

Coordination in high-risk organizations: the need for flexible routines

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Abstract In this article, we link the literatures on organizational routines and the management of uncertainties in order to establish the concept of flexible routines. Supported by flexible rules, this type of routine is argued to help achieve the right balance between standardization and flexibility, thus enabling resilience through loose coupling in high-risk organizations. The operationalization of the concept of flexible routine can help strategic decision-making regarding the design of high-risk systems as well as operational decision-making in the course of handling complex work processes. To underpin these arguments, findings from a case study on rules management in a railway organization are presented, where alignment of rules with the amount of uncertainty and actors' competencies for handling uncertainties were analyzed. Implications for future research on flexible routines are discussed.

Keywords Organizational routines · Uncertainty · High-risk organizations · Rules management · Loose coupling

1 Introduction

One of the most fundamental questions in the design of organizations and the coordination of work processes concerns striking the right balance between standardization on the one hand and flexibility and openness to change on the other. There are a number of perspectives from which

this question can be approached, from a very theoretical one based on organization theory (e.g., Gouldner 1959; Weick 1979) to a very pragmatic one focusing on practical issues such as streamlining industrial production processes. The general gist of any of these approaches is, however, that in order to coordinate processes in organizations routines and rules are essential (Reynaud 2005), with the need for flexibility and change being recognized as important, though difficult to meet without losing organizational coherence and efficiency.

One important factor in determining the right balance between standardization and flexibility is the amount and nature of uncertainties stemming from within the transformation processes in the organization and from the organization's environment. It is generally assumed that flexibility is particularly needed under higher degrees of uncertainty allowing for competent coping with the uncertainties, while low levels of uncertainty can be best handled through standardized processes aimed at minimizing uncertainties (e.g., Grote 2004b; Thompson 1967; Van de Ven et al. 1976; Wall et al. 2002). However, while it is found that organizational flexibility enables competent coping with uncertainties and thereby resilience (Hollnagel et al. 2006), there is still a widespread belief that flexibility and change carry risks of system failure. This belief has been particularly influential in the design of high-risk organizations, where tight coupling requires centralization of control (Perrow 1984). Hence, in nuclear power plants, spacecraft, commercial and military aircraft, and railway networks a high level of standardization is seen as necessary (Amalberti 1999) to prevent system failure from occurring. The concurrent loss of flexibility is considered undesirable, but inevitable.

More recent literature on flexible routines and rules might offer new perspectives and means for devising stable

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and flexible organizations even given high degrees of uncertainty. The concept of flexible routines (Howard-Grenville 2005) takes into account that routines must be enacted by people to come to life and that this enactment process inevitably allows for variation and change in the routine (Feldman and Pentland 2003). Flexible routines and rules may provide new means for dealing with uncertain and complex situations flexibly but safely.

The purpose of this paper is to establish links between organizational routines and management of uncertainties, which could prove useful in resolving the dilemma of concurrent standardization and flexibility in high-risk organizations. The paper unfolds as follows: firstly, literature on organizational routines, mainly from an enactment perspective, is reviewed. Secondly, difficulties in the management of uncertainty are outlined followed by some considerations particularly concerned with the limits of standardization in high-risk organizations. It is argued, that in these organizations, there is a demand for concurrent standardization and flexibility. Loose coupling has been suggested as a concept to accommodate both the necessity of adhering to routines and of adapting action autonomously to situational demands (Weick 1976), more recently also described as a core characteristic of resilient organizations (Hollnagel et al. 2006). Concepts for the design of rules and rules management as sources for loose coupling are described. Thirdly, a case study on rules management in a railway organization is presented and discussed in terms of propositions concerning contingencies for the effects of rules. Finally, by building on the insights from the case study, we propose several implications for future research on organizational routines and rules management in high-risk organizations.

2 Organizational routines and organizational flexibility

Organizational routines have been defined as “repetitive, recognizable patterns of interdependent actions, carried out by multiple actors” (Feldman and Pentland 2003). This definition first of all points to routines as basis for coordinated action, without specifying in which form these routines exist, for instance as written down rules, technologically determined courses of action, or experience based tacit understandings of the right course of action. The basic assumption is that routines develop in organizations because they are functional in reducing complexity and uncertainty and increase stability, managerial control, and legitimacy. Routines embody organizational memory of the knowledge needed for successful performance and support coordination based on shared expectations without need for explicit coordination between the actors (Nelson and

Winter 1982). Routines are built on repetition, but do not necessarily require repetition by the individual actors. Instead actors can rely on the experience by others that is represented by the routine. Routines may be regarded as a static product of learning, which—once established—impedes further learning and thereby reduces organizational flexibility.

2.1 Enactment of routines

Feldman and Pentland (2003) challenge this prevailing view by arguing that routines always contain the duality of principle and practice. The principle of a routine as determined by a written procedure, a taken-for-granted norm or some shared procedural knowledge has to be put into practice and in this process adapted to the necessities of a concrete situation. Rules are resources for action, but they do not fully determine action (Feldman and Pentland 2003). Similarly, Reynaud (2005) argues that rules are inherently incomplete due to their general and abstract nature. To fill this “void at the heart of rules” (Becker and Knudsen 2005; Reynaud 2005) contextualized and specific routines are to be enacted.

In this enactment process, the “routine in principle” helps through guiding, accounting, and referring. Guiding is accomplished by the routine serving as a normative goal for action. By providing explanations for what we do, routines also support accounting for actions. Finally, routines can provide simple labels for complex action patterns, which can be used as commonly understood reference to these sets of actions. The routine in practice is essential for the establishment and maintenance of the routine in principle, as routines only develop through repeated action. At the same time, the “routine in practice” can also modify the routine in principle as new ways of acting are found to be appropriate under specific circumstances. Whether these modifications get incorporated in the routine in principle depends, for instance, on the power of the respective actors to turn exceptions into rules. Routines may therefore also be the source for change and flexibility. However, the exact preconditions under which the enactment of routines leads to stability or change are not known, as Feldman and Pentland (2003) state.

This new way of conceptualizing organizational routines incorporates static as well as dynamic elements, or in other words an ostensive aspect (the more or less static routine in principle) and a performative aspect (the routine in practice, which inevitably allows for improvisation and flexibility). This perspective of a duality of principle and practice may be useful for solving a dilemma which high-risk organization faces that is the concurrent necessity for both standardization and flexibility to ensure system safety.

2.2 General versus differential processes in routine enactment

Several studies have addressed factors that influence flexible use of routines and routine changes. Based on a case study on the use of project management routines in a chip manufacturer, Howard-Grenville (2005) suggested that actor's time orientation (to past, present, or future) and the degree of embeddedness of a given routine in other organizational structures influence the flexibility with which a routine is applied and how likely the routine will be changed as a consequence of this flexibility. She assumed that present and future orientation and weak embeddedness further flexible use and change, while strong embeddedness hinders change—though not flexible use—even with present and future orientation. Gilbert (2005) broadened the view by looking at company-wide changes in response to new environmental demands, using newspapers' responses to the rise of digital media as an example. He found that pressures for change resulted in new patterns of resource use, but increased routine rigidity, i.e. more centralized authority, less experimentation and focus on existing resources. Edmondson et al. (2001) described leadership and team processes associated with the successful/non-successful change of routines through new technology, identifying enrollment, preparation, trials, and reflection as crucial for successful introduction of new technology and associated routine changes. Yet another approach was taken in a study by Gilson et al. (2005) in which the effects of standardized work processes and support for creativity were analyzed in parallel on two outcomes of technical service teams, technical performance, and customer satisfaction. They found that standardization was positively related to customer satisfaction, while creativity was positively related to technical performance. Their findings indicate that routines do not necessarily have a general effect, but might be appropriate for achieving some outcomes, but not others. Becker and Knudsen (2005) showed that routines can be especially helpful when decisions must be made under pervasive uncertainty, whereas in the case of more manageable forms of uncertainty, decisions should be made by increasing the amount of information considered. Using routines in such a way, as they point out, does not reduce the actual uncertainty but rather the amount of uncertainty perceived by decision-makers.

3 Coordination in organizations and the management of uncertainties

From an organizational perspective, routines are one form of coordination operating within and between parts of an organization. Depending on the degree and type of division

of labor and specialization in an organization, more or less effort will be required for coordination and different kinds of coordination will be more or less successful. Generally, five broad categories of coordination means are distinguished (e.g., Thompson 1967; Van de Ven et al. 1976).

- Technologically defined processes
- Central programs and plans, e.g., standard operating procedures
- Personal leadership
- Mutual adjustment via reciprocal team interaction
- Cultural norms

3.1 Two approaches to managing uncertainties

In order to understand the use of different means of coordination in organizations and thereby also the use of rules and routines, it is helpful to conceptualize organizational activities in terms of the management of uncertainties. Uncertainties can stem from the transformation processes an organization has to perform as well as from the environment within which these processes take place (e.g., Perrow 1967; Thompson 1967; Van de Ven et al. 1976). Two extreme approaches to handling uncertainty can be distinguished (Grote 2004b).

The first one tries to minimize uncertainty or at least the effects of uncertainty in the organization using mainly feed-forward control based on high standardization and programming of work flows. Coordination is mainly achieved through tight plans and procedures and also automation where possible. Enormous efforts are put into centralized planning and continuous monitoring of the execution of these plans, providing minimal degrees of freedom to the people in charge of carrying out the plans. Disturbances are seen as flaws in the system design and are trying to be avoided.

The other approach aims to enable each and every member of an organization to handle uncertainties locally and to allow for feedback control. From this perspective, planning is understood primarily as a resource for situated action (Suchman 1987), not as blueprint for centrally determined and monitored action. Local actors need to be given as many degrees of freedom as possible, achieving concerted action mainly through lateral, task-induced coordination. Disturbances are regarded as opportunities for use and expansion of individual competencies and for organizational innovation and change.

3.2 Minimizing uncertainties through standardization and its limitations

Most high-risk systems have relied heavily on minimizing uncertainties. Standardization in the form of standard

operating procedures has been developed with ever increasing detail in order to streamline human action and to reduce its influence as a risk factor. Procedures are often a direct consequence of incidents and accidents and the analysis of which provides knowledge of unforeseen wrongful courses of action against which new rules are developed as a defense.

While generally there is an understanding that rules are useful guides for safe behavior, there is also an increasing concern that too many rules incrementally developed will not make up a good system to help human actors do the right thing especially in states of abnormal operation where they would need strong, but also flexible guidance (e.g., Amalberti 1999; Dekker 2003; Woods and Shattuck 2000).

These concerns go back to basic observations on how rules specifying the exact operations to execute can have a detrimental effect on action because they do not allow the performing person to develop an underlying plan of their own, but instead further the atomization of actions and the focus on micro-difficulties (Vermersch 1985). Another problem with standardization is that reliance on common standards may turn into an over-reliance, impeding switches to more explicit coordination and to higher levels of common action regulation, i.e. switches from skill-based to rule-based or to knowledge-based behavior. This problem can be exacerbated by the fact that standardization is a strong force towards shared understanding of a situation and its demands in a team, because it creates a common framework for team behavior reducing the need for explicit coordination. The expectation of shared goals, plans, perspectives, and knowledge bases created by reference to the same set of standard operating procedures, as helpful as it is under most conditions, does involve the risk of not realizing the need for explicit coordination, especially in non-routine situations.

3.3 Balance between minimizing and coping with uncertainties through loose coupling

While standardization can be regarded as the key element in the minimizing uncertainty approach, the competent coping with uncertainty relies much more on personal and lateral coordination. It can be assumed that standardization will work better in situations with few uncertainties while local autonomy and control are needed when uncertainties are high. In situations with high uncertainty standardization may even be harmful, but so far few concrete suggestions exist, what coordination mechanisms to use in order to improve the predictability and controllability of a system while at the same time increasing its flexibility (e.g., Perrow 1984).

Weick (1976) has suggested the principle of loose coupling in order to simultaneously ensure autonomy of

actors and sufficient binding forces for all actors to use their autonomy to promote the organization's objectives. According to Orton and Weick (1990), who expand on the dialectical interpretation of loose coupling, a system is loosely coupled when there is both distinctiveness and responsiveness. Hence, loose coupling is given in situations in which "elements are responsive but retain evidence of separateness and identity" (Orton and Weick 1990, p. 203). The concept of loose coupling enables researchers to investigate the paradoxical co-existence of "rationality and indeterminacy without specializing these two logics in distinct locations" (p. 204).

In Fig. 1, four examples are given for achieving loose coupling. The concept of motivation through task orientation (Emery 1959) assumes that tasks allowing for a high degree of autonomy, task completeness, and task feedback will further an individual's intrinsic motivation towards fulfilling the goals of the primary task of the organization. The concept of higher order autonomy (Grote 1997; Klein 1991) has been suggested to provide autonomy in those situations where in technically tightly coupled systems (Perrow 1984) little operative autonomy is possible. Higher order autonomy allows the actors in the organization to decide on the restrictions of their own operative autonomy, e.g., through participative design of rules and procedures. In studies of high-reliability organizations (e.g., LaPorte and Consolini 1991), it has been observed that organizations may also be capable of changing flexibly between the two organizational modes. Weick (1987) has pointed out that culture serves as a strong basis for a form of coordination and integration that incorporates both decentralization of autonomy and centralization of values and norms as binding forces for local action.

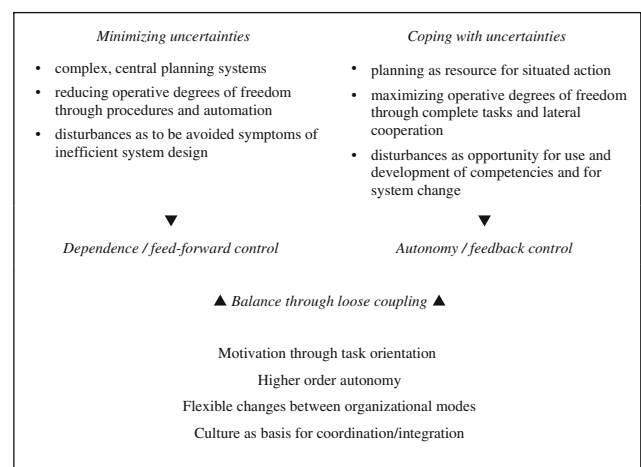


Fig. 1 Two approaches to managing uncertainties in organizations (from Grote 2004b)

4 Flexible routines as support for loose coupling

The newer perspective on routines embodying a duality of principle and practice is thought to be useful for achieving loose coupling in high-risk organizations. Through flexible routines, meaning routines that deliberately allow for more “space” in their usage, such systems could emphasize distinctiveness as well as responsiveness. To further the concurrence of distinctiveness and responsiveness by means of flexible routines we suggest establishing flexible rules, an assumption outlined in the following.

4.1 Flexible routines through flexible rules

In order to study the relationship between rules and routines, it is important to clarify the distinction between the two concepts. Frequently, it seems that they are used more or less interchangeably. We suggest that rules as the written-down formal descriptions of standard operating procedures are artifacts, which are related to and interact with, but are not identical to either routines in principle or routines in practice. Rules are often written by management with the intention to create routines in practice by following the rule. In this case, the match between performance and the rule is the measure of management control. Rules might also express the agreement between actors on what to do or the managers’ understanding of what their subordinates do. Then the rule is more of an after the fact description of routines in practice. Finally, the rule may serve as a formal statement of the routine in principle in terms of a public political statement about how things ought to be with everybody in the organization sharing another understanding of how things are actually supposed to be done.

Systematic research into the design and management of safety-related rules specifically relevant in high-risk organizations has only recently begun (Hale and Swuste 1998; Leplat 1998; Reason et al. 1998) and rules as support for loose coupling have been researched even less to date (Grote 2004a).

Rasmussen (1997, p. 191) has argued that “rather than striving to control behavior by fighting deviations from a particular pre-planned path, the focus should be on the control of behavior by making the boundaries explicit and known and by giving opportunities to develop coping skills at boundaries”. Rules then would have the function to clarify boundaries and to suggest ways of handling system states close to those boundaries. In line with this approach to rules, authors have begun to develop typologies of rules in order to help the design of rule systems directly tailored to the needs for guidance as well as for autonomy and control arising in different stages of action regulation (e.g., Hale and Swuste 1998; Leplat 1998). Hale and Swuste

(1998) distinguish between three kinds of rules: rules can concern goals to be achieved (goal rules), define the way in which decisions about a course of action must be arrived at (process rules), or prescribe concrete actions (action rules).

Especially process rules could be well suited to design stable but flexible systems. This might also involve the development of meta-rules, i.e. having process rules on when rules should be used as coordination mechanism versus when other coordination mechanisms such as mutual adjustment in a team or leadership are more appropriate. To develop such meta-rules would necessitate a better understanding of the relationship between coordination mechanisms and team and organizational effectiveness.

In a study by Grote et al. (2004), coordination behavior in cockpit crews and anesthesia teams as examples of work environments with high versus low standardization was compared, including an analysis of the rules relevant for the observed settings using the Hale and Swuste (1998) categories. There were generally more rules for the aviation setting as was expected and there were also less process rules and more action rules as compared to the anesthesia setting. Considering the higher degrees of operational uncertainty contained in handling a patient as compared to flying an aircraft, the less specific rules in medicine seemed appropriate. Very rare in both settings were rules that also provide a rationale for the rule. Interestingly and contrary to our original assumptions, we found that anesthesia teams coordinated more implicitly than cockpit crews despite having fewer written rules guiding their behavior. For the aviation data, a clear link between higher levels of explicit coordination and higher levels of performance could be established, which hints at the importance of backing up standards with a constant effort to reassure a common understanding of the situation and the relevance of the standards for the situation (Weick and Roberts 1993). The anesthesia teams, by comparison, coordinated their tasks more implicitly despite overall fewer standards, which may be related to more informal rules and the immediacy of common action in a shared visual field (Heath et al. 2002). Very rare in both settings were rules that also provided a rationale for the rule. This last finding is interesting in light of a study by Wright et al. (1998) in which the annotations in a *Quick Reference Handbook* by an airline pilot were analyzed. Almost 40% of the annotations concerned explanations on why the procedure was the way it was, indicating the need of users of procedures to understand their reasoning, which then can be used to apply the procedure adaptively, as was indicated by another about 25% of the annotations.

Another set of analyses in the study by Grote et al. (2004) concerned patterns of coordination within each

professional setting, comparing work phases with different degrees of standardization. One important finding here was that high levels of personal leadership in highly standardized situations appeared to be related to worse team performance. Another finding was that cockpit crews performed worse when first officers used higher levels of implicit coordination, pointing to the importance of experience for coordinating action on the basis of shared views of situations and their demands. All these findings indicate the importance of process rules to help teams to deal with the demands of adaptive coordination better, which change with the nature of the task, the uncertainties to be handled, the task load, and actors' expertise.

Besides the rules themselves, the process of generating and modifying rules is crucial in providing or impeding flexibility. Bierly and Spender (1995) showed in her comparative case studies on the organization of maintenance work in four nuclear power plants how the maintenance workers' influence on the writing and modifying of procedures was positively related to them following the ensuing rules. This can be taken as evidence for the importance of higher order autonomy (Grote 2004b; Klein 1991), i.e. autonomy in restricting one's own operative autonomy.

4.2 Research implications

By integrating findings from the literatures on organizational routines, rules management, and management of uncertainty research questions emerge that have not received adequate attention to date.

Firstly, as the enactment of organizational routines inevitably allows for variation and change, decision latitude for the rule user should be explicitly designed into safety rules. By defining boundary conditions for rule use more systematically, flexible rules do not undermine system safety (Rasmussen 1997).

Secondly, not only the amount of rules, but also the types of rules appropriate for a particular work process have to be defined systematically to further loose coupling. Process rules have been put forward as being particularly promising to enable loose coupling, including also rules on the situated usage of different coordination means.

Thirdly, an important distinction must be made between flexible routines and flexible use of a routine: as has been pointed out, a flexible routine incorporates a leeway for decision-making. Flexible use of a routine on the other hand may imply that a rule is adapted by the user without the rule itself explicitly allowing such an adaptation. In this case flexible use is usually considered a violation with a number of sanctions attached. To what extent formally granted or informally seized decision latitude is actually used in accordance with task and situational requirements

are strongly influenced by the actor's competence and experience level.

To elaborate and discuss these propositions further a field study on rules management is presented in the following.

5 The field study: rules management in a high-risk organization

The field study was conducted in a railway organization—a setting considered to be particularly suited for investigating rules and routines as railways are among the most proceduralized organizations. Railway organizations have a very long history of using rule books as the basis for coordination mainly due to their highly distributed nature of operation. Further, until very recently no means for direct communication between the different actors such as train drivers, controllers, and maintenance workers existed, necessitating impersonal forms of coordination through standards and programs (Hale and Heijer 2006). At the same time, rule violations, and inadequacies of rules and rule management have been found to be crucial safety problems in rail organizations (Farrington-Darby et al. 2005; Hale et al. 2003; Lawton 1998).

5.1 Research purpose

The general purpose of the study reported here was to provide an analysis of existing rules and of the rule management process shared between the state regulator and the railway organization. From a research perspective, the adequacy of existing rules and rule management processes for providing optimal support for the management of uncertainties in rail operations was focused on, using the uncertainty management framework (Grote 2004b) described above. For the railway company and the regulator, the study was to provide a basis for reflecting upon four themes: adequate detail of rules, interplay of rules and training, interplay between rule design and rule auditing, and distribution of responsibility between actors involved in rule design, rule following, and rule monitoring.

5.2 Methods

The study was based on data stemming from

- interviews with the five executives responsible for rule management at the railway organization and the regulator (1.5–2 h each),
- analysis of documents on rule management provided by both the railway organization and the regulator (e.g., Basic principles for rule management, Guidelines for

- rule writing, process descriptions in the management system for auditing rule compliance, written comments on the most recent revision of the rule book),
- analysis of reports on incidents and accidents related to rule following (summary of all incident reports between 2003 and 2005, reports on the accident analysis for four accidents),
 - observations of the relevant work processes (shunting team in a small/large station (half day each), large shunting yard (1 day), signalers supervising train departures in a large station (half day), signalers' team in a small station (half day), train driver (half day),
 - interviews with two shunters, two signalers, and one train driver (1–1.5 h each),
 - rules analysis of a sample of rules based on two work processes (train departure, coupling, and braking of cars during shunting operations).

The interviews and document analysis concerning the rule management process followed the model of rule management suggested by Hale et al. (2003), which has been used in previous investigations of rule management in railways. The rules analysis is the focus of the current paper, therefore more detailed information on this analysis is provided below. Information from observations, interviews, and document analyses will be referred to where necessary to interpret the results and to provide some further context for the findings.

For the rules analysis, categories suggested by Hale and Swuste (1998) were used in a slightly modified form:

1 Level of action regulation

- Goal (the rule only defines the goal without determining the way for achieving the goal).
- Process (the rule describes the processes needed to determine the right course of action).

- Action (the rule prescribes a concrete operative course of action).
- 2 Obligation (Advice vs. command)
 - 3 Decision latitude (with vs. without decision latitude)
 - 4 Distribution of responsibility (Responsible person(s) mentioned vs. not mentioned)
 - 5 Exceptions (with vs. without exceptions)
 - 6 Reasons (with vs. without reasons)

Two raters rated all rules chosen for the analysis according to these categories using Atlas.ti for the coding ($\kappa = 0.83$, $p < 0.001$).

5.3 Results

Table 1 presents the results of the analysis of rules concerning the coupling and braking of cars during shunting operations and the moving of trains. Regarding the moving of trains, train departure was focused on, for which new rules had recently been devised by the regulator. In the analysis, the old and new rules for train departure were compared as well as all current rules on moving trains analyzed to obtain a reference profile for the changes made by the regulator. Overall, 221 rules were analyzed. The majority of rules were action rules (e.g., “If fixed signals for permitting train departure are available, they are to be used”). Also, many rules contained decision latitude (e.g., “If a delayed readiness of the train is anticipated, the train driver informs the signaler. This information happens as early as possible, usually before the permission for train departure is signaled.”). Very few rules were goal rules (e.g., “The signaler has to grant permission for train departure so as to allow for punctual traffic while also considering operational effectiveness.”) and also very few rules contained just an advice instead of a command.

Table 1 Results of the rules analysis

Rule type	Shunting		Moving trains (new rules related to train departure)		Moving trains (old rules related to train departure)		Moving trains (all rules)	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Total	28	100	32	100	38	100	155	100
Goal rule	0	0	1	3	0	0	1	1
Process rule	6	21	9	28	2	5	19	12
Action rule	22	79	22	69	36	95	135	87
Advice	0	0	1	3	0	0	3	2
With decision latitude	20	71	15	47	14	37	61	39
With resp. person/s mentioned	2	7	17	53	13	34	46	30
With exceptions	7	25	6	19	7	18	34	22
With reasons	1	4	0	0	1	3	5	3

Exceptions were mentioned fairly frequently. Reasons for a rule were rarely given. There were a number of interesting differences between the rules concerning different work processes and also between the old and new rules concerning train departure which will be commented on in the following section.

5.4 Discussion

The analysis surfaced a number of interesting issues, which have to be interpreted cautiously, however, given that only a sample of rules was analyzed that may or may not be representative of all rules in the rail organization studied. Rules for the rail organization are written by different people depending on the topic and the organizational groups affected with very few content-related guidelines provided. In fact, only one content-related statement was found in the existing documents on rule management: “Rules should only contain normative statements and/or recommendations and should define the handling of exceptions; informative statements should be restricted to the absolute minimum.” Therefore, it is unlikely that any subset of rules could be representative of all rules in this organization.

Table 1 shows that very few goal rules exist, which might be regarded positively as goal rules by their very nature do not offer much guidance for the actors on how to pursue the goal. However, goal rules are helpful by providing information on system boundaries (Rasmussen 1997) and on priorities in certain situations, thereby supporting the actors in their individual priority setting (Wright et al. 1998). This may concern very basic priorities such as punctuality versus safety or more specific priorities such as the timing of own actions and communication to other actors about these actions.

Compared to the old rules for moving trains the new rules included more process rules and also a clearer distribution of responsibility. Especially the latter had been a declared goal of the rule revision in order to avoid diffusion of responsibility. At the same time, the discussion about the stricter definition of responsibility with the people affected indicated the potential problem of too little sharing of responsibility, thereby reducing information flow and cross-checking between the various actors. This problem is assumed to gain importance due to different actors like train drivers, maintenance crews, shunters, and signalers belonging to different companies within a holding structure with fewer and fewer of them having had the experience of belonging to the one previously existing company.

The higher level of process rules in the new rules on train departure can be considered a positive development as process rules provide guidance without restricting flexible action. Signalers and train drivers are well qualified with

high professional ethics, who still have to act to a large part on very defined and prescriptive action rules, but “stretching” these in order to accommodate non-routine situations. So an even higher proportion of process rules might be appropriate.

The high percentage of process rules and even more rules with decision latitude was evaluated more critically with respect to shunting operations. The prevalence of more open and less prescriptive rules on how to handle shunting operations has to be seen in the context of the shunters’ comparatively low level of qualification and their reluctance to take responsibility for using the decision latitude offered. When discussing this obvious mismatch with the people responsible for rule making, it was pointed out that shunting occurs in so many different contexts (within stations, on shunting yards with varying degrees of automation etc.) that rules have to be less specific. So the issue becomes whether the current level of qualification and training is sufficient for handling this flexibility. Efforts are underway to improve training for shunting accordingly. One may also raise the issue, though, which has been brought up in other rail organizations as well (Hale and Heijer 2006), whether rules for shunting are paid less attention to by rule makers as they mainly concern the safety of the individual workers and less the politically far more prevalent safety of passengers. This is also related to the basic issue of rules having different purposes for different actors in an organization (Leplat 1998; Power 2004). While management sees devising rules and enforcing rule compliance mainly as a way to fulfill their responsibility of controlling employees’ actions, employees evaluate rules in terms of their potential for supporting or hindering adequate action. Less risk implies less management attention and therefore fewer and less specific rules, less education, and training implies more demands for guidance through specific rules by the shunters.

A high percentage of rules with exceptions was found, which can mainly be explained by the fact that a variety of local conditions has to be covered, e.g., regarding the level of automation, the number and distribution of personnel (trains with/without conductors, stations with/without signalers etc.), or the particular geographical layout. The main issue to be discussed with respect to these exceptions is the level of detail the rules should have and whether local knowledge should be incorporated in the rules or rather be provided by complementary training. The fundamental dilemma of not being able to have general, simple, and detailed prescriptions at the same time became obvious here.

Finally, rules very rarely included reasons, raising the question of whether training is designed to provide the necessary background information. Given an increasing pressure for interoperability of rail systems, thereby

requiring personnel with more and more diverse educational and training backgrounds having to work together, rules might have to include more explanations in the future.

6 Implications and future research avenues

In this paper, we have explored organizational routines and rules management as means for coordinating processes in high-risk organizations in a flexible and concurrently safe manner. We did so by reviewing some of the more recent findings on organizational routines and uncertainty management. Further a field study in a railway organization was conducted to assess existing rules and rule management processes and their adequacy in providing optimal support for the management of uncertainties.

Findings from the field study clearly show difficulties in aligning rules with given uncertainties and the actors' competencies for handling uncertainties. Two opposite patterns of mismatch were observed which lead to the following conclusions for the case studied: on one hand, uncertainties in shunting operations need to be reduced through more detailed and prescriptive rules and/or individual competencies need to be increased to adequately use the provided decision latitude; on the other hand, signalers and train drivers need to be supported more in coping with uncertainties, potentially through more process rules including rules that support adaptive coordination, e.g., switching from proceduralized, implicitly coordinated action to explicit coordination through direct communication and mutual adjustment between different actors. However, in providing signalers with more scope of action, a critical balance with the decision latitude for other actors has to be maintained. The analysis of the rules and even more so the analysis of some incident reports seemed to indicate that the signalers sometimes handle uncertainties in a way that reduces other actors' possibilities for handling their part of the situation appropriately, e.g., by providing not enough or untimely information about their actions or the actions required by the others. Here also a power differential between different professional groups is apparent, as signalers have the power to shift uncertainties to other actors who sometimes do not even have the adequate resources to handle these uncertainties (Hale and Heijer 2006; Marris 1996).

By reinterpreting these findings through an organizational routines lens, more dangers potentially arising from these mismatches become visible. In the case of shunters, the lack of regulation could lead to the development of routines disintegrated from other parts of the organization and not in line with organizational safety standards. If no other forms of coordination (like shared cultural norms on safe operations and frequent communication with other

parts of the organization) take place, this integration deficit could compromise the organization's safety. In the case of signalers, where the workflow and coordination was found to be well (if not over-) regulated, this high level of standardization could suppress adaptation of routines when the actual state of affairs differs from the one assumed in the regulation, thus compromising safety as well. In summary, reducing the mismatch between the distribution of uncertainties and the resources for coping with them could lead to the establishing of better-suited flexible routines.

Before drawing the conclusion that the concept of organizational routines can be linked with that of loose coupling, their difference in viewpoint needs to be considered, however. The perspective that the organizational routines literature takes is largely descriptive. Researchers are trying to depict routines as characteristics and processes that make up an organization; they try to find "what's there". The concept of loose coupling, uses a more normative and prescriptive approach. Loose coupling is considered a favored form of organizing, with research being more focused on how to change and shape an organization.

These two perspectives may be connected in such a way, that knowing more precisely what is, puts one in a better position to decide what should be. For the case of connecting organizational routines with loose coupling as a form of managing uncertainties, this could mean the following: if routines and rules need to be enacted to actually exist in an organization (and not just on paper), and if this enactment process inevitably allows for some degree of variation of that rule, the acceptance of this as a fact by the organization's members (especially executives and rule-makers) could improve the organizations' capabilities of managing uncertainties. Rules then would still be relied on as a coordination mechanism and in high-risk organizations there would still be a high degree of standardization necessary. But with this knowledge in mind, the design of better rules—rules that give its users decision latitude where possible and needed—could be achieved.

To recapitulate, on a general level the solution to the dilemma of concurrent standardization and flexibility is described well by the concept of loose coupling (Weick 1976). However, while different approaches have been suggested in the literature to translate this framework into practice, more research seems to be necessary to understand firstly, how to put loose coupling into practice, and secondly what the role of organizational routines is in achieving loose coupling in high-risk organizations. Keeping in mind that in different parts of an organization with different types of work processes and different workers in terms of knowledge, skills, values, and needs there are also different kinds of balance needed between standardization and flexibility, it is evident that more

knowledge about the variables that influence this balance and their interrelations is necessary. Further research on the subject can support decision-makers to further their organization's resilience by striking the right balance between standardization and flexibility and by finding the right means to establish and maintain this balance.

Future research should provide more detailed qualitative analyses of how different contexts influence the enactment of routines, for example by systematically looking at the enactment of routines under different degrees of standardization. This would then allow for formulating more specific hypotheses on the linkages between uncertainties, routines, and rules. Hence, longitudinal, interpretive case studies seem necessary to more fully understand the co-evolution of routines and rules across time. By looking very closely at both the actual content of rules and how they are acted out in everyday practice and at the interplay between rules and other coordination mechanisms—which has not been done previously—a step could be taken towards resolving the dilemma of concurrent standardization and flexibility in high-risk organizations.

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