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Error management culture in a team management game: A pilot[1]

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

(Frese, 1991). 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

systemic resilience when confronting unknown future changes. Sitkin (1996) argues that success enhances reliability and short term performance, while strategic failure enhances resilience and long term performance. For long term success, Sitkin argues, organizations should encourage strategic failure.

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

	Eta^2	1	2	3	4	5	6	7
1. Analysis	.45**							
2. Learning	.47**	.44**						
3. Recovery	.44*	.50**	.45**					
4. Communication	.37	.60**	.42**	.53**				
5. Anticipation	.45**	.01	.39**	.03	-.04			
6. Risk taking	.40	.04	.52**	.12	.10	.73**		
7. Strain	.34	.30	-.15	.08	.01	-.25	-.37*	
8. Covering up	.33	.03	-.20	-.24	-.20	-.17	-.33*	.62**

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 then 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.

Table 2

Means, standard deviations, eta^2's, Cronbach's alpha's and correlations of team error culture dimensions, goals, and team performance.

	M	SD	Eta^2	Alfa	1	2	3	4	5
1. Mastery	3.80	.27	.48**	.79					
2. Awareness	3.64	.38	.48**	.84	.16				
3. Error Aversion	1.99	.33	.34	.75	-.06	-.33**			
4. Learning goals	4.04	.34	.44	.92	.60**	.40**	-.16		
5. Judgement goals	3.26	.29	.45*	.66	.19	-.03	.40**	.24	
6. Team performance	4844	4185	n.a.	n.a.	.04	-.08	-.26$^{\#}$	.02	-.06

N = 44 teams; * $p < .05$; ** $p < .01$; # $p < .10$, two-tailed tests. n.a. = not applicable.

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.

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 entrepreneural) 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.

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