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Cedergren, Alexander

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Implementing recommendations from accident investigations: A case study of inter-organisational challenges

Alexander Cedergren[a, *]
[a] Lund University Centre for Risk Assessment and Management (LUCRAM),
Lund University, Box 118, 221 00 Lund, Sweden

ABSTRACT

In many industries, a national accident investigation board conducts investigations following major accidents. For safety improvements to be achieved, however, it is essential that the recommendations presented in these investigations are followed by necessary actions. In this paper, challenges related to implementation of recommendations from accident investigations are studied. The theoretical framework providing the foundation for the study lies at the intersection between systems safety, risk governance, and implementation research. Empirical data for the case study was collected from the Swedish railway sector. The first part of the paper presents an analysis of the extent of recommendations that have not resulted in implemented actions. The second part consists of an interview study aiming at providing a deeper understanding of the difficulties related to transforming these recommendations into actual changes. Two key factors that give rise to challenges to implementation of recommendations are identified. The first factor is related to the different actors' views on their own and other stakeholders' roles in the implementation process, and can be described as a trade-off between being insider and outsider to the industry. The second factor is related to the scope of the accident investigations and their recommendations, and can be described as a trade-off between micro-level and macro-level factors. The opportunities for implementing recommendations, and achieving safety improvements at the industry level, are affected by the ways in which the different stakeholders manage these trade-offs at the local level. This study thus mainly contributes by highlighting the importance of co-ordinating the various actors involved in the implementation process, and the results show that challenges to implementation to a large extent arise in the interactions between these actors.

[*] Corresponding author. Tel.: +46 46 288 09 39; fax: +46 46 222 46 12
E-mail address: alexander.cedergren@lucram.lu.se

1. INTRODUCTION

In the aftermath of major accidents, a number of activities are normally initiated aimed at creating an understanding of why the accident occurred and to prevent similar events in the future. One of these activities involves the accident investigations conducted in many sectors. The investigation itself, however, is merely one of the elements in the process of learning from accidents. For safety improvements to be achieved, it is essential that the recommendations on remedial actions presented in the accident investigations are followed by necessary actions, i.e. that they are implemented. Whereas a lot of research has dealt with challenges related to accident investigation and the methods used in this step, limited focus has been given to the implementation of recommendations (Lundberg et al., 2010; Carroll and Fahlbruch, 2011). This process therefore merits further attention.

Responsibility for the different steps, from accident investigation to implementation of remedial actions, is normally distributed across several different organisations. This is particularly the case for major accidents, where many sectors have a national accident investigation board conducting the accident investigation and formulating recommendations on remedial actions, whereas a safety authority, the affected operators, and other relevant bodies are involved in the implementation of these remedial actions. This process thus involves a variety of different stakeholders.

Taking risk-reducing measures in settings involving a large number of stakeholders is often difficult due to the diverse roles and perspectives among these various actors (Renn et al., 2011; van Asselt and Renn, 2011). This type of challenges potentially also exists in the multi-organisational process in which the findings from accident investigations are transformed into actual changes. To investigate this further in the context of the Swedish railway sector, two objectives of this paper have been formulated. The first objective is to study to what extent recommendations from accident investigations have not resulted in implemented actions, and the second objective is to study the ways in which the interplay between different actors influence the possibility to implement these recommendations.

As described above, a similar structure for investigation of accidents and implementation of recommendations exists across many different industries. In this paper, the implementation process in the Swedish railway sector is studied. Section 2 describes the main actors involved in this process. Section 3 outlines the theoretical framework of the paper, which draws upon insights from the fields of safety science, risk governance, and implementation research. Section 4 describes the method and material for the study, which is followed by Section 5 that presents the stepwise approach to identifying challenges to the implementation process. Firstly, the proportion of recommendations on remedial actions that have not resulted in any implemented actions is analysed. Secondly, an interview study aiming at gaining deeper insights into challenges related to implementation is conducted. Finally, Section 6 presents a discussion of the results, and Section 7 highlights the conclusions drawn from the paper.

2. THE ACCIDENT INVESTIGATION PROCESS IN THE EU RAILWAY SECTOR

According to the Railway Safety Directive of the European Union (Directive 2004/49/EC) each member state needs to establish a permanent and independent investigation body, i.e. an accident investigation board, with the task of investigating serious railway accidents and incidents. The objective of these investigations is described as improving railway safety and preventing future accidents. Once the investigation board is notified of an incident or accident, a decision is made whether to initiate an investigation. Where appropriate, these investigations shall contain safety recommendations addressed to the national safety authority or other relevant bodies. A schematic outline of the process involving accident investigation and implementation of recommendations is shown in Figure 1. The safety authority shall take the necessary measures to ensure that the safety recommendations are taken into consideration and acted upon. As a part of this process, the relevant actors report to the safety authority regarding their progress on the implementation of recommendations. Following each investigation, the safety authority reports back to the investigation board on measures that are planned or taken as a result of the

recommendations. The feedback from the safety authority to the investigation board (see Figure 1) provides the basis for the analysis described in Sections 4 and 5 with regards to the proportion of recommendations that has not resulted in implemented measures. Before this analysis is further described, the theoretical framework of the paper will be outlined.

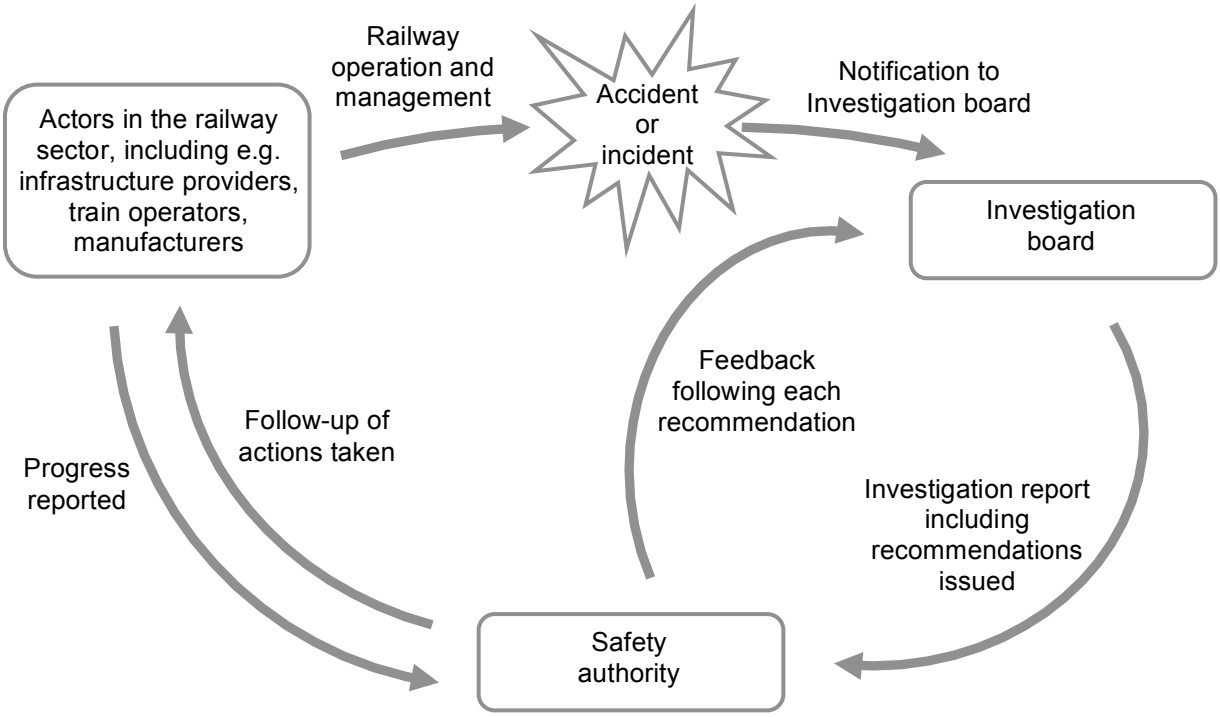

Figure 1: Schematic outline of the process involving accident investigation and implementation of recommendations

3. THEORETICAL FRAMEWORK

The theoretical framework underpinning this paper lies at the intersection of three research fields: systems safety, risk governance, and implementation research. The first field, systems safety, seeks to develop knowledge and understanding of how accidents can be prevented, and is therefore of significant importance to this paper. In the systems safety field, a large number of methods for accident investigation have been presented (for overviews, see for example Dien et al., 2012; Sklet, 2004; Kjellén, 2000). The early models were based on a view of accidents as a sequential chain of events culminating in some form of injury (Kjellén, 2000). However, this relatively simple cause–effect relation is of limited value for explaining accidents that occur in modern socio-technical systems, which are characterised by a high degree of complexity (Hollnagel, 2004; Leveson, 2011). Later developments of accident investigation methods have contributed with a distinction between "active failures" and "latent conditions". Active failures represent errors or mistakes that are committed by individual workers in the operational environment of a system, whereas latent conditions represent deficiencies in design, maintenance, procedures, or automation, which lie dormant in a system. These ideas form the basis for several accident investigation methods, for example the well-known "Swiss cheese" method presented by Reason (1997). Methods of this type are often referred to as epidemiological models. Although they are more complex than the sequential models, they are still based on a relatively linear assumption of accident occurrence, and they have difficulties explaining how latent conditions have emerged and how they interact with active failures (Dekker, 2006; Hollnagel, 2004; Rollenhagen, 2011).

As socio-technical systems have become more coupled, the need for more advanced models has grown. Perrow (1984) argues that systems consisting of a large number of parts that are tightly coupled and interact in non-linear ways are capable of generating unknown and unexpected events. Accidents in complex systems are in Perrow's view therefore inevitable, which is the message behind his concept "normal accidents". According to the same view, Leveson (2011) argues that accidents in complex systems often result from interactions between perfect functioning components. With this perspective, accidents (and safety) can be seen as "emergent" phenomena, i.e. something that cannot be derived from the constituent parts of a system, but rather appear on system level (Dekker, 2011; Hollnagel, 2004; Leveson, 2004). In order to create an understanding of how accidents in complex systems occur, Dekker (2011) has emphasised the importance of studying relations between different parts of a system, and not only the different parts or actors in isolation. In a similar vein, Rasmussen and Svedung (2000) argue that it is often the unexpected side effects from daily, and locally rational, decisions at different levels of a socio-technical system that pave the way for accidents. In this view, the causes to accidents in complex systems are "embedded in the banality of organizational life" and facilitated by an environment characterised by scarce resources, competition and incremental changes (Vaughan, 1996). These processes, involving stepwise acceptance of risk and gradual adaptation, are not well captured by using accident models that look for components that are "broken" (Dekker, 2011). Based on these insights, a number of "systemic" accident investigation methods have been developed (see e.g. Hollnagel (2004) and Leveson (2004)), with the aim of paying attention to the interactions between different parts of a complex system.

The vast amount of different methods for accident investigation can be seen as an indication that development of new methods is the "holy grail" of systems safety research (Lundberg et al., 2010). However, the investigation is only a first step to achieve safety improvements. In order to make necessary changes, it is essential that the recommendations on remedial actions are implemented, which merits the objectives of this paper. As described in the previous section, several actors are involved in the different steps of the national accident investigation and implementation process. Research on the interaction between different actors involved in managing risks in such multi-organisational contexts is studied in the area of risk governance. This field constitutes the second research area upon which this paper is based.

Risk governance denotes the ways in which various actors deal with risks characterised by uncertainty, complexity and/or ambiguity (IRGC, 2005; Renn et al., 2011; van Asselt and Renn, 2011). In particular, risk governance is concerned with situations where the nature of the risk requires co-ordination and collaboration between a large number of diverse stakeholders (IRGC, 2005). These stakeholders can involve public as well as private actors, and typically they have different roles and framings of the risks involved. According to Hermans et al. (2012), risk governance incorporates, but is not restricted to, the traditional elements of risk analysis, including risk assessment, risk management, and risk communication. In addition to these elements, risk governance also incorporates the larger contexts in which risks are evaluated and decisions are made, such as the legal, institutional, and political mechanisms involved (IRGC, 2005). Particularly, the present paper shares Boholm et al.'s (2012) view on the importance of taking inter-organisational interactions into account when studying risk governance, including how responsibility, power and control is distributed between different actors. By adopting the risk governance perspective in the present paper, focus of attention is thus directed towards the interplay between the various actors involved in managing risks.

The term risk governance represents the application of the "governance" concept to the field of risk research. Governance has been used in the policy sciences to stress that the state is not the only, and in many cases not even the most important, actor in managing and organising society (Hermans et al., 2012; Marsh and Furlong, 2002). In contrast, the governance perspective represents a view in which "collective binding decisions are generated and implemented in complex multi-actor networks and processes. Power is distributed, as multi-actor networks involve a wide variety of actors" (van Asselt and Renn, 2011: p. 434).

The governance perspective has also been inspirational in the area of implementation research, which constitutes the third pillar of the theoretical framework of this paper. The close relation between governance and implementation has been emphasised by Hill and Hupe (2002), who point out that a range of stakeholders are often involved in the implementation process. Consequently, studying implementation requires consideration of inter-connectedness and interdependencies between different actors (Exworthy and Powell, 2004; O'Toole, 2000). Since the seminal work by Pressman and Wildavsky (1984, first edition published in 1973), the field of implementation research has grown dramatically. In simple terms, implementation means "to carry out, accomplish, fulfill, produce, complete" (Hill and Hupe, 2002: p. 3). In the words of DeLeon (1999: p. 330), implementation can be described as "little more than a comparison of the expected versus the achieved". In this general sense, the problems facing implementation of public policy are therefore similar to the problems related to implementation of recommendations from accident investigations. For this reason, insights accumulated in the field of implementation research have provided a valuable basis for this study. Lessons from implementation research constituted the foundation for formulating questions that were used in the interviews conducted with a number of actors involved in the implementation of recommendations from accident investigations. Specifically, the work by Vedung (1997) and Hogwood and Gunn (1984), which will be further described in the next section, were used for this purpose.

4. MATERIALS AND METHODS

A first step of this paper was to make an inventory of the proportion of recommendations that have not resulted in any action. For this reason, a content analysis was conducted of the feedback from the safety authority to the investigation board following each recommendation. This feedback is reported about six months after the accident investigation has been issued. The material included in the study encompassed all documented feedback that was publicly available at the time of writing the paper, and covered recommendations issued between 2004 and 2011. In total, the material included feedback following 105 recommendations. Normally, this feedback is rather brief, containing a few sentences up to one page of text.

The content analysis was conducted by classifying the feedback for each recommendation into two categories by looking for keywords describing whether actions had been taken or not (corresponding to categories A and B, respectively). This analysis formed an initial approach to find out if any challenges to implementation of recommendations could be identified. During the work with the content analysis, additional sub-categories were created to facilitate the classification. Category A was divided into three sub-categories to distinguish recommendations that had resulted in actions already undertaken and completed (A1); actions planned and partly initiated, but not yet completed (A2); and actions only planned but not yet initiated (A3). For these recommendations it is important to note that the analysis did not include any assessment of the thoroughness or effectiveness of the actions taken. The remaining recommendations were classified in category B, which corresponded to no planned or taken actions. This category was also further divided into two sub-categories, based on common themes among these recommendations. These sub-categories are described in Section 5, where the results from the content analysis are presented.

It is important to stress that the results from the content analysis represented the author's classification. Practically all recommendations were described as "considered" in the reported feedback, notwithstanding the fact that this formulation did not necessarily imply any planned action. In order to check the stability of the coding (cf. Weber, 1990), the content analysis was carried out twice by the author. In addition, the inter-subjective agreement (cf. Krippendorff, 2004) was checked by letting a master student in risk management and systems safety use the coding instructions to conduct the same analysis on a randomly selected sample of the material. The results from this reliability check are presented in Table 1 in Section 5.1.

The next step involved an interview study with a number of respondents. The aim of the interview study was both to identify general challenges to implementation that different actors encountered, and to gain a deeper explanation of the results from the content analysis. As described in Section 3, an important aspect of studying the governance of risk in this type of multi-actor setting is to gain understanding of the interplay between various actors with different roles and responsibilities. For this reason, semi-structured interviews were carried out with 14 respondents from 4 actor affiliations: accident investigation board (n=3); safety authority (n=2); infrastructure provider (n=4); and railway operator (n=5).

A particular focus of the paper was devoted to the interplay between the accident investigation board and the safety authority, since these actors are involved in the process of formulating and implementing all recommendations. Therefore, three of the respondents included staff from the accident investigation board, and two of the respondents included staff from the safety authority. These respondents had been involved in writing numerous of the investigation reports or the feedback regarding implemented actions following these reports.

Four respondents from the infrastructure provider and five respondents from different operators were also included in the study. These respondents were selected in order to illuminate the implementation process from multiple perspectives, and hence to provide a richer understanding of challenges related to implementation. The respondents from the train companies represented the two largest actors in the Swedish railway sector (one freight train company and one passenger train company). The respondents from the other three passenger train operators represented smaller companies. All respondents from the train operators held a position in the safety department of their respective organisation.

The interviews with the safety authority and the four passenger train companies were conducted by telephone, whereas the others were conducted face-to-face. The interviews lasted between 30 min and 2 h. All interviews were transcribed, and all quotations presented in Section 5 have been translated from Swedish to English by the author. All respondents received the interview questions prior to the interviews, and when the results were analysed they were offered the possibility to comment on a draft of the paper.

The same interview guide was used as a point of departure for all interviews. However, the focus varied somewhat depending on the respondent's role, and telephone interviews were generally less extensive than the face-to-face interviews. Since the interviews were conducted after the content analysis, the interview guide was to some extent based upon questions that emerged during this process. In particular, these questions focused on why some recommendations did not lead to actions. In addition to these specific questions, the interview guide contained general questions regarding challenges to implementation. These questions were based on a synthesis of factors presented by Vedung (1997) and Hogwood and Gunn (1984). These authors have identified a number of important aspects to consider in policy implementation, which is a process similar to the implementation of recommendations from accident investigations. The following themes were addressed, upon which more detailed interview questions were raised:

- Formulation and design of remedial action (e.g. clarity, level of detail).
- Validity of remedial action (e.g. link between analysis and recommendations).
- Understanding and agreement on remedial action (e.g. shared view on required changes).
- Time, resources and willingness to support implementation (e.g. scarcity, commitment).
- Communication and coordination to facilitate implementation (e.g. interaction between key players and understanding for each other's roles).
- External circumstances affecting implementation (e.g. influence from media attention).

The transcribed interviews were analysed by searching for quotations that described challenges to the implementation of recommendations. Especially quotations that could provide a deeper explanation to the results from the content analysis were sought, i.e. why some recommendations did not result in actions

taken. All such quotations that expressed challenges to implementation were subsequently highlighted. These selected quotations were categorised with regard to common factors. This process resulted in two main factors, which are presented in Section 5.2.

5. RESULTS AND ANALYSIS

5.1 Content analysis

This section presents the results from the content analysis of the feedback from the safety authority to the accident investigation board. As shown in Table 1, only about 12 % of the recommendations had been followed by completed actions when the safety authority reported back to the accident investigation board (see category A1), whereas 43 % of the recommendations had led to actions that were initiated but not completed (category A2). In addition, 27 % of the recommendations had only resulted in actions that were planned but not yet initiated (category A3). Although these results show that most recommendations at least resulted in some planned actions, almost one out of five (18 %) of the recommendations did not lead to any actions at all (classified into category B). These results hence indicate the existence of some challenges to implementation of recommendations.

Category B was divided into two sub-categories based on common factors, see Table 1. The first sub-category included remedial actions that were described as not falling under the receiver's role or mandate (B1). The second sub-category included remedial actions that were described as not relevant or not necessary, e.g. since they already existed in current legislations, procedures etc. (B2). Table 1 shows that 9 recommendations were classified into category B1, and 10 recommendations into category B2. This corresponded to 8.6 % and 9.5 % of the total number of recommendations, respectively. As described previously, interviews with a number of key players involved in the implementation process were conducted in order to gain deeper insights into these challenges. In the following two sections (5.2.1. and 5.2.2.), results from these interviews are presented.

Table 1: Results from the content analysis of reported feedback following 105 recommendations regarding their subsequent actions

Category	Description	Number of recommendations	Proportion of all recommendations
A1	Actions already taken and completed	13	12.4 %
A2	Actions initiated, but not fully completed	45	42.9 %
A3	Actions planned, but not yet initiated	28	26.7 %
B1	No action planned or taken because the remedial action was described as not falling under the receiver's role or mandate	9	8.6 %
B2	No action planned or taken because the remedial action was described as not relevant or not necessary, e.g. since it already existed in current legislations, procedures etc.	10	9.5 %
	Total	105	100 %

The inter-subjective agreement was checked by letting a master student in risk management and systems safety use the coding instructions to conduct a content analysis on a randomly selected sample of 60 % (n=63) of the reported feedback. The results revealed 97 % agreement between the author's and the master student's classifications.

5.2 Interviews

5.2.1 Roles: insider vs. outsider

This section describes challenges related to implementing the recommendations that were classified into category B1, i.e. actions not falling under the receiver's role or mandate. These challenges can be attributed to the diverse views on each other's roles among the various actors, particularly regarding how close ties the investigation board and the safety authority had to the rest of the railway industry. The section will firstly describe the differences in views on the investigation board's role, and secondly, the differences in views on the safety authority's role.

Although the Railway Safety Directive clearly points out that the investigation board shall be independent from the rest of the industry, the interviews revealed some challenges to fully achieve this in practice. In order to conduct adequate investigations it is essential that the investigators have significant knowledge of the ways in which daily operations in the sector are carried out. Attaining this knowledge requires that the investigators have experience from, and therefore also personal ties to, the industry. At the same time, an external view is necessary in order to identify weaknesses in the system under scrutiny. This is because actors who are too deeply immersed in the sector easily get a "tunnel vision", which makes it difficult to uphold this critical view. One of the respondents from the infrastructure provider commented upon this trade-off facing the investigation board:

> "It is very difficult to uphold an independence and simultaneously have sufficient knowledge of the sector in order to actually understand what has happened. […] You need to have a certain degree of sector knowledge, an understanding of what is going on and how the system is built"

These conflicting interests between independence and sector knowledge create a need for the investigation board (as well as for the safety authority, as described later in this section) to make a trade-off regarding their connection to the industry they work with. This trade-off can be described in terms of being an "insider", i.e. having a high degree of knowledge and close ties to the sector, but a limited degree of independence and external view, versus being an "outsider", i.e. having a limited knowledge of the sector but a strong ability to see events from a new perspective. In those cases when the investigation board recruits staff with long experience from the industry, it is important to be aware of the investigator's preconceptions and potential biases. This was pointed out by one of the respondents from one of the smaller train operator companies:

> "A risk that you need to be watchful of is that you are accustomed to a specific way of thinking, acting, and analysing from the operator you come from, and in this way fail to make a critical analysis"

The respondents from the investigation board emphasised their independence, and that they see themselves as outsiders. They described their task as pointing out problematic areas rather than coming up with specific instructions for action, since they do not have the sector knowledge required for designing such detailed suggestions for changes. As a result, the respondents from the investigation board argued that a recommendation should be relatively general and contain different alternatives for action on how to achieve desired effects:

> "We rather try to find problematic areas and point at them […]. We do not believe that we are the ones who know best what should be done; we do not have that sector knowledge or the actual expertise, but we try to identify areas where something should be done, and then it is up to the safety authority and the operators to find the best solution together"

Overall, most respondents stated that the primary value of the investigation board was its independence, since this creates opportunities to see things from a more holistic perspective (which will be further described in the next section). One of the respondents from the infrastructure provider emphasised that:

> "The investigation board can put things in a more wide-ranging perspective. Their role is to see the event from a broader perspective […]. They shall assess the big picture in a different way"

However, in contrast to the other respondents, the safety authority experienced that the investigation board in some respects had too much of an outsider role in the sense that the investigators did not have sufficient knowledge of the safety authority's mandate. As a result, the investigation board sometimes issued recommendations that the safety authority considered they could not address, since these recommendations were directed at factors outside the safety authority's powers. One of the respondents from the safety authority highlighted that actions can only be taken as long as the recommendations fall under their mandate:

> "We must never go outside of the mandate we have in laws and regulations […]. This is decisive; we have to make sure that we have a mandate before we impose any requirements […]. If the investigation board recommends us to prescribe something in a regulation, then it has to be within the limits of our mandate, otherwise we cannot prescribe it"

In the cases when the investigation board issued recommendations that the safety authority did not consider to be within the scope of their mandate, no further actions were taken. These recommendations were classified into category B1 in Table 1. Although the respondents from both the investigation board and the safety authority pointed out that the communication between these two actors had improved gradually, it can be concluded that mutual understanding of each other's roles is essential for successful implementation of recommendations.

So far, this section has only revealed differences in views on the investigation board's role. However, the results from the interviews also showed differences in views on the safety authority's role. Particularly, this divergence in viewpoints concerned the level of detail of the safety authority's inspections. To some extent, this is a question of resources and power, which was pointed out by one of the respondents from a smaller operator:

> "The tiny safety authority in this industry – how many are they? 40 persons on the railway branch – of which 10 deal with infrastructure issues? And the giant [infrastructure provider] with 6000 [employees], how are they supposed to be able to conduct effective inspections? […] There is some kind of imbalance of power"

Although resource constraints play an important role, this was not the only explanation as to why the key players had diverse views regarding an adequate level of detail of the safety authority's inspections. The interviews revealed that the safety authority faces a similar challenge as the investigation board between being insider and outsider. For the safety authority, too close involvement means that they practically become a part of the operators' safety management processes. In this way they fail to maintain an external view of the operators' work, i.e. they become too much of an insider. On the other hand, if the safety authority merely carries out a superficial assessment of the operators' safety management systems, they fail to identify weaknesses. In this way they become too much of an outsider. The interviews revealed that the investigation board and the safety authority had divergent views on the way that the safety authority should handle this trade-off between insider and outsider. The investigation board expressed expectations vis-à-vis the safety authority to carry out a detailed examination of the operators' safety management systems. However, these expectations were generally not met, and one respondent from the investigation board expressed the different views on the safety authority's work:

> "Sometimes there is a rather significant difference in views on roles, and it happens that we are mocking each other […]. We have different views on for example inspections. We think that inspections, just the concept inspection means something else than just call and ask 'is everything fine? Yes. Ok, fine.' This is not our view of inspections, at least not worth its name. Inspection is when you actually find something out yourself, and not just ask 'Is everything fine?'. And this is where our views have significantly diverged. And this means that they [the safety authority] feel that we demand a lot of things from their inspections that they simply cannot deliver"

The safety authority's view on an adequate trade-off between insider and outsider was revealed by the reported feedback to some of the recommendations. For example, one of the recommendations from the investigation board (denoted RJ 2009:06 R2) following a collision incident suggested that the safety authority should discover each occurrence of changes to regulations that demanded operators to revise their risk assessments or take other actions. The close involvement in the operators' safety management processes requested by this recommendation was not in agreement with the safety authority's view on their role. This is evident from the safety authority's feedback to the investigation board:

> "The safety authority has the task of supervising that operators have an operational safety management system. For this reason the authority *should not be seen as an integrated part of their safety management system*. The safety authority considers that *it is not the authority's role to discover and test all changes that an operator can carry out*. This has to be covered by the operators' internal control" (italics added)

In the same way the feedback following another recommendation (denoted RJ 2010:03 R4) expressed:

> "The detailed knowledge of the facility and the responsibility for its use lies with the infrastructure provider. [The safety authority] *considers that the safety authority cannot and shall not carry out a detailed inspection of each infrastructure provider's own TRI* [Traffic Safety Instructions] in the way referred to in the recommendation. The companies must themselves ensure that the rules they have, regarding for example safety critical communication, are safe and applicable to their infrastructure" (italics added)

This feedback revealed that the safety authority views their role as more of an outsider than the investigation board does. The safety authority places a lot of emphasis on each operator's individual responsibility to work systematically with safety. By way of preliminary conclusion, the results presented in this section showed that a divergent view exists on how close ties the safety authority and the investigation board should have to the operators. From these findings it can be concluded that this difference in views on each other's roles influences the potential for implementing recommendations. Another factor of importance to the implementation of recommendations relates to the scope of the investigations and their ensuing recommendations. This factor will be described in Section 5.2.2.

5.2.2 Scope of investigation: micro-level vs. macro-level

In this section, the challenges to implementing the recommendations classified into category B2 will be described. The common theme for these recommendations was that they suggested changes to the safety authority's processes related to certification and inspection. However, the safety authority experienced that the analysis in these investigations did not provide sufficient guidance on how their work should be modified in order to prevent similar events in the future. In particular, the safety authority experienced that these recommendations suggested actions that already were carried out or processes that already existed. As a result, these recommendations were not followed by any actions. Examples of this include an investigation of an incident with uncontrolled movement of a train (denoted RJ 2008:04). The findings of the investigation were as follows:

> "The direct cause of the incident was the fact that the carriages were not secured against rolling when the brake system was emptied of air. The underlying cause to not securing the carriages against rolling was the fact that the [staff] was not sufficiently familiar with the location. Furthermore, there was no information about the inclination of the tracks in [Location X] in the [infrastructure provider's] safety plan which could be transferred to the [train operator's] internal procedures"

The primary causes of the incident as described in this report consequently included the actions taken by individual operators (which will here be referred to as factors at the system's micro-level) and the organisational factors influencing these conditions (referred to as factors at the meso-level). From these attributed causes the investigation board formulated three recommendations, of which the first one read (denoted RJ 2008: 04 R1):

> "[The safety authority] is recommended to act to ensure that the train operators' safety management systems are sufficient for capturing that their staff has the right competence to carry out their work tasks"

This means that the recommendation was directed towards the safety authority's internal processes related to certification and inspection at the macro-level of the system. However, the investigation report identified causes or contributory factors at this level only to a limited extent. Therefore, the respondents from the safety authority experienced that they were lacking guidance on how their work processes had contributed to the incident, and what changes should be made in order to prevent similar incidents in the future. In this respect, they experienced that the link between the analysis and recommendations in the investigation report was weak. One of the respondents from the safety authority commented upon this:

> "We have levelled quite strong critique […] towards the investigation board, and we mean […] there has to be at least a causal connection, I think, between the event and the conclusions. And we think that it has happened that [the investigation board] has pointed at factors that have not been important to the occurrence of the accident, and built a recommendation upon that, and this is something that we have raised, of course […]. It is extremely difficult… we cannot implement a recommendation that does not have a full support in the conclusions, analysis and facts. That is not possible for us; it is a really important thing. This does not happen every time, but it has occurred that this has been unclear, and that we have not been able to see that link"

Since the safety authority experienced that the investigation board's report did not demonstrate a clear link between the work carried out by the safety authority at the macro-level and the attributed causes to the incident at the micro and meso levels, the safety authority chose to not take any actions. This is shown in the feedback to the investigation board. In this feedback the safety authority described that the recommended actions were no different from the actions that were already carried out, and that changes therefore could not be justified:

> "[The safety authority] *always checks* in its certification that the railway operators' safety management systems are able to capture that their staff has the right competences to carry out their work tasks. Through our inspections, the railway operators' safety management in this respect are also checked" (italics added)

In several similar recommendations in category B2, the safety authority described that they experienced an analytical gap between analysis and recommendations. In these cases, a thorough analysis of the way in which factors at the macro-level influenced factors at the micro-level was missing. By failing to describe this link, the investigation board's recommendations did not result in any actions, since the safety authority perceived that the recommended actions did not differ from the activities that were already carried out.

These results underline the importance of accident investigations that provide a sufficiently thorough basis for the receivers to take actions that can lead to safety improvements. Normally, a significant focus of accident investigations is devoted to analysing the way that micro-level factors have contributed to the accident (such as the train driver's actions in the immediate time span before the accident). Lessons from these aspects are particularly valuable for those organisations that were involved in the accident, especially when their own resources are not sufficient for carrying out as extensive investigations as the accident board does. However, in many cases, factors at lower system levels merely represent symptoms of more profound problems, which means that the investigation should not be restricted to factors at these levels. Rather, a trade-off between aspects at different levels of a socio-technical system is necessary. By including aspects at the macro-level of a system, such as the work processes by the safety authority, lessons can be identified that are of cross-sector value and that are not captured in the operators' internal investigations. This potential to investigate accidents from a more holistic perspective was emphasised by several respondents as one of the main strengths of an independent investigation board. For example, one of the respondents from the safety authority expressed that:

> "The added value of [the investigation board's reports] is to get this holistic perspective […]. I don't think that the value of the investigation board is that they are better at investigating the details, but that they can have a broader perspective of the system as a whole, and perhaps to see things in the operators and their systems that you cannot see internally. These things, such as interfaces between [different authorities], can be difficult to see if you are not from the outside. At major events it is important that you have someone who looks at it from a higher level than what the individual operator is able to do"

It should be noted, however, that there are numerous difficulties in carrying out investigations that include aspects at the macro-level. As described in Section 3, a common observation is that the further away from the immediate accident scene an accident investigation moves, the more "normal" everything looks. In this way, there are generally no obvious "errors" or parts that are "broken" on higher system levels. The complexity arising as a result of the non-linear interactions between processes at various levels of a socio-technical system therefore raises high demands on the skills of the investigators as well as the method adopted. Unless the investigation report presents a coherent account of the relationships between factors at different levels, as well as the way this account gives rise to the recommendations, the implementation process is likely to face the type of challenges outlined in this section.

6. DISCUSSION

The results presented in this paper showed that the key players' views on each other's roles (insider vs. outsider) and the scope of the investigations (micro-level vs. macro-level) posed challenges to the implementation of recommendations. However, these obstacles should not be seen as a motive for abandoning the investigation process altogether. Despite some challenges to implementation, the respondents expressed their appreciation of the investigations conducted by the investigation board. For example, these investigations often contribute to providing a holistic perspective of the accident; they can be used by the operators' safety departments to argue with management about safety investments; and they are generally much more detailed and thorough than the internal investigations conducted by each operator. In order to further increase the value of the investigations, it is therefore important to identify ways of overcoming some of the obstacles to implementation.

The findings in this paper showed that one of the areas in which potential improvements could be made is the link between analysis and recommendations in accident investigations (see Section 5.2.2). While it is obvious that an important task for the investigation board is to find out what happened and why, it is equally important to provide a clear and logically coherent description of the way this narrative is transformed into a roadmap for avoiding similar failures in the future. In the investigation reports studied in this paper, the connection between the historical account (what happened) and the normative one

(what should be done) appears unproblematic; once a number of "causes" have been identified, the "remedies" are obvious. In most cases, however, this transition from analysis to recommendation – from history to future – is far from straightforward. In complex socio-technical systems there are typically many possible types of counter-measures for dealing with a specific problem, all of which have their strengths and weaknesses (for example regarding their effectiveness and their potential for causing unintended side effects). The connection between analysis and recommendation thus leaves great room for improvement. If this link is not clearly demonstrated, the receivers will face significant difficulties in their efforts to implement the recommendations.

Several challenges to presenting more detailed suggestions on improvements of the implementation process can be identified, which demonstrates the need for further studies. In particular, it is important to recognise that there is no "correct" way of making trade-offs on the factors identified in this paper regarding the views on each other's roles (insider vs. outsider) and regarding the scope of the investigations (micro-level vs. macro-level). If heavy focus is placed on one aspect, a number of benefits will emerge, but also inevitable drawbacks. For example, at the same time as a closer connection between the investigation board and the safety authority is advocated in order to create increased understanding of each other's roles and perspectives, this may also put the investigation board's independence at risk. Making suggestions on improvements of the implementation process becomes even more complex by the fact that the two trade-offs identified in this paper are not completely independent of each other. For example, being an outsider increases the possibility, although it is not a guarantee for, identification of important aspects at the macro-level of a socio-technical system. Therefore, in order to suggest changes to the ways in which the identified trade-offs should be made, careful consideration of the potentially negative side effects of such changes needs to be taken.

As a basis for this study of challenges to implementation, two key data sources were used. Firstly, all reported feedback from the safety authority to the investigation board that was available at the time of writing the paper was included in the analysis. This comprehensive data set included feedback following 105 recommendations. Secondly, interviews with a number of key players involved in the implementation process were conducted. In these interviews, particular attention was paid to the ways in which the interplay between the investigation board and the safety authority affects implementation of recommendations. Since both of these actors are relatively small, the selected respondents represent a large proportion of each organisation's staff. The interviews therefore gave a broad picture of their work. In addition, interviews were conducted with the infrastructure provider and a number of various operators, since these actors also play essential roles in the implementation process (see Figure 1). The selected operators included two of the largest actors in the Swedish railway sector. Moreover, respondents from three smaller operators were interviewed. The problem of incorporating the smaller actors in the study was that they very rarely are involved in accidents of magnitudes calling for the involvement of the investigation board. It was therefore difficult to attain more general responses from these smaller operators. Despite this limitation, the interviews contributed with valuable insights by illuminating the investigation process from multiple perspectives, which is essential in order to gain understanding of the governance of risk in this type of multi-actor setting.

The interviews were conducted with the aim of explaining why some recommendations did not result in implemented actions. The obvious rationale behind this objective was that unless recommendations lead to implemented actions, the entire investigation process loses much of its value. Understanding of potential challenges to this process is therefore essential. Nonetheless, interesting insights could also have been gained by reversing the objective, i.e. to investigate why recommendations actually become implemented. This approach would be in line with Hollnagel's (2011) remark that focus in safety science should not only be placed on why things go wrong, but also why they go right. Although not investigated in the present paper, explanations of successful implementation constitute an interesting possibility for future research.

The trade-offs identified in this paper have previously not attracted much attention with regard to their role for implementation of recommendations from accident investigations. Nonetheless, other authors have to some extent identified these factors in related contexts. The first challenge, which related to balancing the roles of being an insider and outsider to the industry, has been discussed by for example Dekker (2011). He raises the problem of lacking credibility, which a high degree of an outsider role may entail. The same problem is addressed by Roed-Larsen and Stoop (2012), who argue that total independence is neither practically possible, nor desirable, since this disconnects the investigation board from the operative environment (see also Dechy et al., 2012, for a similar line of argument). Woods (2006) raises a similar point regarding the need for an organisation's safety department to be both "informed" (the need to know how the organisation is operating) and "independent" (the need to be able to challenge conventional assumptions). Moreover, Vaughan highlights the risk of becoming "enculturated", i.e. the danger that the persons scrutinising a system become so familiar with it that they cannot see it from an external and critical perspective (1996).

The second challenge, which related to making a trade-off between micro-level and macro-level factors, has also been described in the research literature. Several authors have stressed the importance of including factors at the macro-level by adopting a systems perspective in accident investigations (see e.g. Leveson, 2011). Focus of accident investigations is often placed on aspects at the micro-level (see Cedergren and Petersen, 2011). However, at the same time as Dekker (2011) claims that investigations including factors at the macro-level have become more common, he points out that the approach behind these analyses in many cases cannot be considered as systems approaches. This is because the investigations place significant attention to finding individual parts that have malfunctioned at the various system levels, rather than focusing upon the relations between different levels, which is the essential meaning of a systems perspective.

In addition to confirming the importance of the results from these previous studies in the current context, the main value of the present paper lies in the perspective that has been adopted. In previous studies of challenges to implementation, the process has been analysed from a relatively one-sided perspective. For example, Lundberg et al. (2010; 2012) studied challenges to implementation from the investigators' perspective. Although this is a valuable viewpoint, it leads to a somewhat incomplete description of the difficulties related to making safety improvements in multi-organisational settings. The reason for this is that the investigator is not normally the actor with the responsibility for implementing remedial actions. Knowledge and understanding of the processes that take place after the completion of the accident investigation and its ensuing recommendations are thus missed with this perspective.

In order to create deep understanding of challenges to the governance of risk in contexts involving a large number of actors, it is not sufficient to restrict the data source to one single stakeholder. Rather, a multi-organisational perspective that takes the constraints and trade-offs facing each actor into consideration is necessary. The value of this perspective for studies of implementation is highlighted by for example Hill and Hupe (2002: p. 16): "The broadening of the perspective on implementation to a multi-disciplinary, multi-level and multi-focal exercise looking at a multiplicity of actors, loci and layers clearly should be welcomed". Following the advice from these authors, this paper has paid significant attention to the importance of studying the interplay between various actors involved in the implementation process. In particular, the interaction between the investigation board and the safety authority has been investigated. These bodies need to be established in all EU member states according to the Railway Safety Directive (although they are not identically organised in different countries). The relevance of the results is therefore not restricted to the Swedish railway sector. On the contrary, similar structures exist both in the railway sector in an international perspective, and in other industries.

The interviews with various stakeholders involved in the implementation process contributed with insights into their internal work processes as well as the interactions between them. These various stakeholders have different roles and responsibilities in the implementation process. A negative side-effect of this specialisation and division of responsibilities is that limited attention is paid to the co-ordination of the

different tasks to create a whole (Heath and Staudenmayer, 2000). This means that the trade-offs that are made at the local level in each organisation have implications for the ability to make safety improvements that affect the system at the industry level. In this way, the paper contributes by highlighting the risk that implementation in this type of context leads to "multi-organizational sub-optimization" (Exworthy and Powell, 2004; Hood, 1976), i.e. that each organisation is pursuing its separate objectives but with outcomes that are not optimal overall (see also Ostrom, 1999; Woods and Branlat, 2011).

7. CONCLUSIONS

From the results presented in this paper, it can be concluded that most recommendations issued by the investigation board were followed by some kind of action (implemented, initiated or planned). However, almost one out of five recommendations did not result in any actions at all. In the interview study conducted with a number of key players involved in the implementation process, challenges to the implementation of these recommendations were further investigated. Two important factors that gave rise to such challenges were identified. The first factor related to the various key players' views on each other's roles, and can be described as a trade-off between being insider and outsider to the industry. The second factor related to the scope of the investigations and their recommendations, and can be described as a trade-off between micro-level and macro-level factors. The way that these trade-offs are made by each individual actor has a major impact for other actors' work with implementation. In this way, the results highlighted the importance of co-ordination of the different actors involved in the implementation process, and it can be concluded that challenges to implementation from accident investigations to a large extent arise in the interplay between these actors.

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REFERENCES

Boholm, Å., Corvellec, H., Karlsson, M., 2012. The practice of risk governance: Lessons from the field. Journal of Risk Research 15 (1), 1-20.

Carroll, J.S., Fahlbruch, B., 2011. "The gift of failure: New approaches to analyzing and learning from events and near-misses." Honoring the contributions of Bernhard Wilpert. Safety Science 49 (1), 1-4.

Cedergren, A., Petersen, K., 2011. Prerequisites for learning from accident investigations - A cross-country comparison of national accident investigation boards. Safety Science 49 (8-9), 1238-1245.

Dechy, N., Dien, Y., Funnemark, E., Roed-Larsen, S., Stoop, J., Valvisto, T., Arellano, A.L.V., 2012. Results and lessons learned from the ESReDA's accident investigation working group: Introducing article to "safety science" special issue on "Industrial events investigation". Safety Science 50 (6), 1380–1391.

Dekker, S., 2006. The field guide to understanding human error. Ashgate, Aldershot.

Dekker, S., 2011. Drift into failure: From hunting broken components to understanding complex systems. Ashgate, Farnham.

DeLeon, P., 1999. The missing link revisited: Contemporary implementation research. Review of Policy Research 16 (3-4), 311-338.

Dien, Y., Dechy, N., Guillaume, E., 2012. Accident investigation: From searching direct causes to finding in-depth causes – Problem of analysis or/and of analyst? Safety Science 50 (6), 1398–1407.

Exworthy, M., Powell, M., 2004. Big windows and little windows: Implementation in the 'congested state'. Public Administration 82 (2), 263-281.

Heath, C., Staudenmayer, N., 2000. Coordination neglect: How lay theories of organizing complicate coordination in organizations. Research in Organizational Behaviour 22, 153-191.

Hermans, M.A., Fox, T., van Asselt, M., Risk governance. In: Roeser, S., Hillerbrand, R., Sandin, P., Peterson, M. eds. Handbook of risk theory. Springer, New York, pp. 1093-1117.

Hill, M., Hupe, P., 2002. Implementing public policy: Governance in theory and in practice. Sage, London.

Hogwood, B.W., Gunn, L.A., 1984. Policy analysis for the real world. Oxford University Press, Oxford.

Hollnagel, E., 2004. Barriers and accident prevention. Ashgate, Aldershot.

Hollnagel, E., 2011. Prologue: The scope of resilience engineering. In: Hollnagel, E., Paries, J., Woods, D.D., Wreathall, J. eds. Resilience engineering in practice: A guidebook. Ashgate, Farnham, pp. xxix-xxxix.

Hood, C.C., 1976. The limits of administration. John Wiley & Sons, London.

IRGC, 2005. White paper on risk governance: Towards an integrative approach. International Risk Governance Council (IRGC), Geneva.

Kjellén, U., 2000. Prevention of accidents through experience feedback. Taylor & Francis, New York.

Krippendorff, K., 2004. Content analysis: An introduction to its methodology. Sage, London.

Leveson, N., 2004. A new accident model for engineering safer systems. Safety Science 42 (4), 237-270.

Leveson, N., 2011. Applying systems thinking to analyze and learn from events. Safety Science 49 (1), 55-64.

Lundberg, J., Rollenhagen, C., Hollnagel, E., 2010. What you find is not always what you fix—How other aspects than causes of accidents decide recommendations for remedial actions. Accident Analysis and Prevention 42 (6), 2132–2139.

Lundberg, J., Rollenhagen, C., Hollnagel, E., Rankin, A., 2012. Strategies for dealing with resistance to recommendations from accident investigations. Accident Analysis and Prevention 45, 455-467.

Marsh, D., Furlong, P., 2002. A skin, not a sweater: Ontology and epistemology in political science. In: Marsh, D., Stoker, G. eds. Theory and methods in political science. 2 ed. Palgrave Macmillan, New York, pp. 17-41.

Ostrom, E., 1999. Coping with tragedies of the commons. Annual Review of Political Science 2 (1), 493-535.

O'Toole, L.J.Jr., 2000. Research on policy implementation: Assessment and Prospects. Journal of Public Administration Research and Theory 10 (2), 263-288.

Perrow, C., 1984. Normal accidents: Living with high-risk technologies. Basic Books, New York.

Pressman, J.L., Wildavsky, A., 1984. Implementation: How great expectations in Washington are dashed in Oakland, 3rd ed. University of California Press, Berkeley.

Railway Safety Directive of the European Union (2004/49/EC) of 29 April 2004

Rasmussen, J., Svedung, I., 2000. Proactive risk management in a dynamic society. Swedish Rescue Services Agency, Karlstad.

Reason, J., 1997. Managing the risks of organizational accidents. Ashgate, Aldershot.

Renn, O., Klinke, A., van Asselt, M., 2011. Coping with complexity, uncertainty and ambiguity in risk governance: A synthesis. AMBIO: A Journal of the Human Environment 40 (2), 231-246.

Roed-Larsen, S., Stoop, J., 2012. Modern accident investigation – Four major challenges. Safety Science 50 (6), 1392–1397.

Rollenhagen, C., 2011. Event investigations at nuclear power plants in Sweden: Reflections about a method and some associated practices. Safety Science 49 (1), 21-26.

Sklet, S., 2004. Comparison of some selected methods for accident investigation. Journal of Hazardous Materials 111 (1-3), 29–37.

van Asselt, M., Renn, O., 2011. Risk governance. Journal of Risk Research 14 (4), 431-449.

Vaughan, D., 1996. The challenger launch decision: Risky technology, culture, and deviance at NASA. The University of Chicago Press, Chicago.

Vedung, E., 1997. Public policy and program evaluation. Transaction Publishers, New Jersey.

Weber, R.P., 1990. Basic content analysis. Sage, London.

Woods, D.D., 2006. How to design a safety organization: Test case for resilience engineering. In: Hollnagel, E., Woods, D.D., Leveson, N. eds. Resilience engineering: Concepts and precepts. Ashgate, Aldershot, pp. 315-325.

Woods, D.D., Branlat, M., 2011. Basic patterns in how adaptive systems fail. In: Hollnagel, E., Paries, J., Woods, D.D., Wreathall, J. eds. Resilience engineering in practice: A guidebook. Ashgate, Farnham, pp. 127-144.