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Safety rules as instruments for organizational control, coordination and knowledge: Implications for rules management

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ABSTRACT

Recent research in the field of safety science on the limitedness of rules as a measure to achieve safety has coincided with new research in organization science on rules and routines, and their mutual relationship in particular. The present article is an attempt to uncover what the field of safety science can learn from the latter. It outlines three functions of rules in organizations (as a means for organizational control, as coordination mechanism, and as codified organizational knowledge) and applies these to safety rules in high-risk industries. Four common challenges of safety rules, as well as four typical measures of good rules management are illustrated by discussing examples from safety research. These challenges and typical measures of rules management are furthermore examined in terms of the three functions of rules in organizations. The article demonstrates how safety science, by taking a broader perspective, can benefit from organization theory.

1. Introduction

Safety rules are an indispensable part of safety management in high-risk systems. Whether in the form of rule books, checklists, or procedures, safety rules are abundant in industries like power generation, aviation, transportation, medicine, and other high-risk industries. Through prescribing human action and interaction (with other individuals as well as with machines), it is hoped to reduce errors and eliminate risks. Rules are thus usually designed and introduced by experts, based on risk and task analysis, intended to influence and control human behavior. This use of safety rules is ultimately rooted in Scientific Management and the idea of rationalization (Taylor, 1911). A core idea behind the design of safety rules is thus the assumption that work tasks are designable and controllable in a top-down fashion and that organizational control should therefore be used to identify and eliminate safety risks (Berman et al., 2007; Grote, 2009; Hale and Borys, 2013a; McCarthy et al., 1998).

However, there has also been a growing concern in the field of safety science that such an approach to safety may be flawed and that rules in the actual organizational context do not work in such a simplistic way (Amalberti, 2001; Dekker, 2003; Grote et al., 2009; Iszatt-White, 2007; Lawton, 1998; Rasmussen, 1997; Reason et al., 1998; Weichbrodt and Grote, 2008; Woods and Shattuck, 2000). Most recently, Hale and Borys (2013a) presented an extensive review of the literature on the management of safety rules. They contrasted two paradigms of how rules are perceived, used, and managed. Model 1 is characterized by a top-down approach, based on rationality and control, where rules are made by experts and seen as necessary and binding. Accordingly, violations are seen as "bad practice" and are therefore to be sanctioned. In contrast, model 2 recognizes the impossibility of a perfect rules system. Rule violations are seen as inevitable, and should be dealt with by treating local operators as experts in improving the rules. In short, "model 1 sees the solutions in modifying reality to match the rules, while model 2 advocates changing the rules and their definition fundamentally to match reality" (Hale and Borys, 2013a, p. 14). In a companion paper (Hale and Borys, 2013b), the authors then make valuable suggestions for rules management in order to essentially move from model 1 to model 2. In other words, at the core of the issue thus lies the difficulty of differentiating between violations that truly are *bad practice* and violations that instead are the result of *bad rules*.

This difficulty is pinnacled in high-risk systems, where it can represent a matter of life and death. However, insofar as all organizations are rule-based systems, very similar questions arise in virtually all industries or public administrations. The question of how to deal with the gap between written procedures and actual practices is not only relevant to high-risk organizations. Indeed, there is a substantial body of literature in organizational and management theory dealing with issues akin to the ones outlined above (e.g.,

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Cardinal et al., 2004; Desai, 2010; Olin and Wickenberg, 2001; Ortmann, 2010; Reynaud, 2005; Silbey et al., 2009; Tyler and Blader, 2005). This gives reason to the assumption that there are fundamental issues about the functions of rules in organizations (e.g., how to prevent excessive bureaucracy, or how to deal with the inherent abstractness of rules), from which conclusions can also be drawn for the case of safety rules. Research endeavors crossing organization science and safety science have been called for by safety researchers in order to broaden the understanding of the role of humans in technologically complex systems – and ultimately also to increase safety in such systems (Bourrier, 2005).

In this paper, I therefore aim to bridge the two literatures: By discussing selected literature and examples from safety science, I re-examine common challenges of safety rules in high-risk systems, as well as measures intended to deal with these challenges. I apply theory about rules as organizational control, as a coordination mechanism, and as organizational knowledge to each of these issues of safety rules and rules management. By broadening the view and incorporating basic organizational theory, a more fundamental understanding of how rules work (and do not work) in high-risk organizations can be gained.

The paper is organized as follows: First, I briefly review the three functions of rules in organizations. I then discuss four typical challenges of safety rules in high-risk industries and their effect on rules as control, coordination and knowledge. In the third part, I describe four "good practices" of rules management, showing how these practices function in regard to organizational control, coordination and organizational knowledge. Additionally, I will explain how the challenges and good practices are related. The resulting juxtaposition of safety science with organizational theory provides safety researchers with a deeper understanding of the workings of rules in organizations, and helps rule-makers and safety managers in high-risk industries with useful guidance as to how typical challenges around rules can be dealt with.

Throughout the paper, I will use the term "rule" to refer to any written, formal rule or procedure in an organization. "Safety rule" refers to any such rule that regards personal or process safety (Grote, 2012). Distinct from this are informal or so-called "unwritten" rules, which are instead part of organizational routines (Pentland and Feldman, 2005; Weichbrodt and Grote, 2010; as outlined below).

2. Rules as instruments for organizational control, coordination and knowledge

Formal rules in organizational theory are usually seen as a means for organizational control, as a mechanism for coordination, and furthermore as a form of codified organizational knowledge. These conceptualizations are generally based on a behaviorist approach to organizations (e.g., Cyert and March, 1963; March and Simon, 1958), often using the concept of organizational routines as a key element (Feldman and Pentland, 2003; Nelson and Winter, 1982). Organizational routines are defined as "repetitive, recognizable patterns of interdependent actions, carried out by multiple actors" (Feldman and Pentland, 2003, p. 96). Although routines are "repetitive patterns", they are by no means mindless repetitions (Cohen, 2007; Essén, 2008; Parmigiani and Howard-Grenville, 2011). In the recent literature on organizational routines, they are seen as effortful accomplishments and even as a potential source for change (Feldman, 2000; Feldman and Pentland, 2003). Based on this understanding, routines are differentiated from rules, which are seen as formal, written artifacts (Pentland and Feldman, 2005). This has enabled researchers to study the relationship between the two (Becker, 2005; Bruns, 2009; Burns and Scapens, 2000; D'Adderio, 2008; Grote et al., 2009; Kieser, 2008; Reynaud, 2005; Weichbrodt and Grote, 2010). In this article I will build on these ideas. In the following, I will describe the three functions of rules as control, coordination and organizational knowledge.

Rule-making is one form of exercising power and control in organizations (Clegg et al., 2006; Gouldner, 1954; Mintzberg, 1983). Rules function as mechanisms of control through their two-sided nature of restriction (by reducing freedom of action) and support (by providing solutions for known problems) for rule followers (Farjoun, 2010; Ortmann, 2010; Weichbrodt and Grote, 2010; Zhou, 1997). Rules as organizational control are often associated with bureaucracy, which constitutes a general scheme of control distinguished from others, such as markets (which use prices as an instrument of control) and clans (which rely on traditions; Cardinal et al., 2010; Ouchi, 1979, 1980). Characteristic of bureaucracies is their reliance on formal rules and aversion towards informal control mechanisms, such as traditions or other social norms. However, most organizations employ a blend of different forms of control. Cardinal et al. (2004) showed in a decade long case study of a moving company how organizations can shift between phases of low and high formalization, trying to find the right balance. Grote (2004, 2009) describes this balance in terms of the management of uncertainty, for which she distinguishes two general approaches: Uncertainty can either be minimized through rules, central planning and standardization (thereby reducing operative degrees of freedom), or be dealt with locally, which requires flexibility by maximizing operative degrees of freedom. In general terms, the approach of minimizing uncertainty means organizational control through restrictive, detailed rules and surveillance, whereas the approach of coping with uncertainty means generating less rules, or rules which are less restrictive and offer decision latitude (see below).

Rules are also a form of coordination. Coordination mechanisms in organizations can be defined as "the organizational arrangements that allow individuals to realize a collective performance" (Okhuysen and Bechky, 2009, p. 472). Rules are one type of coordination mechanism, whereas others are, for example, technologically defined processes, personal leadership, or mutual adjustment via reciprocal team interaction (Thompson, 1967; Van de Ven et al., 1976). Rules provide accountability and predictability by defining responsibilities for tasks, and help in achieving a common understanding by developing agreement between organizational actors (Okhuysen and Bechky, 2009). Interestingly, both following rules as well as collectively breaking rules can serve coordination: In a field study in a medical trauma center, Faraj and Xiao (2006) identified reliance on protocol as one among several coordination practices. They also found that, under certain unusual circumstances, collective protocol breaking was used as one of several ways to respond to time-critical or novel events.

Rules can furthermore serve as repositories of organizational knowledge (Kieser, 2008; Levitt and March, 1988; March et al., 2000). Organizations can learn by developing routines for solutions to recurring problems, and then codifying these routines into formal rules for later retrieval (Beck and Kieser, 2003). Instead of developing a new solution each time a problem occurs, organizational actors can apply the rule and thus draw from organizational knowledge. Formal rules can also be used to teach newcomers, and furthermore to replicate the underlying routines, for example, to a new factory of an expanding organization (Argote and Darr, 2000; Winter and Szulansky, 2001). A key point regarding rules as codified organizational knowledge is, however, that rules are naturally abstract and incomplete (Bourdieu, 2005; Ortmann, 2010). Tacit knowledge is knowledge that is tied to movement skills, intuition, or implicit heuristics (Nonaka, 1994; Nonaka et al., 2006). Such knowledge cannot be stored in formal rules, but is instead reliant on the continuing application of rules in the form of organizational routines (Lazaric, 2000; Reynaud, 2005). Nonaka and von Krogh (2009) theorized tacit and explicit knowledge along a continuum.

Formal rules would then be positioned as strongly explicit. Viewing rules as explicit knowledge and as learned and codified problem solutions means that rule violations can be seen as opportunities for organizational learning: If environments change, the established rules may no longer represent the best solution to a specific problem and actors may start to actively search for a better way – which, however, can mean breaking rules (Desai, 2010). Rule violations are then indicators that the codified knowledge is obsolete and needs to be replaced.

3. Four common challenges with safety rules

All three of these functions of rules in organizations apply to safety rules in high-risk systems as well. In the following, I will outline four typical challenges of safety rules based on safety science literature (e.g., Battmann and Klumb, 1993; Dekker, 2003; Grote et al., 2009; Hale and Borys, 2013a; Hopkins, 2011; Lawton, 1998) and describe them in terms of their effect on organizational control, on coordination and on organizational knowledge.

3.1. The allurement of writing rules

Safety rules are created and issued by people (or organizational authorities) who are responsible for safety in an organization. This typically means reducing the chance for human or machine error – and one way of reducing human error is to exercise organizational control and prescribe certain behavior by means of safety rules. Safety rules are of course only one type of resource for people responsible for safety (others being, for example, training and technology). But the issuing of rules can be very tempting. In their responsibility for regulating safety, organizations can essentially make two mistakes: they can either be excessively strict or inappropriately lenient. It is not hard to imagine that most rule-makers try harder to avoid the latter one, since safety ultimately is a matter of life and death. In essence – while scrutiny and strictness are certainly necessary – there exists a certain allurement of writing rules to tackle issues of safety.

This allurement is sometimes further increased by the drive of finding a quick solution to a complex problem. Especially after accidents and incidents, there can be public pressure on managers and others in charge of safety to take action immediately – with creating a new rule being an easy and fast measure to take (Mascini, 2005). The notion that accidents represent a "hole" in the rules system that needs "fixing", is still very prevalent. Morris et al. (1999) showed that decision makers are more prone to attribute accidents to human error rather than technological failure when they are asked to generate an "if only ... the accident would not have happened" conjecture of accident prevention.

Since high-risk organizations do not operate independent from society and instead are themselves subjected to a system of laws and regulations, pressure to write rules furthermore comes from outside the organization. If an accident occurred, and there was a rule in place that should have prevented it, the rule violator usually is to blame. But if there was no rule in place, at least part of the blame may be assigned to the rule maker. This was the case with the 2006 accident on the "Transrapid" testing track in Northern Germany. The maglev train crashed into a maintenance vehicle still parked on the tracks, killing 23 and severely injuring ten people. During the trial, the judges identified the signaler as the main culprit for not having closed off the track while the maintenance vehicle occupied it. However, two operations managers were additionally sentenced to a € 20,000 fine for not having regulated the process adequately (Regional Court of Osnabrück, 2008). In other words: rule makers were prosecuted for insufficient rules.

An extreme form of the allurement of writing rules is the so-called "cover-your-back" attitude (Ackoff, 2006; Bardach and Kagan, 1982), when safety rules are made by managers with the intention of avoiding even the most remote possibility of taking blame themselves. "Cover-your-back" rule-making is not just about trying to be on the safe side (which is the core responsibility of rule makers), but rather about wanting to be on the safe side *every time*, in every instance, however small the issue may be.

The allurement of writing rules represents an imbalance towards formal control mechanisms (cf. Cardinal et al., 2004). In organization theory, this has also been captured in the idea of ever-increasing bureaucratization, commonly based on Max Weber's ideas (e.g., 1978). Classic bureaucratization theory argues that formalization has a self-promoting tendency to create more rules. Schulz (1998), however, found that rules do not infinitely "breed" more rules – instead, the production of new rules slows down as more rules are already in place. In any case, too many and too detailed rules are a problem for organizations because they can slow down organizational processes, thus ultimately decreasing organizational control. Too many rules incrementally developed may not make up a good system. Such an inefficient system of rules has also been termed "red tape" and is defined as excessive formalization in the form of burdensome rules and procedures (Pandey and Kingsley, 2000; Pandey and Scott, 2002). For organizational rule makers, "red tape" means creating a false sense of control. The same phenomenon applied to safety rules in high-risk industries could ultimately mean creating a false sense of safety. For instance, Amalberti (2001) argued that in ultra-safe systems – those which already collect and analyze data on accidents, quasi-accidents, incidents and quasi-incidents – the additional "treatment" of these incidents does not lead to more safety.

Too many rules can also hinder coordination. When, as in the case of "red tape", the rules system becomes too strict, its practicality and usefulness is limited and it thus offers only little actual guidance and support for rule-followers. The likelihood of contradictions among rules and other cases of inapplicability increases. Too much restriction furthermore means that actors are less free to choose the appropriate coordination mechanism themselves. Depending on organizational and situational contingencies, more direct forms of coordination like mutual adjustment may be appropriate (Grote et al., 2009; Van de Ven et al., 1976). Especially in non-routine situations, where strong but also flexible guidance is needed, strict procedures may actually hinder safe coordinated operation (Dekker, 2003; Woods and Shattuck, 2000).

Regarding rules as a form of organizational knowledge, the allurement of writing rules can lead to high levels of formalized knowledge – at the cost of informal, tacit knowledge. In seafaring, for example, Knudsen (2009) contrasted the proliferation of formal procedures with the traditional idea of seamanship, which she defined as "a blend of professional knowledge, professional pride, and experience-based common sense" (p. 295). She showed that seamen's reluctance towards the formalization of practices – even though intended to increase their safety – is due to their fear that experience and practical knowledge may get less valued and even lost. Because tacit knowledge cannot be codified easily, increasing formalization of safety–critical processes may actually lead to a loss of organizational knowledge.

3.2. Differences in the symbolic meaning of rules

Safety rules can be seen as organizational artifacts that require interpretation and "translation" into behavioral routines. Artifacts, including rules, can be interpreted both as instruments and as symbols (Heimer, 2008; Rafaeli and Vilnai-Yavetz, 2004; Vilnai-Yavetz and Rafaeli, 2006). Instrumentality is about the usefulness of an artifact, or more precisely: "whether or how artifacts support

or hamper desired activities" (Rafaeli and Vilnai-Yavetz, 2004, p. 673). In the case of safety rules, the instrumental dimension is probably the most important one: rules are generally seen as instructions on how to perform a task in a safe manner. However, the instrumentality of rules, i.e., their usefulness for safety, can be assessed differently by different organizational members. For example, rules mandating the use of personal protection equipment like helmets or goggles may be judged instrumental to safety by rule makers, but may be seen as a hindrance by the addressees of such rules. Even larger discrepancies in the meaning ascribed to rules can occur regarding their symbolic meaning. The symbolic dimension of artifact interpretation "regards the associations elicited by an artifact" (Rafaeli and Vilnai-Yavetz, 2004, p. 673). Through the symbolic dimension, artifacts can carry a rich body of meanings and messages (Hatch, 2006; Schein, 1992). In the case of rules, they can, for example, stand for support and helpful guidance, or instead for excessive orderliness or even oppression. The existence of safety rules can mean *safety* to some, while it can mean *risk* to others. When actors view rules as irrelevant and ignore them, it can be regarded as rules having no symbolic meaning at all. A positive interpretation of rules, e.g., when they symbolize precision, support and usefulness, is related to the concept of psychological ownership (Pierce et al., 2001, 1991), which has been defined as "the feeling of possessiveness and of being psychologically tied to an object" (Pierce et al., 2001, p. 299). People can feel ownership towards both material and immaterial objects in organizations. Ownership can be regarded as an extension of the self and is generally pleasurable.

The process of artifact interpretation, both instrumentally and symbolically, is prone to a number of influences – one of which is the norms and values held by organizational actors belonging to different professions. That different professional groups ascribe different meaning to artifacts, including formal rules, is not surprising, considering the power of occupational communities on shaping shared understanding and collective action (Van Maanen and Barley, 1984). Authors have long stressed the importance of taking into account the inter-group differences in safety culture in general (Clarke, 1999; Fonne and Myhre, 1996; Gherardi et al., 1998; Malloy et al., 2009; Rasmussen and Kroon Lundell, 2012; Silbey, 2009) – but studies on inter-group differences in beliefs about safety rules in particular are scarce. McDonald et al. (2005) showed how the same rules can have very different meanings to different professional groups. In their study, doctors and nurses were interviewed about their perception of the relevance and meaning of safety procedures. Doctors tended to play down the relevance of written rules, emphasizing the non-routine nature of events and the importance of experience and tacit knowledge in medical care. For nurses, on the other hand, following the rules was an important part of their professional ethic. Working according to the rules, for them, was a key element in providing safe and high-quality patient care. These results can be interpreted in such a way, that for doctors, rules have little to no symbolic meaning and are instrumental mostly for beginners. For nurses, on the other hand, rules symbolize safety and professionalism and are crucial for error-free work. In a railroad company, Weichbrodt and Grote (2008, 2012) found different symbolic interpretations of formal rules among signalers, shunters, and workers in construction and maintenance: Signalers generally saw rules as helpful and essential to the successful accomplishment of their tasks. Some even symbolized them as strengthening their collective identity. Shunters, in contrast, saw them as an instrument by which management wants to assert control and assign blame. Construction and maintenance workers, lastly, held mixed views on rules, seeing them as both instruments of control by management, but also helpful in increasing safety. Because for them, following rules often stood in conflict with production pressures, they symbolically associated them with conflict and stress.

These examples demonstrate some of the weaknesses of safety rules: Their effectiveness as organizational control, as coordination mechanism, and as codified organizational knowledge depends on how they are interpreted (both instrumentally and symbolically) by organizational actors – specifically among different professional cultures within an organization. Regarding organizational control, different symbolic interpretations of rules mean that managers as creators of rules cannot be certain about their effect, since it is dependent on the professional norms and values different groups of rule followers ascribe to rules. In occupational communities that devalue the instrumentality of rules in general, or consistently attach negative symbolic associations to rules, it is clear that organizational control through rules is very limited. In order to strengthen the control function in these settings, managers can try to back up formal rules with strict supervision and sanctions. This, however, may only increase the negative views on rules held by these actors.

Different interpretations of rules can also become a problem for coordination – especially when the same rules apply to different professional groups ascribing different symbolic meaning to rules. One group's reliance on rules as important instruments for how to conduct a task may be in contrast to another group's emphasis of informal coordination mechanisms – as was apparently the case between nurses and doctors in McDonald's et al. (2005) study. Such differences may hinder efficient coordination between different professional groups with distinct occupational cultures.

Similar issues arise regarding the function of rules as codified organizational knowledge: Professional groups with negative views on formal rules are more likely to independently cultivate their own, non-codified knowledge (Knudsen, 2009). Especially when rules are regarded as irrelevant, they can become decoupled from actual routines and practices. In extreme cases, the procedures captured in the formal rules may be no more than words on paper, fully separated from the "real" organizational routines, and unbeknownst to other professional groups or to managers, who expect the formal rules to represent the actual routines.

3.3. The inevitability of rule violations

It is a recognized fact that safety rules are not always being followed (Bruns, 2009; Dekker, 2005; Iszatt-White, 2007; Phipps et al., 2008). In Hale and Borys' (2013a) review mentioned in the introduction of this paper, both safety rule paradigms recognize a certain inevitability of rule violations. Proponents of model 1 tend to attribute the causes for rule violations to the rule followers and their lack of discipline, conscientiousness or diligence. In model 2, causes are searched for additionally in the work context (for example, lack of knowledge, lack of correct tools, pressure to produce, etc.). Thus, in both models, rule violations are seen as natural phenomena – either due to the fact that people are not perfect, or that rules are not perfect. Accordingly, Lawton (1998, p. 94) concludes: "It is important to remember that violations occur because rules exist".

Rule violations often occur because of goal conflicts. Safety can concern two fundamentally different goals: *Personal safety* is defined as the worker's protection from harm, whereas *process safety* concerns the safe execution of a task (Grote, 2012; Hopkins, 2009). These two types of safety are not necessarily in alignment with each other. For example, hearing protection equipment may reduce workers' risk for hearing impairment (personal safety), while at the same time making it more difficult to detect important changes in machine noise indicating damaged parts (process safety). Operators may be tempted to violate rules prescribing ear protection in order to better identify what is going

on with their machinery and not to miss signals of potential breakdowns. In railroad shunting, Weichbrodt and Grote (2008) identified a converse case (the procedure of coupling two cars together), where workers dealt with a goal conflict by frequently breaking rules regarding process safety in favor of their own personal safety.

A different and often occurring goal conflict is that between (any type of) safety and production, sometimes also called *work-safety tension* (e.g., McGonagle and Kath, 2010; McLain and Jarrell, 2007). From a behavioral economics standpoint, Battmann and Klumb (1993) have long argued that rule violations can be explained by unclear or conflicting rules: "rule following can be described as a hierarchical top-down process, in which global and general rules decide about lower-level optimization. Often global rules ('production first') and local rules ('safety first') contradict each other" (p. 41). Goal conflicts are thus an expression of ambiguous organizational control. Such a goal conflict (in this case, between production and process safety) has been illustrated vividly by Bensman and Gerver (1963), who in the 1950s analyzed the usage of the tap in airplane manufacturing. A tap is a tool to create a hole with a screw thread in metal parts, used in cases when the previously drilled holes are not in sufficient alignment. While using the tap bore significant risks for the stability of the airplane's structure and was thus deemed "the most serious crime of workmanship conceivable in the plant" (Bensman and Gerver, 1963, p. 590), applying it in exceptional (but regularly occurring) situations was commonplace. Following the rule and never using the tap would have meant delays in production, so it was no surprise that Bensman and Gerver discovered this common violation. Along with it, they found a set of informal norms in place regarding the usage of the tap: Workers would deliberately and regularly not use the tap whenever inspectors were near, and there were professional norms (enforced and upheld by foremen) that prevented the overuse of it. In retrospect, the case of the tap could be explained as a relatively simple case of ill-suited rules: productivity demands and safety demands simply where not in alignment. Either the rule needed some official exceptions or management had to accept slower production (or both). For all we know, however, it required two organizational researchers to uncover this misalignment. Because rule violations are usually hidden practices, the underlying goal conflicts are very difficult to discover.

Lawton (1998) studied the reasons for rule violations among shunters and found four different types of violations, two of them relating to goal conflicts: *Situational violations* are "provoked" by lack of the correct tools or understaffing. Workers usually regard these violations as necessary. Secondly, *routine violations* constitute a shortcut that has become regular behavior. Lawton defines them as "high-frequency and low-risk violations", which "usually go unpunished, and often have benign effects" (p. 88). Especially routine violations are a problem because they can dilute the entire rules system. Because they are seemingly not very relevant and often improve productivity, workers as well as supervisors tend to accept the violations as inevitable. This can lead to a lack of clarity about which rules it is accepted to break and which it is not. From the workers' point of view, a legitimate question to ask is: Why should I follow *these* rules, if we all silently agreed that we do not always need to follow *those other* rules? This phenomenon, in its extreme form, has been termed *practical drift* and is described as "a slow, steady uncoupling of local practice from written procedure" (Snook, 2002, p. 225) with Ortmann (2010, p. 210) adding: "Often, this process establishes a slightly or even completely different operating procedure that is well known by insiders though not by outsiders – outsiders in the sense of non-members of a rather narrow community of practice".

Obviously, routine violations (and practical drift in particular) constitute the biggest threat to rules as organizational control. If rule followers' practice deviates *routinely* more and more from written procedures over time, rules as a means of control become less and less effective.

Furthermore, the inevitability of rule violations also diminishes the coordination function of rules: Goal conflicts and resulting rule violations create ambiguity among organizational actors about how to accomplish a task. Increasing numbers of routine violations may dilute the entire rules system, making it difficult to rely on rules as coordination mechanisms at all.

Regarding organizational knowledge, frequent rule violations mean that newcomers need to learn two sets of knowledge – the one represented in the formal rules and the knowledge of the actual practices. Even worse, different organizational actors may "solve" goal conflicts differently, with some regularly following the rule and others not. If rule violations are indeed the norm (as for example, in Bensman and Gerver's case of tap usage), this means that the "wrong" organizational knowledge is stored in routines, and the gap between what is practiced and what is prescribed in rules widens.

3.4. Individual decision-making versus rule-following

Underneath all three challenges discussed so far – the allurement of writing rules; different symbolic interpretations of rules; and goal conflicts and the inevitability of violations – lies a central polarity: On the one hand, formal rules are necessary for large organizations to function, but on the other hand, individual initiative, which requires scope of action, is also necessary (cf. Grote, 2009). Zhou (1997) has described this as two contrasting models of organizational decision making: choice versus rule-following.

For rule makers in high-risk organizations, this polarity takes the following shape: While safety rules are necessary, all rule makers would agree that workers' "common sense" is also necessary. Safety rules and common sense are of course not always in contrast to each other, but they *can be* – yet managers still have to demand both rule adherence and applying common sense from their workers. The same issue can be viewed from the rule followers' point of view, who are, theoretically speaking, faced with a double-bind situation. The two opposing messages are: "Safety is everyone's responsibility, so use your good judgment and decision-making capabilities" versus "for the sake of safety you ought to follow the rules, so *do not* use your own judgment". Whereas goal conflicts are about contradicting goals at the organizational level, this "dilemma" is about individual decision making versus rule following and goes back to the two-sidedness of rules as both restriction and support (Farjoun, 2010; Ortmann, 2010; Weichbrodt and Grote, 2010).

Although inherent in any safety rule, this tension becomes very visible in regulation regarding personal health and safety. In many work settings, for example, workers are required to wear a hard hat as part of personal protection equipment at all times – even when there is no danger from above or risk of bumping one's head. Workers are discouraged from actively using their judgment in identifying and dealing with risks regarding this aspect. Their risk assessment capabilities (a key aspect of taking responsibility for safety) are essentially declared unneeded, as they are only required to follow a simple rule. This is not to say that safety rules about hard hats or other personal protection equipment should be abolished. A rule is a simplification of a decision process, and as such it often makes sense because it reduces the need for risk assessments regarding when and where a hard hat is necessary. But simultaneously, a rule in place also deprives a worker from the opportunity to make a decision on his or her own (and take responsibility for it).

Illustrating this polarity, Sanne (2008) studied railroad maintenance work in Sweden and found that risk-taking is an inherent part of workers' activity. Although a number of organizational or

Table 1
Challenges for safety rules and their functions as control, coordination and knowledge.

Challenge	...for rules as organizational control	...for rules as coordination mechanism	...for rules as organizational knowledge
Allurement of writing rules	• Imbalance towards formal control • Too many rules may lead to false sense of safety	• Possibility of contradictory rules • Difficulty to choose appropriate coordination mechanism, especially in non-routine situations	• Tacit knowledge may get lost
Differences in the symbolic interpretation of rules	• Effectiveness of rules as control depends on rule followers' interpretation	• Difficulty in rules-based coordination across communities	• Gap between codified and practical knowledge may increase
Inevitability of rule violations	• Loss of control, especially in cases of "practical drift"	• Diminished reliance on rules as coordination mechanism	• "Wrong knowledge" is stored in routines
Individual decision-making versus rule-following	• Loss of control in cases of "work-to-rule"	• Double-bind can hinder coordination	• Individual decision-making necessary for creating new solutions

technological safety measures for reducing risk are implemented (and accepted by the workforce), in order to "make it work" in the allocated time, rules may be broken and risks taken. Similarly, Knudsen (2009) contrasted the traditional idea of seamanship with formal rules. Seamen's reluctance towards rules, as she showed, was in part due to their fear that responsibility and opportunities for individual decision making are taken away from them.

The polarity of individual decision making versus rule following poses a challenge to organizational control because organizations cannot function without one or the other. While rule following behavior is necessary for an organization to function, it clearly cannot operate on this alone. If, in the case of "work-to-rule", rule followers decide to act *exclusively* according to the rules and to withhold individual decision making, operations can be severely slowed down (Napier, 1972).

Regarding rules as a coordination mechanism, the double-bind situation of "follow the rules" versus "follow your own judgment" represents a fundamental challenge for organizational actors trying to coordinate themselves. Individuals sometimes need to carefully consider whether following the rules like everybody else really is the right thing to do.

Finally, the described polarity also depicts the limitedness of rules as organizational knowledge: Relying on past solutions codified in rules only works for known and repeatedly appearing situations. In unexpected events, quick and sound decision making is inevitably necessary, particularly in high-risk organizations (Dekker, 2003; Woods and Shattuck, 2000).

The four challenges with safety rules with regard to their functions as control, coordination and knowledge are summarized in Table 1.

4. Four Measures of good rules management

In the second part of the paper, I will outline four important measures organizations can employ to face these challenges around rules. These measures are based on common themes in literature on the management of safety rules (Grote, 2012; Hale and Borys, 2013b; Hale and Swuste, 1998; Hale et al., 2003; Larsen and Hale, 2004; Leplat, 1998; Reason et al., 1998). Each of these measures works, again, through the three functions of rules in organizations, the specifics of which are outlined below. The four measures are not linked one-on-one to the four challenges discussed before. Instead, most measures address several challenges at once. The relevance of each measure to the four challenges is described at the end of each section.

4.1. Managing the restrictiveness of rules

For many, the term "safety rule" invokes ideas of clarity and unambiguity and is thus often defined very strictly (e.g., as describing "the ONLY proper way to perform a work activity" (Ranney and Nelson, 2007, p. 1; emphasis in the original)). The idea of a rule explicitly providing decision latitude is often met with skepticism and labeled as a "soft rule". However, several authors in the field of safety science have highlighted the benefits of varying the degree of restriction in rules. Often building on Hale and Swuste's (1998) work, authors have shown how different levels of scope of action are needed, depending on situational, personnel or task characteristics (Blakstad et al., 2010; Borys, 2012; Grote, 2012; Grote et al., 2009).

Hale and Swuste (1998, p. 165) defined safety rules as follows: "A safety rule is a defined state of a system or way of behaving in response to a predicted situation, established before the event and imposed upon those operating in the system [...] as a way of improving safety or achieving a required level of safety". Their typology of safety rules distinguished rules at the level of action regulation: *Action rules* define the required behavior on a concrete and detailed level; *process rules* specify the means of how to come to a decision about the right course of action and thus can function as solution search rules; and *goal rules* only broadly define a desired goal or state of a system, leaving it up to the rule follower which actions to take in order to achieve it. Goal rules provide the least restriction for rule followers, but also offer only little support. Action rules are highly restrictive, but on the other hand also offer ample support (Weichbrodt and Grote, 2010).

Another often ignored possibility in rule design is that it could be desirable to frame rules in a non-binding way as advice or recommendation. While some exclude such rules from their definitions of safety rules altogether, I argue that such recommendatory rules can offer a balancing function in many cases. However, recommendatory rules can pose problems when an accident or incident happens: Because of their indefinite nature, assessing human error is more difficult. Rule makers might fear not adequately meeting their responsibility for safety when there is no single course of action deemed the correct one – thus shy away from issuing recommendations. As such, I argue that especially in less-critical processes they might be useful in order to decrease the overall restriction workers experience and allow for variation in the tasks performed (Weichbrodt and Grote, 2010). In connection with informal, unwritten norms and work ethics, recommendatory rules could serve as a form of "best practice solution" made explicit and integrated within the safety culture. Another way to use recommendatory rules is to combine them with goal rules: In this case, achieving an unambiguous goal would be mandatory, but the documented way to achieve said goal is less restrictive and "only" a useful recommendation. Similar to process rules, such combinations would strike a balance by being both restrictive and supportive.

From an organizational perspective, the issue of finding the right degree of restriction can be dealt with by delegating

increasing levels of restriction downwards in the organizational hierarchy. Rules made at the top level can be written less strictly, covering only the minimally required safety level. Sub-divisions of the organization can then be authorized to issue stricter rules if their specific tasks or its context requires them. For example, a general rule could require workers to always have safety goggles with them and put them on only when needed. In work areas where risk of eye injuries is especially high, the respective managers could make the rule more restrictive and require workers to always wear them.

Blakstad et al. (2010) presented a case study of rules revision in the Norwegian railway system where action rules were supposed to be changed towards more outcome-oriented rules with greater latitude for decision-making (i.e., goal rules). However, the final results of the rules revision, involving a process termed "reverse invention" by the authors, showed a combination of goal and action rules. The case shows how a combination of top-down processes (aiming to introduce outcome-oriented rules) and bottom-up processes (inclusion of existing rules and knowledge, mainly action rules) can be a strategy in order to find the correct degree of restriction.

Generally speaking, the more uncertainty for a task is involved, the less restriction should be used (Grote et al., 2009). If the degree of restriction is too high, actors might not be able to do the right thing in exceptional situations and are potentially forced to commit rule violations. Especially action rules greatly reduce actors' responsibilities, aggravating the dilemma between individual decision-making and rule-following outlined above – whereas rules providing scope for action always leave a fair share of decision-making with the rule follower. Indeed, when dealing with occurrences of repeated (small-scale) violations, reconsidering the restrictiveness of the rules in question is a useful approach. Avoiding overly strict rules by carefully selecting the right degree of restriction will thus reduce "inevitable" violations. In this way, making rules less restrictive can actually *increase* organizational control: It may be better to have a rule that is less detailed and leaves some room for individual decision-making, but is accepted by rule followers because it fits the task – than having a rule that prescribes a task down to the last detail, but is detached from reality and not possible to adhere to in frequently occurring situations. An overly restrictive rule that gets ignored is less effective than a more lenient rule which is being followed.

Furthermore, better-suited rules whose restrictiveness is tailored to actors' task and context requirements are also beneficial to coordination: Rule followers can only rely on rules as a shared coordination mechanism when they are actually able to follow them (and can expect others to follow them, as well). Reducing the necessity of violations by actively managing the restrictiveness of rules is therefore beneficial to both organizational control and coordination. Bearing in mind and truly considering the option of varying the restrictiveness (whether by goal or process rules or by recommendatory rules) should furthermore mitigate some of the allurements of writing rules.

Regarding rules as a representation of organizational knowledge, it is equally important to have rules tailored well to rule followers' actual behavior. If rules are too restrictive and detailed, the corresponding organizational routines may therefore incorporate variations not covered in the rules. In such cases, relying on the formal rules as representations of people's actual behavior may lead to false conclusions and organizational knowledge may actually be lost. It is important to keep in mind that most knowledge cannot be fully codified in rules. Reducing the detailedness in written rules may therefore not really be a loss in many cases, as knowledge is to some degree always stored in rule followers' application of these rules in everyday organizational life. Managing the restrictiveness of rules can also mean trying to grasp this practical knowledge and take it as a starting point to formulate new rules around it in a bottom-up process (a further measure of good rules management discussed next).

In summary, managing the restrictiveness of rules can mitigate some of the allurements of writing rules and reduce rule violations by giving appropriate leeway. Less restrictive rules can thus also help strike a balance between individual decision-making and rule-following.

4.2. Participation in rule creation and adaptation

Designing completely new rules on the basis of the organizational routines in place can be considered an extraordinary form of participation and is probably practiced only rarely. More common seem to be consultation procedures in cases of new rules or adaptations to existing rules: Before they become official, rules suggestions are sent out to relevant stakeholders within the organization for comments. Through this procedure, middle managers and team leaders familiar with local requirements and working conditions have the opportunity to voice concerns (but also to give positive feedback) about regulation to be implemented. Though often this is merely a form of consulting and not binding for the rule making authority, it nevertheless gives rule followers a real chance to point out flaws and foreseeable difficulties. Rule makers on the other hand have an opportunity to rule out heavy mistakes beforehand, and can expect better support for the implementation of their new rules.

Research on participation in rule creation has only recently begun, but has nevertheless brought about interesting findings: Although not testing participation in rule creation per se, Simard and Marchand (1997) found that a participatory management style in manufacturing plant workgroups is positively related to rule compliance. Bax et al. (1998) report on a survey of 143 employees of high-risk organizations (mostly in healthcare) with somewhat conflicting results: Workers perceived the legitimacy of formal rules as higher when enforcement was stricter and when they were consulted regularly by supervisors about the rules, but also when they did *not* take part in the formulation of the rules. According to the authors, this finding could indicate the existence of a blame culture, where workers do not want to be held responsible for the rules, but consultations with management about the rules are needed for marking the boundaries of their responsibilities. Ranney and Nelson (2004, 2007) found evidence for participation in rules revision having positive effects on safety culture and incident rates in the U.S. railroad industry: In one out of three railroad carriers analyzed, a statistically significant improvement in incident rates could be found after a participatory rules revision process. Interview data pointed towards further benefits of such a change process, such as a reduced number of safety rules, better-suited rules (and thus increased compliance), improvements in union-management relations, and increased psychological ownership of the workforce regarding safety rules and safety. This last finding points to the symbolic interpretation of rules. Participation in rules revision, its seems, shapes rule followers' perception of the relevance and meaning of rules. Taking part in the creation process of rules may lead to actors symbolizing rules in a more positive light.

Compelling findings regarding participation in rule changes also come from Bourrier (1996, 1998), who analyzed and compared maintenance work in four nuclear power plants. She found that in two of the plants different practices of swift rule adaptation where in place in order to make rule compliance easier when conditions have changed. In one plant, the engineers responsible for the formal procedures maintained a close relationship with the foremen and maintenance workers carrying them out. In another plant, the maintenance foremen themselves had the authority to

change the procedures. However, in the two other plants, no such mechanisms for swift rule adaptation were in place, and thus bypassing rules in order to get the job done was the norm. This finding particularly highlights how participation can reduce "necessary" violations.

These studies provide a convincing starting point in terms of scientific evidence for the benefits of participation in rule creation and adaption. Participation thus leads to fewer goal conflicts and fewer violations as the overall "usability" of rules is increased. Similar to managing the restrictiveness of rules, these measures thus improve both organizational control by means of rules and the functioning of rules as a coordination mechanism. In particular, cases of *practical drift* would become apparent and could be counter-balanced either by adapting rules or trying to change rule followers behavior (e.g., by education and training as outlined below). Additionally, participation can act as a measure to counter the allurement of writing rules in an organization, because it provides rule followers with an opportunity to voice their concerns in cases of too many rules already in place. Especially "cover-your-back" rule-making would become visible and preventable – although such cases probably have some underlying issues of lack of trust and a co-operative atmosphere between rule makers and rule followers and therefore may not be easily fixable.

If different professional groups within an organization have fundamentally different interpretations of rules, and all are sufficiently able to participate in the rule-making process, these differences should be noticed by rule makers and can be addressed appropriately. Furthermore, increasing psychological ownership of rules through participation should shift the symbolization of rules towards a more positive interpretation. Coordination across communities could thus be improved.

With regard to organizational knowledge, participation in the rule creation process can help align routines and rules in a bottom-up process. As described in Bourrier's (1998) case, participation can be seen as a process of turning "wrong routines" (i.e., routines incorporating disallowed but necessary violations) into "correct rules" (rules that cover the actual, adequate routines). When the actual routines (which have proven to be successful) are represented better in the formal rules, the rules system can work more efficiently as codified organizational knowledge.

Participation can thus be used to face three challenges: allurement of writing too many rules is countered by rule-followers, the symbolic interpretation of rules can be influenced in a positive way, and "inevitable" rule violations are reduced.

4.3. Education and training about rules

Obviously, in order to follow rules, one has to know about them. Given the vast numbers of rules and regulations in some high-risk industries, stemming from different sources, this is not a trivial issue. Education and training about rules can take many different forms. Even before entering an organization, actors' professional education already constitutes a background of (theoretical) knowledge about practices and possibly even basic formal rules. When workers enter the organization as new members, they are most amenable to organization-specific shared values and beliefs. As such, during initial training after entering an organization, workers are learning not only formal rules and procedures but also "breathe in" the informal norms and values of an organization – including the ones around how the rules are typically perceived and dealt with (Gherardi and Nicolini, 2002). Through additional training later on in an employee's career, explicit knowledge can be more or less easily changed, but changing tacit knowledge usually requires much more effort (Salas and Cannon-Bowers, 2001). For safety trainings, it has been found that the more participants are actively engaged, the more effective the training (Burke et al., 2006). Rather than just ordering practices by means of issuing rules, managers should therefore actively engage with workers in order to explain and persuade (Conley et al., 2011). In this way, educating about rules and their reasons is key in bridging the gap between knowledge stored in formal rules and in organizational routines. Especially in aviation, crew resource training has become a standard in safety management (Helmreich et al., 1999; Salas et al., 2006). Through training, members of heterogeneous teams with different professional backgrounds can develop a better shared understanding, while homogenous teams can learn to counter complacency and challenge their assumptions (Grote, 2012).

Regarding rules as organizational control, education about them can first and foremost reduce violations. During safety trainings, well-known routine violations can be addressed and the reasoning behind the rules can be communicated. Such trainings are also an opportunity to discuss typical goal conflicts and, ideally, give rule followers some assistance in how to deal with them. In such a way, training can be used to teach not only the formal rules, but also informal organizational norms and desired priorities.

Assistance in goal conflicts (and thereby reducing them) is also beneficial to coordination. Intensive interdisciplinary training can align different interpretations of rules among different professional groups – ideally enhancing coordination between them.

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

To sum up the effects of education and training, such measures can shape informal norms and symbolic interpretations of rules, they can provide assistance in goal conflicts and thus reduce the problem of necessary violations, and they can increase actors' ability for balancing individual decision-making and rule-following.

4.4. Considering alternative to rules

Another solution to overcome the challenges of safety rules is to simply not create them in the first place and instead consider alternatives. Two different forms of alternatives are discussed here: The first choice is to alter equipment or infrastructure design instead of writing rules in order to encourage or enforce safe behavior. The second is attempting to change norms and values regarding safety as a form of informal control.

Leplat (1998), building on Norman (1988), suggested system designers should check if ergonomic principles could be applied instead of safety rules. For example, the principle of affordance means that instruments or infrastructure can be designed so as to afford, or "invite" the safest usage. Even more effective could be the use of forcing functions, which "are a form of physical constraint: situations in which the actions are constrained so that failure at one stage prevents the next step from happening" (Norman, 1988). An example would be safety mechanisms that prevent operators from opening a machine while it is running. Leplat (1998, p. 202) concludes: "For every rule, it is always good to ask: what should be done to eliminate the necessity for this rule?" Changing objects or infrastructure in order to eliminate the need for safety rules seems like a promising approach. But implementing principles like affordance or forcing functions into equipment and infrastructure only leads us back to the question of finding the right degree of restriction. Designing forcing functions, by its nature, is strongly restrictive. It actually means higher restriction

than prescribing behavior through rules, as these usually can be more easily broken than forcing functions can be circumvented – which could turn out to be necessary in an unforeseen situation. Ultimately, the question of how to strike a balance between restriction and support is just as relevant in equipment design.

Theoretically, another alternative to formal rules could be *informality*. Researchers in the High Reliability Organizations (HRO) framework have long pointed out the importance of "soft factors" like culture for achieving safety (e.g., Bierly and Spender, 1995; Rochlin, 1999; Weick, 1987). The HRO literature, however, offers only little support for rule makers and others in charge of safety on how to tap into the social or cultural aspects of safety. In fact, there is considerable consensus that safety culture is not directly controllable or modifiable (Gherardi and Nicolini, 2002; Grote and Weichbrodt, 2013; Silbey, 2009). Nevertheless, culture seems to be such a strong force in organizations that it should not be neglected. Levers for influencing culture are – as outlined above – education and training, as well as leadership. When trying to influence employees' norms and values, informal hierarchies among them can be taken advantage of: By getting experienced and well-respected workers on one's side, these can act as role models and influence others. In any case, however, it is clear that changing culture is a difficult and long-term process, whereas rules, if implemented well, have a much more short-term effect.

Outside of organizations, an interesting example of replacing rules with alternatives can be found in traffic regulation in the form of *shared spaces* (e.g., Hamilton-Baillie, 2008; Karndacharuk et al., 2014). Shared spaces are a combination of re-designing infrastructure and counting on informal forms of coordination. Through rebuilding streets and squares by removing curbs and markings and abolishing traffic signs and street lights, all public space is available to all stakeholders (cars, bicycles, pedestrians). Traffic is regulated not by rules that separate space into roads and pedestrian walkways, but instead by mutual communication and awareness. Re-designing infrastructure in this case notably does not include forcing functions, but rather the opposite: By removing clear boundaries and making all space available to everybody, uncertainty is increased, which is thought to prompt actors to act more cautious. The principle behind shared spaces can thus be described as "dangerous is more safe". The idea has been implemented in a number of cases in small towns across Europe with some success and is part of the national policy for road safety in The Netherlands (Wegman et al., 2008).

Considering alternatives to rules is an important measure of rules management in organizations, albeit not without its own difficulties. On the positive side, choosing alternatives to rules of course eliminates violations and goal conflicts around rules and all related challenges for organizational control and coordination. Even more, merely actively considering alternatives works against the allurement of writing rules and can thus increase organizational control by averting "red tape" and a false sense of safety. However, as outlined above, fundamental questions about the degree of restrictions still apply to equipment design, and organizational control through informal measures is often much more difficult to achieve, especially in large organizations (Walsh and Dewar, 1987).

Regarding coordination, it is not clear whether replacing rules with alternatives makes it easier for organizational actors to coordinate: First, the supporting function of rules (as guidelines and orientation) are lost. Second, implementing forcing functions can hinder coordination in exceptional situations. Take, for example, spikes in the pavement of one-way streets that fold into the ground when driving over them from the correct side, but pierce the tires when entering from the wrong side (these are used in countries like Turkey): While this installment forces drivers to obey the one-way street rule and thus supports coordination, it leaves no operational leeway for police or ambulance cars in emergencies. Hence, forcing functions carry the risk of being too restrictive, just like rules. In contrast, rules can be replaced with informal norms and rules. Relying on informal forms of coordination means that actors are not restricted on how to achieve coordinated action and instead can try to find the best mechanism for coordination on their own. This process, however, requires sufficient training and resources (Grote et al., 2009).

With regard to organizational knowledge, re-designing equipment in order to reduce the number of rules only shifts the gap problem: Technology or infrastructure can be used to store organizational knowledge, but it can also be "mis-used" by employees, meaning that actual practices can diverge from designers' intentions, thus creating a similar gap as between formal and practical knowledge. Knowledge stored in technology or infrastructure furthermore has the problem that it is not as easy to decode as is

Table 2
Measures of good rules management and implications for the three functions of rules.

Measure	Implications for organizational control	Implications for coordination	Implications for organizational knowledge
Managing the restrictiveness of rules	• Reduces violations by giving appropriate leeway (less restriction can mean more control)	• Increases rule followers' ability to rely on rules as coordination mechanism	• Formal rules can better represent actual routines
Participation in rule creation and adaptation	• Reduces violations and goal conflicts • Mitigates "practical drift" • Possibly counters allurement of writing rules	• Reducing necessary violations improves coordination • Different interpretations are noticed • Increases ownership of rules	• Can align rules and routines by turning "wrong knowledge" into "correct rules"
Education and training	• Reduces rule violations • Provides assistance in goal conflicts	• Helps to align different perceptions on rules • Provides assistance in goal conflicts	• Strengthens "correct" knowledge • Provides resources for better individual decision-making
Considering alternatives to rules: *Re-designing equipment*	• Eliminates violations and goal conflicts • Counters allurement of writing rules • Difficulty of finding the right degree of restriction still remains	• Actors could be hindered to coordinate in exceptional situations	• Gap problem shifts to possible divergence between designers' intentions and practice • Knowledge stored in equipment is more difficult to decode, requires documentation
Considering alternatives to rules: *Relying on culture and informal norms*	• Eliminates violations and goal conflicts • Counters allurement of writing rules • Control through informality is more difficult	• Although supporting function of rules is lost, actors may be able to better find adequate coordination mechanism	• Eliminates gap between formal and practical knowledge • Strengthens practical knowledge

written text. Machinery usually requires extensive documentation to preserve the knowledge of its intended use. Relying on culture instead of rules means eliminating the knowledge gap problem, but of course it also means that extensive measures have to be taken in order to strengthen the "cultural" knowledge (Gherardi and Nicolini, 2002). For example, regularly exchanging their individual solutions to safety problems ("best practices") in meetings or team trainings could strengthen informal knowledge among safety workers.

In summary, choosing alternatives to rules eliminates the problem of rule violations and can act as a countermeasure to the allurement of writing rules. While an important aspect of rules management, the impact of abolishing rules should be carefully considered.

The four measures of rules management discussed above and their implications for organizational control, coordination and organizational knowledge are summarized in Table 2.

5. Conclusion

In this article, I have linked research on safety rules and rules management with broader theory on rules in organizations. The result is a juxtaposition of challenges and measures regarding safety rules as means for organizational control, as coordination mechanism, and as codified organizational knowledge.

This article can serve as an example for the transfer of knowledge from one domain to another. Prior research has proposed similar issues regarding safety rules and ways of dealing with them (Dekker, 2003; Hale and Borys, 2013a,b; Hale and Swuste, 1998; Hale et al., 2003; Larsen and Hale, 2004; Leplat, 1998; Reason et al., 1998). Putting these issues of safety in high-risk industries into a broader organizational context is a novel achievement of this article. The resulting framework can benefit both researchers and practitioners.

For researchers in the domain of safety science, organization theory provides an important backdrop for all that goes on in high-risk industries. Problems and challenges for safety can be regarded as general problems which all organizations are facing. Vice versa, organizational researchers could apply their theories to high-risk organizations in order to test them and determine their range of applicability. This article represents an attempt of the former – with the latter being an excellent opportunity for future research.

For practitioners (especially rule makers) in high-risk industries, the framework presented in this article serves as an orientation for taking into account the multiple and diverse functions of rules. Keeping in mind that rules are not just instruments of organizational control, but have to work as mechanisms for coordination and as codified organizational knowledge as well, will generate better rules. The four challenges outlined furthermore serve as a reminder that every rules system is in flux, given a large enough timeframe. External requirements, internal conditions, people, technology and probably every other aspect of an organization inevitably change and a rules system needs to address this in order to function (March et al., 2000; Schulz, 2003). The four solutions discussed can thus be seen as strategies for taking into account the multiple functions of rules as well as for dealing with this "impermanent institutionalization" (Schulz, 2003) that lies in the nature of every (safety) rule.

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