducted with the objective measure of organizational performance as the dependent variable. In this second analysis, however, only one dummy (industry category trade) was entered in the first step, since only data on the objective performance variable were available for two of the industry categories (trade and production)3. Table 2 shows that the control

3 The data loss on the objective measure of performance is not random, but relates to line of business (banks and insurance companies are not included), type of organization (“incorporated”) and size of the company (in terms of turnover). This led to data loss due to the fact that we had quite a number of banks and insurance companies in our sample, and because our sample included organizations that were not ‘big’ enough for the De Breed and Partners’ index to have included them. To test for size and
variables did not affect either of the two dependent variables. The two error culture
dimensions were entered in the second step. Hypothesis 1 predicted a positive
relationship between mastery orientation and organizational performance. As can be
seen in Tables 1 and 2, mastery orientation was positively related to both subjective
and objective organizational performance. In Table 2, the significant change in
explained variance in the subjective measure of organizational performance in the
second step was due to the mastery dimension. With the objective measure of
organizational performance a marginally significant change in explained variance
\( (p = .08) \) was found in the second step.

industry effects (apart from our use of control variables for the full sample) we have conducted our
analyses on the subjective measure of performance separately for the two parts of the sample we do and
that we do not have objective data for. These analyses yield identical results.
Table 1

Means, Standard Deviations, and Correlations for Error Management Climate, and Organizational Size, Age, and Performance

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>s.d.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5a</th>
<th>5b</th>
<th>5c</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mastery Orientation</td>
<td>3.23</td>
<td>.46</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Error Aversion</td>
<td>2.64</td>
<td>.53</td>
<td>-.20#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Size</td>
<td>227.69</td>
<td>101.95</td>
<td>-.23*</td>
<td>.21*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Age</td>
<td>49.39</td>
<td>41.34</td>
<td>-.02</td>
<td>-.04</td>
<td>-.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Industry Category</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Trade (dummy)</td>
<td>n.a.</td>
<td>n.a.</td>
<td>-.06</td>
<td>.10</td>
<td>.07</td>
<td>.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Business Services (dummy)</td>
<td>n.a.</td>
<td>n.a.</td>
<td>.05</td>
<td>-.07</td>
<td>-.05</td>
<td>-.31*</td>
<td>.38**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Production (dummy)</td>
<td>n.a.</td>
<td>n.a.</td>
<td>.16</td>
<td>-.14</td>
<td>-.08</td>
<td>.15</td>
<td>-.43**</td>
<td>-.37**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Subjective Performance</td>
<td>3.50</td>
<td>.42</td>
<td>.33**</td>
<td>.09</td>
<td>.16</td>
<td>-.10</td>
<td>-.24#</td>
<td>-.13</td>
<td>-.09</td>
<td></td>
</tr>
<tr>
<td>7. Objective Performance</td>
<td>4.08</td>
<td>1.02</td>
<td>.46*</td>
<td>-.00</td>
<td>-.17</td>
<td>.13</td>
<td>-.26</td>
<td>n.a.</td>
<td>.11</td>
<td>.20</td>
</tr>
</tbody>
</table>

All measures form 5-point scales ranging from 1 (not at all / very unsuccessful) to 5 (completely / very successful), with the exception of the control variables; size (number of employees) and age (in years) of the company, and the dummies for industry category. The number of organizations is sixty-five, except for the objective measure of organizational performance where we only have data on twenty-four of the organizations. n.a. = not applicable; # p< .10 ; * p < .05 ; ** p < .01, all two-tailed tests.
Table 2

*Results of Hierarchical Regression Analyses*

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Subjective organizational performance</th>
<th>Objective organizational performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \Delta R^2 ) F( \Delta ) ( \beta )</td>
<td>( \Delta R^2 ) F( \Delta ) ( \beta )</td>
</tr>
<tr>
<td>Step 1: Control variables:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>.10</td>
<td>1.29 (5, 59)</td>
</tr>
<tr>
<td>Age</td>
<td>-.14</td>
<td></td>
</tr>
<tr>
<td>Industry Category (dummies)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade</td>
<td>.21</td>
<td></td>
</tr>
<tr>
<td>Business Services</td>
<td>-.10</td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td>Step 2: Error management culture:</td>
<td>.15**</td>
<td>5.62 (7, 57)</td>
</tr>
<tr>
<td>Mastery orientation</td>
<td>.40**</td>
<td></td>
</tr>
<tr>
<td>Error Aversion</td>
<td>.11</td>
<td></td>
</tr>
</tbody>
</table>

All measures form 5-point scales ranging from 1 (not at all / very unsuccessful) to 5 (completely / very successful), with the exception of the control variables; size (number of employees) and age (in years) of the company, and the dummies for industry category. The number of organizations is sixty-five, except for the objective measure of organizational performance where we only have data on twenty-four of the organizations. n.a. = not applicable; * \( p = .08 \); * \( p < .05 \); ** \( p < .01 \).
The beta for mastery was significant\textsuperscript{4}. Thus, hypothesis 1 was supported.

Hypothesis 2 could not be tested since we found no justification to aggregate the awareness dimension. As discussed in the methods section, this variable was excluded from further analyses. Error aversion was not significantly correlated with either measure of organizational performance (see Tables 1 and 2). Thus, we did not find support for Hypothesis 3.

**Qualitative Findings**

A striking finding of our qualitative analyses was the absence of mission statements and organizational vision concerning errors. Only one of the sixteen managers indicated that their organization had an explicit error approach, which focused on error prevention. Ten other managers indicated that their organization did not have any specific vision regarding errors. The remaining five managers indicated that errors had never been discussed at the organizational level. Statements were, for example: “Errors have never been explicitly discussed at the organizational level. We do, however, have a quality system, which implies a focus on prevention of errors,

\textsuperscript{4} We also tested for two-way interactions between the error culture dimensions and the industry categories to investigate whether relationships between error culture dimensions and organizational performance measures differed over industry categories. This was done in an equivalent way as described in Table 2 with control variables and error culture dimensions being entered in step 1 and 2 respectively. The interaction terms being entered in the third step. For each of the interaction terms a separate analysis was performed (note that using separate analyses for each of the interaction terms allows us to find non-expected significant effects more easily, therefore this procedure is more conservative than entering all interaction terms together in the third step). No significant effects were
procedures for dealing with specific errors, and registration of customer complaints aimed at improvement.” and “Yes, we do have a very precise procedure for the registration of errors, deviations and accidents.” This sounds as if there were a clear procedure, but it was only related to the registration, and not to the handling of errors.

For validation purposes and for further exploration of important error culture issues, we calculated correlations between survey and interview dimensions (see Table 3). Note that these correlations are based on very few cases and should only be taken as suggestive. Moderate to high positive correlations appeared between the survey dimensions mastery orientation and error aversion and their counterparts in the interview. Due to the small sample size for the qualitative data, these correlations were non-significant. They suggest that both procedures — the survey and qualitative approach — tended to tap the same dimensions. The correlation between the mastery dimension in the interview and the subjective measure of organizational performance was of similar size (albeit not significant) as in the survey data. There was also a negative correlation between the error aversion dimension in the interview and the subjective measure of organizational performance (although, again, not significant due to the small N). We had hypothesized such a relationship but did not find it in the survey.

The other correlations suggest further issues for error culture research. Mastery orientation, as measured in the survey, was significantly negatively correlated with error aversion (interviews), and negatively (non-significantly) found for any of the interactions. This leads to the conclusion that there was no moderator effect of line of industry on error culture and performance relationships.
correlated with punishment (interviews), and positively (marginally significant) correlated with empathy (interviews).

Table 3

Correlations between survey and interview dimensions

<table>
<thead>
<tr>
<th>Survey dimensions:</th>
<th>Mastery</th>
<th>Error Aversion</th>
<th>Subj. Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview dimensions:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mastery</td>
<td>.51</td>
<td>.22</td>
<td>.34</td>
</tr>
<tr>
<td>Error Aversion</td>
<td>-.71*</td>
<td>.40</td>
<td>-.52</td>
</tr>
<tr>
<td>Punishment</td>
<td>-.38</td>
<td>-.17</td>
<td>-.31</td>
</tr>
<tr>
<td>Empathy</td>
<td>.68#</td>
<td>.23</td>
<td>.23</td>
</tr>
</tbody>
</table>

*N = 8 organizations, * p < .05, # p < .10, two-tailed tests.

Another way to look at the qualitative data is a consideration of quotes that illustrate our error culture dimensions. In Table 4a and 4b an overview is given of organizations which’ managers participated in the interviews, scores on mastery orientation, error aversion, punishment and empathy (lower scores in Table 4a, higher scores in Table 4b) and one or two illustrating quotes for each dimension. The organizations whose quotes are given had the following scores in the survey; an organization active in automation with mastery score 3.34, error aversion score 2.73, subjective performance score 4.08; administration (3.23; 3.00; 3.61); retail trade (3.09; 2.73; 3.50); construction (3.32; 2.55; 3.58); wholesale (1) (3.67; 2.22; 3.73); wholesale (2) (3.43; 2.99; 4.21); insurance (3.46; 2.73; 3.33); and technical consultancy (3.27; 2.71; 2.93).
Table 4a

**Illustrating Quotes for the Four Error Culture Dimensions (Interview): Low Scores**

<table>
<thead>
<tr>
<th>Organization</th>
<th>Score</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultancy</td>
<td>2.73</td>
<td>“In this organization, we don’t talk about errors”</td>
</tr>
<tr>
<td>Retail</td>
<td>2.85</td>
<td>“But I don’t want to discuss errors at great length. [...] I indicated that this shouldn’t happen again. And that was the end of it.”</td>
</tr>
<tr>
<td>Wholesale (1)</td>
<td>1.00</td>
<td>“We specifically don’t want to disguise our own mistakes. We want them out in the open.”</td>
</tr>
<tr>
<td>Administration</td>
<td>1.25</td>
<td>“When I first started as a supervisor, I used to get angry at people when they made a mistake. That is very easy and seems forceful. But you have to get used to the fact that it simply does not work. People will get frustrated, fearful, they will be less open about their mistakes and therefore errors will be discovered later.”</td>
</tr>
<tr>
<td>Wholesale (1)</td>
<td>1.75</td>
<td>“Don’t keep matters bottled up. People shouldn’t be given hell about their errors. People have to learn from their errors. I make errors myself.”</td>
</tr>
<tr>
<td>Wholesale (2)</td>
<td>2.00</td>
<td>“[...] Learning from errors. I see them as positive, as free feedback. I always see them as positive. If people report their errors to me I thank them for that. I don’t complain, I regard it as an opportunity to improve things. That’s how I see errors.”</td>
</tr>
<tr>
<td>Retail</td>
<td>2.00</td>
<td>“I said to her: ‘tell him.’ ‘But,’ she responded, ‘I have already informed him [that a certain person would get a raise].’ ‘Well, that’s your problem,’ I replied.”</td>
</tr>
</tbody>
</table>
Table 4b

*Illustrating Quotes for the Four Error Culture Dimensions (Interview): High Scores*

<table>
<thead>
<tr>
<th>Organization</th>
<th>Score</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>4.75</td>
<td>“I try to create an open atmosphere and tell people they should inform me if they have made a mistake, so that we can do something about it. We try to be open and discuss errors, because we believe that is the only way to control damage.”</td>
</tr>
<tr>
<td>Wholesale (2)</td>
<td>4.50</td>
<td>“I have spoken to the responsible manager, and have asked him to use this incident as a learning opportunity in his department.”</td>
</tr>
<tr>
<td>Wholesale (1)</td>
<td>4.35</td>
<td>“I try to create an open atmosphere and tell people they should inform me if they have made a mistake, so that we can do something about it. We try to be open and discuss errors, because we believe that is the only way to control damage.”</td>
</tr>
<tr>
<td>Automation</td>
<td>3.90</td>
<td>“I try to create an open atmosphere and tell people they should inform me if they have made a mistake, so that we can do something about it. We try to be open and discuss errors, because we believe that is the only way to control damage.”</td>
</tr>
<tr>
<td>Consultancy</td>
<td>4.30</td>
<td>“The funny thing was that I got an evasive reaction at first, like ‘don’t worry, nothing’s wrong.’ And then when I started digging a bit deeper, I found a chain of things that indicated people were protecting each other.”</td>
</tr>
<tr>
<td>Retail</td>
<td>3.15</td>
<td>“The workers have to put a stamp with their identification code on their work [...] But they’re even smarter, they just don’t put down their identification code, so that we don’t know who made the mistake.”</td>
</tr>
<tr>
<td>Construction</td>
<td>3.80</td>
<td>“Errors... Well, I accept errors in the sense that when a person makes too many, they’re fired.” “It will be fatal for him [the employee who made a mistake] if the customer finds out.”</td>
</tr>
<tr>
<td>Wholesale (2)</td>
<td>5.00</td>
<td>“The way I go around is that I try to empathize. I take the circumstances onto account. Including the social aspects.”</td>
</tr>
<tr>
<td>Administration</td>
<td>4.50</td>
<td>“If I would have said to that guy, ‘You idiot, how could you have done that?’, he would have felt really small, while ‘why don’t you come up with something that will prevent this error in the future’ will make him feel like a hero.”</td>
</tr>
</tbody>
</table>
The quotes in Tables 4a and 4b illustrate the central aspect of mastery orientation: open, free, and constructive communication, analysis, a focus on error recovery and learning. The quotes on error aversion suggest that fear of being caught while making a mistake is an important issue. The quotes on punishment suggest that managers can be readily differentiated on whether they do or do not punish errors. The same holds for showing empathy. What can further be seen in these quotes, is that with higher scores on mastery and empathy and lower scores on error aversion and punishment, managers more often offer a rationale for their approach (e.g. “We believe that is the only way to control damage”, and “[otherwise] people will get frustrated, fearful, they will be less open […] and therefore errors will be discovered later”). Conversely, with lower scores on mastery and empathy, and higher scores on error aversion and punishment, managers tend to merely state their approach (e.g. “[…] this shouldn’t happen again. And that was the end of it.”). More important, these rationales directly relate to the mastery and error aversion dimensions. That is, rationales given for not punishing subordinates for their errors relate to the fear that punishment will reinforce error aversion, and impede error detection (manager from administration company), that punishment will impede learning (manager from second wholesale company), and that showing empathy will serve the goal of error correction (manager from insurance company).

Discussion

The most interesting finding of our study is that mastery orientation correlated positively with both the subjective and objective measures of organizational
performance. This effect was upheld when we controlled for age and size of the organization, and line of industry the organization is active in. This is in line with our first hypothesis. Unfortunately, our second hypothesis could not be tested, since aggregation of the awareness dimension was not legitimate due to low values of intra-group consensus. No significant negative association was found between error aversion and the organizational performance measures. Thus, there was no support for our third hypothesis.

It makes sense that mastery orientation showed the clearest association with organizational performance because it is at the core of what error management is about. Communication, error analysis, correction of errors and learning from errors all are directly aimed at avoiding negative error consequences and determining better strategies for the future. The importance of the mastery dimension is in line with two of Rochlin’s (1999) central constructs in high reliability organizations and their safety culture; a free flow of communication, the rewarding of reporting of errors and a continuous reflexive and interactive learning approach. Our qualitative data give further support to these ideas. Validation for our two error culture survey dimensions is inferred from positive correlations between these two survey dimensions and their counterparts in the interview data. Further, a similar positive correlation between the interview mastery dimension with the subjective measure of success (survey) was found as in the survey data.

A selection of quotes from our qualitative data illustrates the essence of the error culture dimensions. The reactions to subordinates’ errors (punishment and empathy) can be seen as managers’ reinforcement of the organizational error culture
in lower levels of the organization, and as an expression of the error culture at higher (management) levels of the organization.

A clear limitation of our study is its cross-sectional design. We therefore were unable to test for causality. Our results are consistent with two opposing hypotheses: Either error management culture leads to increased organizational performance, or high organizational performance enables or encourages an error management approach. The interpretation of the latter would be that high performance, or a good position of the company, would make management and employees more relaxed so that they feel free to discuss errors and learn from them, rather than get upset and hide errors. The experimental design of error training research (Dormann & Frese, 1994; Frese, 1995; Frese et al., 1991; Heimbeck, 1999) gives a clear indication that the way people perceive errors and handle them, influences performance. We would argue that these findings on causality on the individual level would also be true at the organizational level. It is, however, plausible that there is a mutual reinforcement of error culture and organizational performance: Error culture influences organizational performance and performance influences error culture. In either event, the causality issue needs to be addressed in future empirical research.

Another problem might lie in self-selection of participating organizations and respondents within them. Organizations that have already developed an interest in the topic of dealing with errors, and that have already given the topic some thought, are more likely to participate. Within these organizations, managers who think they deal with errors well (which does not necessarily conform to our ideas) are more likely to participate. We think, however, that this mechanism is not a very likely explanation of our results. First, our sample displayed enough variation in both error management
culture and organizational performance in the survey data, as well as variation
between participants as assessed in the qualitative data. Second, self-selection should
decrease variance, and therefore, reduce correlations. Third, the absence of mission
statements and organizational visions with respect to dealing with errors in the
interviews suggests that no bias is operative.

One other weakness of our study is the low correlation between the subjective
and objective measures of organizational performance. This suggests that the two
measures tap different aspects of organizational performance. Our subjective measure
of performance refers to organizational goals and to what degree they were attained,
and to how well the organization is doing in comparison to direct competitors. The
objective measure comprises several economic indicators weighted according to their
prediction of organizational survival in that line of industry. It makes sense that these
two measures of performance are different. It attests to the robustness of the results
that mastery orientation is significantly related to both measures.

A strength of our study is that our analyses do not use the same sources of
information for the ‘dependent’ and ‘independent’ variables. The subjective measure
of organizational performance was based on the highest manager who was left out of
the measures of the culture variables. The objective measure of organizational
performance was developed for a different purpose by a commercial firm, unrelated to
our research effort.

We think that the most important mechanism that links error culture and
organizational performance, relates to both issues of control (avoiding negative error
consequences) and learning (promoting positive error consequences). Specific issues
in this respect would be related to learning new approaches, dangerous areas, and
boundary lines of routine approaches. Research in a related area (Wall, Jackson & Davids, 1992) showed that the reason why operators produced performance gains after the introduction of a new payment system was that they optimized fault management. Further research is needed to empirically establish the precise mechanisms by which error management culture influences organizational performance. One suggestion derived from our qualitative analyses would be to focus on interpersonal aspects of error handling such as punishment, and showing empathy with people that err. It is noteworthy in this respect that a similar trend can be observed in the aviation industry, where policies are designed to encourage the reporting of errors without sanctions (Johnston, 1996), thus creating an environment where errors are not punished. Related to the aspect of punishment is that of taking responsibility. Rochlin (1999) reports that highly reliable organizations tend to attribute error to the organization as a whole rather than displacing responsibility to the erring task group or individual.

Up to this point, error management culture with its core of mastery orientation, has been discussed to be useful for all companies. Although we did not find any moderator effect of industry on the mastery orientation - organizational performance relationships, we think that (other) contingencies may affect the relationship. We would argue that all companies benefit from an error management culture, but do so in different ways. In line with the contingency argument presented by Sitkin et al. (1994), for some organizations the advantages of an error management culture would be associated with issues of control, while for others they may be associated with issues of learning. This would then depend on the line of industry, or on whether or not an organization is going through a period of change.
It is important to differentiate between errors and error consequences. People sometimes argue against our error management idea that companies cannot afford to produce faulty products of low quality. This is obviously correct. However, a faulty product is an error consequence and is not necessarily related to error management per se. In fact, a faulty product may be the result of lack of error management. Error management culture may be of central importance to companies. Actually, part of the debate on Taylorism versus Anti-Taylorism can be understood in terms of organizational approaches to errors. Taylor’s (1911) approach was strong, because it entailed an ingenious method to eradicate errors (and inefficiencies) by reducing the complexity of work, by giving the worker exact instructions of what to do under which circumstances, by a high division of labor, and by using tools and machines that made errors unlikely. Taylorism thus leads to an organizational error culture that optimizes error prevention. Tayloristic approaches, however, have serious drawbacks. They reduce responsibility, initiative and internal motivation (Fay & Kamps, 1998). Therefore, alternative approaches to job design have become prominent. These non-Tayloristic approaches, have had to deal with the argument that their approaches lead to a higher degree of errors (Wall & Jackson, 1995). This implies that organizations with non-Tayloristic approaches are forced to develop some strategy for dealing with errors. We think that error management is a useful concept for these non-Tayloristic approaches.

Error management culture should be a matter of high concern for managers as well as an issue of high conceptual importance for studies on organizational change and organizational learning. Errors will appear whenever companies reduce the number of routines people can rely on. Change processes are, therefore, frequently
associated with a higher degree of errors. Moreover, people will more likely participate actively in change processes if their errors are not punished. When companies attempt to be superior to other companies we would advise them to focus on a culture that fosters the open discussion of errors, the analysis and efficient correction of errors, and learning from errors. Managers should realize that errors are not always avoidable and errors should therefore be tolerated to a certain degree. This does not mean that they should not be taken seriously. As a matter of fact, we suggest that errors should be taken more seriously than is often done. In this respect it is important to note the absence of organizational visions or mission statements in the companies of which we interviewed managers. While errors traditionally are discussed only when the consequences are high or even disastrous, we suggest that errors with small consequences should also be taken as chances to learn. In line with Rochlin (1999), we suggest that organizations should be encouraged to take responsibility for their errors. Error management culture may be an important, and up to this point unexplored, element for many if not most companies to gain competitive advantage.
References


Appendix: Items Organizational Error Management Culture

Mastery orientation

Error correction:

When an error has occurred we usually know how to rectify it.

When an error is made, it is corrected right away.

If an error is restorable, we usually know how to do it.

Although we make mistakes, we don’t let go of the final goal.

Learning from errors:

For us, errors are very useful for improving the work process.

An error provides important information for the continuation of the work.

Our errors point us to what we can improve.

In mastering a task, people can learn a lot from their mistakes.

Analyzing errors:

After making a mistake, people try to analyze what caused it.

In this organization, people think a lot about how errors could have been avoided.

If something went wrong, people take the time to think it through.

After an error people think through how to correct it.

After an error has occurred it is analyzed thoroughly.

Communication:

When someone makes an error, (s)he shares it with others so that they won’t make the same mistake.

When people are unable to correct an error, they turn to their colleagues.

If people are unable to continue their work after an error, they can rely on others.

When people do something wrong they can ask others for advice on how to continue.
Chapter 3

Awareness

_Anticipation:_

It is very likely that people will make errors in the process of mastering their task.

When people start to work on something, they are aware that mistakes can occur.

In this organization, people are often amazed by their mistakes.

In this organization we take the occurrence of errors into account.

In this organization, we take into account that things will go wrong from time to time.

_Risk taking:_

For an organization to achieve something, it has to risk the occurrence of errors.

It’s fine to risk an error every once in a while.

To get better in what we do, we don’t mind that something can go wrong in the process.

We would rather make mistakes than do nothing.

Fear of errors

_Error strain:_

In this organization, people feel aggravated when making mistakes.

People in this organization are often afraid of making errors.

In general, people feel embarrassed after making a mistake.

If an error occurs, people get upset and irritated.

During their work, people are often concerned that errors could be made.

_Covering up:_

Our motto is; “Why admit an error when no one will find out?”

It can be harmful to make your errors known to others.

There is no point in discussing errors with others.

There are advantages in covering up one’s errors.

People in this organization prefer to keep their errors to themselves.

Employees that own up to their errors are asking for trouble.
Organizational error management culture and its measurement: Development of an improved questionnaire

In the research described in Chapters 2 and 3, survey data on organizational error management culture were gathered with a questionnaire that comprises adapted items of the Error Orientation Questionnaire (EOQ; Rybowiak, Garst, Frese & Batinic, 1999). The EOQ measures individual error orientation, that is, behavior and attitudes individuals display when confronted with errors. The EOQ comprises a total of 37 items organized in eight scales; Analysis, Learning, Correction, Communication, Anticipation, Risk taking, Strain (negative) and Covering up (negative). All items specifically refer to the individual’s error orientation. The Error Management Culture Questionnaire (EMCQ) was based on the same 37 items as the EOQ. The EMCQ differs from the EOQ in two important ways: First, all items specifically refer to the error culture of the organization as a whole, rather than to an individual’s error orientation. Second, larger dimensions are used: (1) Mastery comprising Analysis, Learning, Recovery and Communication, (2) Awareness comprising Anticipation and Risk taking, and (3) Error Aversion (negative) comprising Strain and Covering up (see also Chapters 2 and 3). Qualitative interviews with managers (see Chapter 3) confirmed the importance of the Mastery dimension, and revealed a moderate effect
for Error Aversion. The Awareness dimension was somewhat problematic: Lower intra-organizational consensus values were found in both survey and interview data (Chapter 3).

Because of its origin in individual error orientation (Rybowiak, et al., 1999) the questionnaire may have under-emphasized social aspects of error management culture. This is one of the lacunas the current studies attempt to resolve.

The current chapter describes two studies aimed at improving the questionnaire. In the first study interviews are used for the development of new items. Interviews are held with employees and managers in software and hardware design companies. This line of industry is chosen for its high degree of error-occurrence. Further, errors with consequences of the full range of magnitude are common. The first study is specifically aimed at identifying topics that the current questionnaire lacks, and the development of corresponding items. In the second study, all old and new developed items are tested in a large sample of students that hold positions in various companies. A calibration sub-sample is used to select items, develop scales and underlying dimensions with structural equation modeling. The remaining sub-sample is used for a confirmatory factor analysis. Further, additional organizational culture scales are administered for building a nomological net.

Study 1: Methods & results

Sample. Four IT-companies participated in the study. These companies had an average of around 100 employees working in the same office. Per company, five employees, all of which were active in software and/or hardware development,
participated. The average level of the participants (19 men, 1 female) was mid-management.

Procedure. In a course for which I served as a supervisor, a group of four students were made familiar with the topic of error management culture, the theory behind it and its measurement thus far. They were trained in conducting interviews.

Interviews. The face-to-face interviews were semi-structured, using the critical incident approach (Flanagan, 1954). Interviews lasted about 45 minutes and were audio-recorded and transcribed. Interviews were administered by four interviewers who worked in pairs.

Transcripts of the interviews comprised information on all eight scales of the EMCQ, as well as on topics the interviewees volunteered: Each of the interviews started with the interviewee providing an error that had occurred in the past. The interviewee was then asked to indicate how the error had been dealt with within the organization. Interviewers asked questions for clarification and elaboration purposes (e.g. “Can you be more specific?” or “What happened then?”) and established whether the example provided by the interviewee was typical (e.g. “Is this what is generally done in this organization?”). When about half of the time planned for the interview had passed, the interviewers checked whether all EMCQ scales were covered by the interviewee. If this was not the case, the interviewers specifically inquired about topics not yet covered (e.g. “Are errors ever covered up?”).
Coding of transcripts. Before the interviews were coded, I divided each of the transcripts into segments, containing one main question along with the interviewee’s answer, clarification and elaboration questions, and subsequent answers. This resulted in 237 segments.

Two pairs of judges (the same as the interviewers, but now with the pairs mixed) then coded all transcript units: The two pairs of judges assessed (1) whether a transcript unit contained information with respect to one (or more) of the eight original EMCQ/EOQ scales (eight categories), and/or (2) whether a transcript unit contained information with respect to one (or more) of the eight original EMCQ/EOQ scales, where the interviewee’s response was not specifically covered by any of the items of the original scale (eight categories), and/or (3) whether the interviewee’s response provided information on the organizational error culture that was not covered by any of the original scales (one category, to be further analyzed). The coding scheme thus contained seventeen categories.

Two transcripts were randomly picked to train the judges with respect to the coding procedure. The remaining eighteen transcripts were independently coded by the two pairs of judges. In total 347 codes were assigned\(^1\). The coding agreement between the two pairs of judges (Cohen’s Kappa) was .54. The pairs discussed codings on which there was disagreement. If necessary, the first author then made the final decision.

\(^1\) The reason that the number of assigned codes exceeds the number of segments, is that some segments contained information on more than one topic.
Development of new items. Codings and interview quotes were used to validate the original eight scales and items, develop additional items for the existing scales, and develop new scales. Topics covered by items of the original eight scales were accounted for in the interviews. Further, topics related to original scales, but not covered by any of their items, and new topics were found in the transcripts. These were used to develop new items for existing scales and new items for development of new scales. Working in pairs, the students developed new items. After that, a meeting was held in which these new items were discussed by all parties (students and myself). In this meeting we discussed (too much) overlap between items developed by the two pairs, and phrasing of the items.

We developed 42 new items for existing scales. In 19 instances these concerned negative phrasings of the topic of the scale (e.g. “We can easily let go of negative feelings associated with errors”, for the scale Strain). Twenty-three newly developed items specifically aimed at topics belonging to an existing scale, but not yet covered by it (e.g. “We try to organize our work in such a way that correction of errors will be as easy as possible”, for the scale Correction). Nineteen items for four new topics were developed. These four topics are: helping each other (e.g. “A person that makes an error will be helped by others”), acceptance of errors (e.g. “In order to achieve long term success, errors in the short term have to be accepted”), error prevention (e.g. “Our aim is to work without errors”) and attribution for failure (e.g. “When something goes wrong, people tend to look for circumstantial causes rather than question their own course of action” (negative)). In total 61 new items were developed. One of the original 37 items (“In this organization, people get upset and irritated if an error occurs”) was rephrased into two separate items, using the same
wording, with “irritated” in the one, and “upset” in the other item. Thus, the initial version of the new questionnaire contains 99 items.

The goals of the second study in this chapter are (a) to select items and develop scales and underlying dimensions for the improved questionnaire, and (b) to place error culture dimensions in a nomological net with other, more general culture scales. For this purpose the 99 items developed in the first study, and two additional questionnaires based on Quinn’s (1988) competing values model were administered in a large sample.

Quinn’s (1988) model describes four organizational perspectives: Human relations, open systems, rational goal and internal process. Organizations with an human relations approach emphasize concern, commitment, morale, discussion, participation and openness. Organizations with an open systems approach emphasize insight, innovation, adaptation, external support, resource acquisition and growth. Organizations with a rational goal approach emphasize accomplishment, productivity, profit, goal clarification, direction and decisiveness. Organizations with an internal process approach emphasize measurement, documentation, information management, stability, control and continuity. The questionnaires used in Study 2 have separate scales for each of the four approaches of Quinn’s model.

Study 2: Methods

Participants, Procedure and Measures. First year Psychology students (N=479, 73% women, 27% men, average age 25.4) participated in an obligatory survey in which numerous questionnaires had to be completed.
In the Netherlands it is common that students work (part-time) during their studies. Therefore we took this opportunity to ask about the error culture of their organization. Participants were instructed to keep in mind that organization they were most familiar with\(^2\). We asked for how long they had been working there, and for how many hours per week. Finally, we asked them how familiar they were (very familiar, familiar, reasonably familiar, poorly, not familiar) with the organization. Participants that had indicated that they were poorly or not familiar with the organization (N=59) were excluded from the sample. Average number of months of employment in the organization was 22.79 (SD=36.20), with on average 23.20 hours per week (SD=13.67). The sample includes over forty different lines of industry with a few students active in each of them. There were two often-mentioned lines of industry: Retail (N = 86) and catering (N = 100).

All participants were instructed to fill out the initial version of the ECQ (99 items). Further, about half of the sample (N = 176) also completed two additional organizational culture scales: The FOCUS questionnaire (Van Muijen, 1994; Van Muijen, Koopman & De Witte, 1996), and the climate perception questionnaire (Van Vianen & Kmieciak, 1998; Van Vianen, in press). Both questionnaires are based on the Competing Values Framework of Quinn (1988). The climate perception questionnaire comprises 13 scales (with 5 to 7 items per scale) organized in the four quadrants of Quinn’s model: The human relations approach is covered by six scales:

\(^2\) To work against the possibility that participants would indicate that they had never worked thereby seeking for a reason for skipping the questionnaire, we instructed them that if this were the case they had to fill in the questionnaire concerning the organization where one of the parents, their partner or friend worked. 20 students indicated that they had never worked, and were excluded from the analyses.
Peer cohesion (support from colleagues), open communication (differences of opinion are discussed in the group), positive feedback (high performance is acknowledged), friendship (friendly relations exist among colleagues), participation (participation in decision making), and development of human resources (opportunity to develop oneself). The open systems approach is covered by two scales: Image (pride of working for the organization), and innovation (willingness to take risks in order to innovate). The rational goal approach is covered by four scales: reward (positive relationship between performance and salary or bonuses), work pressure (high demands), competition (goal is to be better than your colleagues), and morale (putting much effort into one’s work). The internal process approach is covered by one scale: regulation (fixed procedures). Cronbach’s alpha’s vary from .80 to .92. Scores on scales in the same approach were averaged. The FOCUS questionnaire has one scale for each approach. Scales have 6 to 8 items; Cronbach’s alpha ranged from .80 to .93.

Results

Modeling strategy. The sample was randomly divided in two parts of equal size. One half was used to develop scales using structural equation modeling (calibration sample, $N = 199$). The other half was used for confirmatory factor analysis (confirmation sample, $N = 200$). All model tests were based on the covariance matrix and used maximum likelihood estimation as implemented in LISREL VIII (Jöreskog & Sörbom, 1996a; 1996b). No correlations were allowed between residuals.

Item selection. The calibration sample was used for selection of items. One by one, scales were formed. For each of the scales, all possible items (based on content,
varying from 5 to 11 items per scale) were entered, with the scale defined as the latent variable. Modification indices, residuals, standardized parameter estimates, explained variance by the latent variable and content of items were used as selection criteria. With respect to content, two considerations predominated: (1) redundancy; when two items were highly correlated, the best one was kept, and (2) overlap with other scales; some items addressed more than one topic (e.g. “In this organization, people think a lot about how an error could have been avoided.” relating to both error analysis and error prevention). All of the items displaying such overlap were removed.

Satisfactory fit indices and alpha’s (see Table 1a) were obtained for all but one scale: Attribution for failure. This scale was excluded from further analyses. The eleven newly developed scales contained either 4 or 5 items. Reassessment of the scales in the confirmation sample yielded similar fit indices and alpha’s (see Table 1b). The Appendix at the end of this chapter shows the selected items with accompanying standardized parameter estimates and residuals. The full model with all eleven scales had a poor fit (GFI = .71). The research described in Chapters 2 and 3 already revealed that with error culture underlying dimensions were at work. Therefore, a model containing larger dimensions was built.
Table 1a

*Scales developed in the calibration sample*

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Table 1b

*Scales validated in confirmation sample*

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<td>1.00</td>
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</table>

\( N = 200 \)
Table 2

Correlations between error culture scales

<table>
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<td>2. Learning</td>
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<td></td>
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<tr>
<td>3. Correction</td>
<td>.35**</td>
<td>.23**</td>
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<tr>
<td>4. Helping</td>
<td>.51**</td>
<td>.43**</td>
<td>.66**</td>
<td></td>
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<td>5. Communication</td>
<td>.73**</td>
<td>.46**</td>
<td>.46**</td>
<td>.58**</td>
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<td>6. Anticipation</td>
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<td>.46**</td>
<td>.40**</td>
<td>.46**</td>
<td>.30**</td>
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<td>7. Risk taking</td>
<td>.13#</td>
<td>.35**</td>
<td>.10</td>
<td>.23**</td>
<td>.21**</td>
<td>.47**</td>
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<tr>
<td>8. Acceptance</td>
<td>.11</td>
<td>.47**</td>
<td>.18*</td>
<td>.42**</td>
<td>.25**</td>
<td>.59**</td>
<td>.70**</td>
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<td>9. Strain</td>
<td>.05</td>
<td>-.18*</td>
<td>-.13#</td>
<td>-.25**</td>
<td>-.08</td>
<td>-.26**</td>
<td>-.37**</td>
<td>-.55**</td>
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<tr>
<td>10. Covering up</td>
<td>-.21**</td>
<td>-.22**</td>
<td>-.32**</td>
<td>-.36**</td>
<td>-.35**</td>
<td>-.33**</td>
<td>-.23**</td>
<td>-.34**</td>
<td>.48**</td>
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<td>10. Error prevention</td>
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<td>-.11</td>
<td>.17*</td>
<td>-.00</td>
<td>-.00</td>
<td>-.19**</td>
<td>-.31**</td>
<td>-.41**</td>
<td>.41**</td>
<td>.21**</td>
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</table>
**Larger dimensions.** Based on the eleven scales, larger dimensions were formed. In order to do this I analyzed correlations among scales (see Table 2), but primarily based development of larger dimensions on theoretical grounds. Similar to the approach used for forming the eleven scales, possible scales to be combined in a larger dimension, were entered with the dimension defined as the latent variable.

<table>
<thead>
<tr>
<th>Table 3a</th>
</tr>
</thead>
</table>

**Full model developed in the callibration sample**

<table>
<thead>
<tr>
<th>Model Description</th>
<th>$\chi^2$</th>
<th>df</th>
<th>P</th>
<th>RMSEA</th>
<th>RMR</th>
<th>GFI</th>
<th>AGFI</th>
<th>CFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Model (8 scales, 4 factors)</td>
<td>58.00</td>
<td>14</td>
<td>.000</td>
<td>.13</td>
<td>.05</td>
<td>.93</td>
<td>.82</td>
<td>.92</td>
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<tr>
<td>Full Model (11 scales, 4 factors)</td>
<td>212.88</td>
<td>38</td>
<td>.000</td>
<td>.15</td>
<td>.07</td>
<td>.84</td>
<td>.72</td>
<td>.80</td>
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<tr>
<td>3-factor model</td>
<td>76.58</td>
<td>17</td>
<td>.000</td>
<td>.13</td>
<td>.05</td>
<td>.91</td>
<td>.81</td>
<td>.90</td>
</tr>
<tr>
<td>2-factor model</td>
<td>87.64</td>
<td>19</td>
<td>.000</td>
<td>.14</td>
<td>.06</td>
<td>.90</td>
<td>.81</td>
<td>.88</td>
</tr>
<tr>
<td>1-factor model</td>
<td>287.43</td>
<td>20</td>
<td>.000</td>
<td>.26</td>
<td>.09</td>
<td>.73</td>
<td>.52</td>
<td>.59</td>
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</table>

$N = 199$

<table>
<thead>
<tr>
<th>Table 3b</th>
</tr>
</thead>
</table>

**Full model validated in the confirmation sample**

<table>
<thead>
<tr>
<th>Model Description</th>
<th>$\chi^2$</th>
<th>df</th>
<th>P</th>
<th>RMSEA</th>
<th>RMR</th>
<th>GFI</th>
<th>AGFI</th>
<th>CFI</th>
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</thead>
<tbody>
<tr>
<td>Full Model (8 scales, 4 factors)</td>
<td>74.86</td>
<td>14</td>
<td>.000</td>
<td>.15</td>
<td>.05</td>
<td>.91</td>
<td>.78</td>
<td>.89</td>
</tr>
<tr>
<td>Full Model (11 scales, 4 factors)</td>
<td>214.54</td>
<td>38</td>
<td>.000</td>
<td>.15</td>
<td>.06</td>
<td>.84</td>
<td>.72</td>
<td>.80</td>
</tr>
<tr>
<td>3-factor model</td>
<td>89.64</td>
<td>17</td>
<td>.000</td>
<td>.15</td>
<td>.05</td>
<td>.90</td>
<td>.78</td>
<td>.88</td>
</tr>
<tr>
<td>2-factor model</td>
<td>93.99</td>
<td>19</td>
<td>.000</td>
<td>.14</td>
<td>.06</td>
<td>.80</td>
<td>.80</td>
<td>.86</td>
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<tr>
<td>1-factor model</td>
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<td>.000</td>
<td>.23</td>
<td>.07</td>
<td>.78</td>
<td>.61</td>
<td>.62</td>
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</tbody>
</table>

$N = 200$
Initially, four dimensions were developed in the calibration sample (see Table 3a) and validated in the confirmation sample (see Table 3b). These were (1) Mastery containing the analysis, correction and learning scales, (2) Social containing the helping and communication scales (3) Awareness, containing the anticipation, risk taking and acceptance scales, and (4) Error Aversion containing the strain, covering up, and error prevention scales. This initial model yielded poor fit indices (see Table 3a). Modification indices, residuals, standardized parameter estimates, explained variance by the latent variable and content of items were used as further selection criteria. With respect to content, considerations of redundancy and overlap with other dimensions were used. Three scales were removed: Analysis, anticipation and covering up. The resulting eight scale, four dimension model yielded reasonable fit indices (see Table 3a). The testing of the same models in the confirmation sample yields similar results (see Table 3b). A Chi-square difference test revealed that the eight scales, four dimension model had an significant improvement over the twelve scales four dimensions model ($\chi^2\Delta = 154.88$, df$\Delta = 24$, $p < .001$ in callibration sample, $\chi^2\Delta = 139.68$, df$\Delta = 24$, $p < .001$ in confirmation sample). Additionally, the eight scales, four dimensions model was tested against a one-factor model and was found to be superior ($\chi^2\Delta = 229.43$, df$\Delta = 6$, $p < .001$ in callibration sample, $\chi^2\Delta = 147.62$, df$\Delta = 6$, $p < .001$ in confirmation sample).
### Table 4

*Correlations between error culture dimensions and the four competing values*

<table>
<thead>
<tr>
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<th>1</th>
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<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Master</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Social</td>
<td>.67**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Awareness</td>
<td>.37**</td>
<td>.34**</td>
<td></td>
<td></td>
</tr>
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<td>4. Aversion</td>
<td>-.10*</td>
<td>-.11*</td>
<td>-.52**</td>
<td></td>
</tr>
<tr>
<td>5. Human Relations (Climate Perception)</td>
<td>.36**</td>
<td>.59**</td>
<td>.32**</td>
<td>-.33**</td>
</tr>
<tr>
<td>(FOCUS)</td>
<td>.27**</td>
<td>.51**</td>
<td>.29**</td>
<td>-.38**</td>
</tr>
<tr>
<td>6. Open Systems (Climate Perception)</td>
<td>.27**</td>
<td>.41**</td>
<td>.23**</td>
<td>-.16*</td>
</tr>
<tr>
<td>(FOCUS)</td>
<td>.37**</td>
<td>.56**</td>
<td>.27--</td>
<td>-.33**</td>
</tr>
<tr>
<td>7. Rational Goals (Climate Perception)</td>
<td>.06</td>
<td>-.01</td>
<td>-.09</td>
<td>.27**</td>
</tr>
<tr>
<td>(FOCUS)</td>
<td>.31**</td>
<td>.26**</td>
<td>-.15*</td>
<td>.17*</td>
</tr>
<tr>
<td>8. Internal Process (Climate Perception)</td>
<td>.41**</td>
<td>.51**</td>
<td>.06</td>
<td>-.12</td>
</tr>
<tr>
<td>(FOCUS)</td>
<td>.31**</td>
<td>.25**</td>
<td>-.22**</td>
<td>.19*</td>
</tr>
</tbody>
</table>

*N = 399 for error culture dimensions; N = 176 for ‘competing values’; * p < .05; ** p < .01. All tests are two-tailed.*

Low, medium sized and high correlations are found among the four dimensions. A high positive correlation was found between the Mastery and Social dimensions. A high negative correlation was found between the Aversion and Awareness dimension (see Table 4). For this reason, two additional models were tested against the eight scales, four dimensions model. First, a three dimension model, in which the correction, learning, communication and helping scales are combined in one dimension. A Chi-square difference test shows that this model is inferior ($\chi^2_\Delta = 18.58$, df$_\Delta = 3$, $p < .001$ in calibration sample, $\chi^2_\Delta = 14.78$, df$_\Delta = 3$, $p < .01$ in confirmation sample). Second, a two-factor model in which the correction, learning, communication and helping scales are combined in one dimension, and the risk
taking, acceptance, strain and error prevention scales are combined in another
dimension. A Chi-square difference test shows that this model is inferior ($\chi^2\Delta = 29.64$, df$\Delta = 5$, $p < .001$ in callibration sample, $\chi^2\Delta = 19.13$, df$\Delta = 5$, $p < .01$ in confirmation sample). Cronbach’s alpha’s of the four dimensions are satisfactory
(Mastery, $k = 9$, alpha = .75; Social, $k = 9$, alpha = .82; Awareness, $k = 8$, alpha = .85; Error Aversion, $k = 9$, alpha = .76).

Nomological net. Correlations of the four error culture dimensions (Mastery, Social, Awareness and Error Aversion) with the scales based on Quinn’s (1988) competing values model were calculated (see Table 4). The Mastery dimension is moderately correlated with all four approaches. The Social dimension is particularly highly correlated with the human relations and open systems approaches. The Awareness dimension is moderately correlated with the human relations and open systems approaches. The Error Aversion dimension is moderately negatively correlated with the human relations and open systems approaches.

Discussion

The interviews in the first study of this chapter resulted in the development of a total of 62 new items for existing and new scales. In the second study of this chapter eleven scales were initially developed and validated. These scales did not yield acceptable fit indices in the full model. Therefore, underlying dimensions were investigated. A full model with four dimensions, based on eight scales was developed and validated: The Mastery dimension comprised correction and learning, the Social
dimension comprised helping and communication, the Awareness dimension comprised risk taking and acceptance, and the Error Aversion dimension comprised strain and error prevention. This model was tested against alternative models, and each case found to be significantly superior. Thus, although fit indices of the newly developed model are not extremely high, the model is superior to alternative models.

The four dimensions are differently associated with the four approaches of Quinn’s (1988) competing values model: The Mastery dimension is moderately related to all four approaches, the human relations approach with its emphasis on concern, commitment, morale, discussion, participation and openness, the open systems approach with its emphasis on insight, innovation, adaptation, external support, resource acquisition and growth, the rational goal approach with its emphasis on accomplishment, productivity, profit, goal clarification, direction and decisiveness, and finally, the internal process approach with its emphasis on measurement, documentation, information management, stability, control and continuity. The Social dimension is highly correlated with the human relations and open systems approaches, and less strongly correlated with the rational goal and internal process approaches. The Awareness dimension is moderately positive related to the human relations and open systems approaches. The Error Aversion dimension is moderately and negatively related to the human relations and open systems approaches.
References


Appendix

Items organizational error management culture and subjective organizational performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Original scaling</th>
<th>Final scaling</th>
<th>Residuals cal/conf²</th>
<th>SPE² cal/conf²</th>
<th>Underlying dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Although we make mistakes, we don’t let go of the final goal.</td>
<td>Correction</td>
<td>Correction</td>
<td>.59/.56</td>
<td>.63/.54</td>
<td>Mastery</td>
</tr>
<tr>
<td>In this organization, people think a lot about how an error could have been avoided.</td>
<td>Analyzing</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>After an error, people think through how to correct it.</td>
<td>Analyzing</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>After an error has occurred, it is analyzed thoroughly</td>
<td>Analyzing</td>
<td>Analyzing</td>
<td>.69/.46</td>
<td>.90/.95</td>
<td>–</td>
</tr>
<tr>
<td>If something went wrong, people take the time to think it through.</td>
<td>Analyzing</td>
<td>Analyzing</td>
<td>.52/.63</td>
<td>.79/.65</td>
<td>–</td>
</tr>
<tr>
<td>After making a mistake, people try to analyze what caused it.</td>
<td>Analyzing</td>
<td>Analyzing</td>
<td>.71/.74</td>
<td>.74/.66</td>
<td>–</td>
</tr>
<tr>
<td>In this organization we think that it is useful to analyze errors.</td>
<td>–</td>
<td>Analyzing</td>
<td>.56/.47</td>
<td>.81/.85</td>
<td>–</td>
</tr>
<tr>
<td>For us, errors are very useful for improving the work process.</td>
<td>Learning</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>An error provides important information for the continuation of the work.</td>
<td>Learning</td>
<td>Learning</td>
<td>.99/.90</td>
<td>.35/.39</td>
<td>Mastery</td>
</tr>
<tr>
<td>Our errors point us to what we can improve.</td>
<td>Learning</td>
<td>Learning</td>
<td>.56/.64</td>
<td>.74/.62</td>
<td>Mastery</td>
</tr>
<tr>
<td>In mastering a task, people can learn a lot from their mistakes.</td>
<td>Learning</td>
<td>Learning</td>
<td>.33/.42</td>
<td>.82/.86</td>
<td>Mastery</td>
</tr>
<tr>
<td>For getting better at what we do, errors provide a good source for learning.</td>
<td>–</td>
<td>Learning</td>
<td>.61/.39</td>
<td>.82/.86</td>
<td>Mastery</td>
</tr>
<tr>
<td>When an error has occurred, we usually know how to rectify it.</td>
<td>Correction</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>When an error is made, it is corrected right away.</td>
<td>Correction</td>
<td>Correction</td>
<td>.36/.42</td>
<td>.68/.64</td>
<td>Mastery</td>
</tr>
<tr>
<td>Item</td>
<td>Original scaling</td>
<td>Final scaling</td>
<td>Residuals cal/conf&lt;sup&gt;a&lt;/sup&gt;</td>
<td>SPE&lt;sup&gt;2&lt;/sup&gt; cal/conf&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Underlying dimension</td>
</tr>
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<td>----------------------------------------------------------------------</td>
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<td>---------------------------------</td>
<td>--------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Although we make mistakes, we don’t let go of the final goal.</td>
<td>Correction</td>
<td>Correction</td>
<td>.59/.56</td>
<td>.63/.54</td>
<td>Mastery</td>
</tr>
<tr>
<td>We try to organize our work in such a way that correction of errors</td>
<td>–</td>
<td>Correction</td>
<td>.46/.49</td>
<td>.69/.54</td>
<td>Mastery</td>
</tr>
<tr>
<td>will be as easy as possible.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quick and adequate correction of errors has high priority.</td>
<td>–</td>
<td>Correction</td>
<td>.51/.40</td>
<td>.50/.59</td>
<td>Mastery</td>
</tr>
<tr>
<td>A person that makes an error will be helped by others.</td>
<td>–</td>
<td>Helping</td>
<td>.46/.56</td>
<td>.60/.50</td>
<td>Social</td>
</tr>
<tr>
<td>When people are unable to correct an error by themselves, they turn</td>
<td>Communication</td>
<td>Helping</td>
<td>.24/.24</td>
<td>.57/.54</td>
<td>Social</td>
</tr>
<tr>
<td>to their colleagues.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If people are unable to continue their work after an error, they can</td>
<td>Communication</td>
<td>Helping</td>
<td>.34/.37</td>
<td>.66/.64</td>
<td>Social</td>
</tr>
<tr>
<td>rely on others.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>When people make an error they can ask others for advice on how to</td>
<td>Communication</td>
<td>Helping</td>
<td>.79/.86</td>
<td>.51/.33</td>
<td>Social</td>
</tr>
<tr>
<td>continue.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When someone makes an error, (s)he shares it with others so that</td>
<td>Communication</td>
<td>Communication</td>
<td>.71/.88</td>
<td>.70/.56</td>
<td>Social</td>
</tr>
<tr>
<td>they won’t make the same mistake.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In general, people warn each other about errors that might come up.</td>
<td>–</td>
<td>Communication</td>
<td>.67/.73</td>
<td>.38/.28</td>
<td>Social</td>
</tr>
<tr>
<td>Since errors and their solutions provide important information for</td>
<td>–</td>
<td>Communication</td>
<td>.59/.49</td>
<td>.85/.83</td>
<td>Social</td>
</tr>
<tr>
<td>our work, we discuss them.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Errors are discussed amongst colleagues.</td>
<td>–</td>
<td>Communication</td>
<td>.26/.42</td>
<td>.99/.85</td>
<td>Social</td>
</tr>
<tr>
<td>Errors are discussed openly.</td>
<td>–</td>
<td>Communication</td>
<td>.43/.52</td>
<td>.85/.81</td>
<td>Social</td>
</tr>
<tr>
<td>In this organization, people are often surprised by their mistakes.</td>
<td>Anticipation</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>It is very likely that people will make errors in the process of</td>
<td>Anticipation</td>
<td>Anticipation</td>
<td>.72/.81</td>
<td>.50/.48</td>
<td>–</td>
</tr>
<tr>
<td>mastering their task.</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

<sup>a</sup> cal/conf: critical value/confidence interval

Error culture questionnaire
<table>
<thead>
<tr>
<th>Item</th>
<th>Original scaling</th>
<th>Final scaling</th>
<th>Residuals cal/conf $^a$</th>
<th>SPE$^{(2)}$ cal/conf $^a$</th>
<th>Underlying dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>When people start to work on something, they are aware that errors can occur. In this organization we take the occurrence of errors into account.</td>
<td>Anticipation</td>
<td>Anticipation</td>
<td>.43/.35</td>
<td>.58/.48</td>
<td>–</td>
</tr>
<tr>
<td>In this organization we take the occurrence of errors into account.</td>
<td>Anticipation</td>
<td>Anticipation</td>
<td>.79/.64</td>
<td>.51/.57</td>
<td>–</td>
</tr>
<tr>
<td>In this organization, we take into account that errors will be made from time to time.</td>
<td>Anticipation</td>
<td>Anticipation</td>
<td>.54/.65</td>
<td>.55/.53</td>
<td>–</td>
</tr>
<tr>
<td>We would rather make mistakes than do nothing.</td>
<td>Risk taking</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>For an organization to achieve something, it has to risk the occurrence of errors.</td>
<td>Risk taking</td>
<td>Risk taking</td>
<td>.50/.47</td>
<td>.85/.84</td>
<td>Awareness</td>
</tr>
<tr>
<td>It’s fine to risk an error every once in a while.</td>
<td>Risk taking</td>
<td>Risk taking</td>
<td>.51/.77</td>
<td>.83/.73</td>
<td>Awareness</td>
</tr>
<tr>
<td>To get better in what we do, we don’t mind that something can go wrong in the process.</td>
<td>Risk taking</td>
<td>Risk taking</td>
<td>.75/.52</td>
<td>.66/.66</td>
<td>Awareness</td>
</tr>
<tr>
<td>Taking calculated risks is encouraged in this organization.</td>
<td>–</td>
<td>Risk taking</td>
<td>.83/.88</td>
<td>.72/.63</td>
<td>Awareness</td>
</tr>
<tr>
<td>Errors are accepted in this organization.</td>
<td>–</td>
<td>Acceptance</td>
<td>.40/.66</td>
<td>.85/.75</td>
<td>–</td>
</tr>
<tr>
<td>It is okay to make an error.</td>
<td>–</td>
<td>Acceptance</td>
<td>.61/.41</td>
<td>.84/.93</td>
<td>Awareness</td>
</tr>
<tr>
<td>It is impossible to work without making errors.</td>
<td>–</td>
<td>Acceptance</td>
<td>.88/1.01</td>
<td>.65/.53</td>
<td>Awareness</td>
</tr>
<tr>
<td>In order to achieve long term success, we must accept errors in the short term.</td>
<td>–</td>
<td>Acceptance</td>
<td>.87/.73</td>
<td>.58/.65</td>
<td>Awareness</td>
</tr>
<tr>
<td>In this organization, people feel stressed when making mistakes.</td>
<td>Error strain</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>In general, people in this organization feel embarrassed after making a mistake.</td>
<td>Error strain</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>People in this organization are often afraid of making errors.</td>
<td>Error strain</td>
<td>Error strain</td>
<td>.79/.67</td>
<td>.64/.72</td>
<td>Error Aversion</td>
</tr>
<tr>
<td>Item</td>
<td>Original scaling</td>
<td>Final scaling</td>
<td>Residuals cal/conf</td>
<td>SPE (1) cal/conf</td>
<td>Underlying dimension</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------</td>
<td>---------------</td>
<td>-------------------</td>
<td>-----------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>In this organization, people get upset if an error occurs.</td>
<td>Error strain</td>
<td>Error strain</td>
<td>.65/.64</td>
<td>.66/.65</td>
<td>Error Aversion</td>
</tr>
<tr>
<td>In this organization, people get irritated if an error occurs.</td>
<td>Error strain</td>
<td>Error strain</td>
<td>.71/.54</td>
<td>.71/.74</td>
<td>Error Aversion</td>
</tr>
<tr>
<td>During their work, people are often concerned that errors might occur.</td>
<td>Error strain</td>
<td>Error strain</td>
<td>.78/.83</td>
<td>.61/.48</td>
<td>Error Aversion</td>
</tr>
<tr>
<td>People in this organization are often relieved if someone other than they themselves, makes an error.</td>
<td>–</td>
<td>Error strain</td>
<td>.86/.74</td>
<td>.68/.71</td>
<td>Error Aversion</td>
</tr>
<tr>
<td>Our motto is; “Why admit an error when no one will find out?”</td>
<td>Covering up</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>There is no point in discussing errors with others.</td>
<td>Covering up</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>There are advantages in covering up one’s errors.</td>
<td>Covering up</td>
<td>Covering up</td>
<td>1.03/.85</td>
<td>.48/.54</td>
<td>–</td>
</tr>
<tr>
<td>People prefer to keep their errors to themselves.</td>
<td>Covering up</td>
<td>Covering up</td>
<td>.67/.62</td>
<td>.59/.61</td>
<td>–</td>
</tr>
<tr>
<td>Employees that admit their errors are asking for trouble.</td>
<td>Covering up</td>
<td>Covering up</td>
<td>.41/.55</td>
<td>.79/.81</td>
<td>–</td>
</tr>
<tr>
<td>It can be harmful to make your errors known to others.</td>
<td>Covering up</td>
<td>Covering up</td>
<td>.56/.62</td>
<td>.76/.67</td>
<td>–</td>
</tr>
<tr>
<td>Our goal is to work without errors.</td>
<td>–</td>
<td>Prevention</td>
<td>.87/.85</td>
<td>.56/.54</td>
<td>–</td>
</tr>
<tr>
<td>We can work without errors, if we put effort in it.</td>
<td>–</td>
<td>Prevention</td>
<td>.83/.83</td>
<td>.78/.64</td>
<td>Error Aversion</td>
</tr>
<tr>
<td>Making errors is unnecessary.</td>
<td>–</td>
<td>Prevention</td>
<td>.70/.69</td>
<td>.61/.63</td>
<td>Error Aversion</td>
</tr>
<tr>
<td>For an organization to survive, it is essential to work without errors.</td>
<td>–</td>
<td>Prevention</td>
<td>.74/.92</td>
<td>.74/.51</td>
<td>Error Aversion</td>
</tr>
</tbody>
</table>

2. SPE: Standadized Parameter Estimates.
Summary, Conclusions and Future Research

With the kick off at Mount Everest, I have tried to share with you my (non-active) fascination with high-altitude mountaineering. More importantly, though, the introductory chapter addressed, in an anecdotal manner, the major issues of this dissertation. In spite of the quote at the start of the introductory chapter, errors do appear, even in "environments so extreme that there is no room for them". People (expedition leaders) differ in their convictions on the best approach when it comes to errors (as well as violations and forces of nature): On the one hand there are the legalists who rely mainly on rules that should prevent disasters. On the other hand there are the situationalists who are convinced that dangerous situations cannot always be prevented by rules, and who are therefore more focussed on the best ways of dealing with a dangerous situation when it presents itself. Whatever convictions underlie an error approach, the occurrence of errors has to be taken into account. Certainly, in both expeditions, with their somewhat different convictions, plenty errors occurred.

What I tried to illustrate further, was that convictions of leaders are not just that. These convictions instill a shared approach among members of the expedition. An example of this is given when client Krakauer — an experienced mountaineer himself — neglected to recognize that guide Harris was hypoxic. Krakauer explains
that in another expedition he would not have been likely to overlook this. What his explanation comes down to, is that — in the Adventure Consultants' expedition — a culture was enforced in which clients were to rely on the judgement calls of their guides, where these judgements were not questioned, and where rules were to be obeyed. The 1996 summit bid tells a tale of shared beliefs, attitudes, norms and behavioral approaches: It tells a tale of error cultures. This Everest tale is an anecdotal one, in need of systematic empirical founding.

What exact questions need to be addressed in empirical research? First of all, whether there is such a thing as an error culture. That is, whether beliefs, attitudes, norms and behavioral approaches with respect to errors are shared in expeditions, teams and organizations. Chapter 2 described a pilot study, in which the ideas of an error culture were tested in teams that participated in a management game. The sufficiently high intra-group consensus values indicate that indeed 'error orientations' are shared within a team. Similarly, sufficiently high values were found on two of the three error culture dimensions in the survey described in Chapter 3. Additionally, the interview study of Chapter 3 revealed (high) positive correlations between managers from the same company. I conclude that beliefs, attitudes, norms and behavioral approaches with respect to errors can be shared: There is such a thing as error culture.

A second important question is whether one error culture is better than the other. That is, whether there are specific beliefs, attitudes, norms and behavioral approaches that are especially productive for dealing with errors. To address this question, I built on three broad lines of research. The first and most prominent one is concerned with the
error management ideas (Frese, 1991). In Chapters 2 and 3 I discussed empirical research on error orientation (Rybowiak, Garst, Frese & Batinic, 1999; Göbel, 1998; Göbel, and Frese, 1999), error training (e.g. Frese, 1995), and the independent research of Edmondson (1996) whose ideas can be linked to those of error management. The second line of research is discussed in Chapter 2 and relates to two general orientations related to overcoming failure (Dweck, & Legget, 1988). The third line of research is discussed in Chapter 3. It entails ideas developed in the literature on Total Quality Management (Sitkin, Sutcliffe & Schroeder, 1994), High Reliability Organizations (Rochlin, 1999), exploitation versus exploration (March, 1991), and the Learning Organization (Argyris, 1992). The argument made here relates to the goals of Control and Learning (Sitkin, et al., 1994). In all, I argue that errors cannot always be avoided, nor need they always be avoided. Most important is that error's negative consequences are avoided (goal of Control). Further, I argue that errors can also have positive consequences that should be fostered (goal of Learning).

The introductory chapter described anecdotal evidence that attests that errors can be managed even in an environment as extreme as Mount Everest. I suggested that an error management culture - which is best illustrated by Boukreev's 1997 expedition - is superior. In Chapters 2 and 3 this hypothesis was tested empirically. I chose to test the superiority of an error management culture by investigating its relationship with (team and organizational) performance. The pilot study described in Chapter 2 revealed a negative correlation between the Error Aversion dimension and team performance. The survey described in Chapter 3 revealed a positive correlation between the Mastery dimension and both subjective and objective measures of organizational performance. This effect was upheld when controlling for size and age
of the organization and the line of industry it is active in. Very encouraging in this respect are two recent replications of these effects, one in Germany (Baer, 1999), and one in China (Wang & Van Dyck, 1999). In Germany, a positive correlation was found between the Mastery dimension and organizational performance (in this study, the Awareness and Error Aversion dimensions were not measured). In China, a positive correlation between the Mastery dimension and organizational performance, and a negative correlation between the Error Aversion dimension and organizational performance were found.

The qualitative study described in Chapter 3 supported the importance of the Mastery and Error Aversion dimensions. The interviews additionally focussed at a particular expression of organizational error culture; managers' reaction to subordinates' errors. Two dimensions surfaced; punishment and empathy.

A third question I addressed in this dissertation is whether error culture was optimally measured. The questionnaire used in Chapters 2 and 3 was directly adapted from the Error Orientation Questionnaire (Rybowiak, et al., 1999), which is aimed at the measurement of the error orientation of individuals. This direct adaptation may have resulted in an underestimation of social aspects of error culture. Chapter 4 describes a qualitative study in which interviews are conducted with the explicit goal of identifying lacunas in the original questionnaire. Sixty-two new items were developed, which, together with the original thirty-seven items, were administered in a large sample (see also Chapter 4). This sample was divided into a calibration and confirmation sample. Items were selected, and sub-scales and underlying dimensions were formed with the use of structural equation modeling (LISREL). The new
questionnaire comprises four main dimensions: Mastery orientation, Social orientation, Awareness and Error Aversion. Three new sub-scales need specific mentioning; helping as an aspect of the Social orientation, acceptance of errors as an aspect of the Awareness dimension, and error prevention as an aspect of the Error Aversion dimension.

A fourth question concerned the relationship between error culture and other — more general — aspects of organizational culture. To address this issue, I administered additional organizational culture questionnaires (Van Muijen, 1994; Van Muijen, Koopman, & De Witte, 1996; Van Vianen & Kmieciak, 1998; Van Vianen, in press) in a sub-sample of the survey described in Chapter 4. The four dimensions of the error culture questionnaire are placed in a nomological net with the 'competing values' of Quinn's (1988) model.

In a recent study - not described in this dissertation - data have been gathered on the four error culture dimensions and psychological safety (Edmondson, 1999), reflexivity (Schippers, 1999), group potency (Guzzo, Yost, Campbell, & Shea, 1993), communication, innovation, goals, and routines (Team Climate Inventory; Anderson & West, 1994; 1996). Thus, the nomological net will be further investigated.

The research I described in this dissertation addressed the four proposed questions. The following issues need to be investigated in future research. First, causality of the relationship between error culture and organizational performance. As has been argued in Chapter 3, there are, in the error training literature (Frese, 1995), indications that the way errors are dealt with influences performance. Currently, Luus Reijken, a
graduate student at the University of Amsterdam, is conducting an experiment in which group error culture is manipulated, and its causal effect on group performance will be tested. In addition, some possible mediators in the error culture – performance relationship will be investigated. So far, I have argued that error management culture has a positive effect on performance because it helps avoiding negative error consequences and fostering positive error consequences. The specifics, however, still have to be investigated. I propose that issues such as taking responsibility (e.g. Rochlin, 1999), attribution of failure (e.g. Leary & Forsyth, 1987) and psychological safety (Edmondson, 1999) deserve attention in future empirical research. Research on issues of causality and mediation must not be restricted to the artificiality of the laboratory. In time, new insights need to be tested in the field.
References


