

Approaches to accident prevention: A comparative study of eleven Swedish authorities

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Abstract

A comparison has been made between 11 Swedish authorities involved in accident prevention. The authorities' fields of responsibility were in industry, transportation, the environment, and medical care. The aim of the investigation has been to examine approaches to and methods for the prevention of accidents. Representatives from the authorities participated in three seminars and responded to a questionnaire.

There are several issues and problems which are of common concern to the authorities. A majority state that one of their greatest problems is to get the "object" of their surveillance to take responsibility, act in a committed manner and work systematically. Also, nearly all state that there are safety problems with computer-controlled equipment and with demands imposed on individuals, e.g., skills demands.

At a majority of the authorities, development is in progress of methodologies to be utilized in safety matters. This applies, for example, to the investigation of accidents, surveillance and inspection, and the scrutiny of results from safety analyses. There did not seem to be any appreciable collaboration between authorities across sectoral boundaries with regard to development aimed at safety issues. However, a need for such collaboration appeared to have advantages. Only a few of the authorities gave prominence to contacts with the international scientific community as a means for improving their approaches and working methods in relation to safety.

1. Introduction

Accidents are a major societal problem. In Sweden alone, they give rise to 3000 fatalities and 140000 persons requiring hospital care each year (Socialstyrelsen, 1991). Different types of accidents require different strategies and methods for prevention. This study focuses on accidents related to organized activities, such as industrial operations, the provision of public transport and other public services. Between 20 and 30 per cent of accidents can be

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attributed to such activities. As well as injuries to human beings, accidents can give rise to environmental damage, the destruction of investments, and the disruption of industrial and social operations.

Society has a range of control instruments through which it can influence accident risks. In preventive work, supervisory agencies and inspectorates have a central role to play. The influence of these authorities on risk management in society takes on several different forms, which are operative at different levels. Influence can be exerted **formally** through the issuing of directives and advice, licensing requirements for certain activities, and inspection. The breadth of formal control is wide, ranging from strict direction to playing an advisory role, sometimes even via other organs. An authority can also take an **informal** route by, intentionally or unintentionally, exerting influence on other authorities, organizations, companies or private citizens. That the inspectorates have different roles and tasks means that they have a variety of requirements with regard to methodological expertise, dissemination of information, etc.

The main focus of this study is on the methodologies employed by the authorities to identify and assess accident risks in organized activities, and on how these authorities then utilize a variety of means to exert influence on those with responsibility for hazard prevention. To our knowledge relatively little research has been conducted in this area, despite its importance.

The role of the authorities with regard to major accidents and in relation to the Seveso Directive (CEC, 1982) has been examined in a number of studies. For example, ‘national approaches to the safety report’ have been investigated by Amendola and Contini (1991), while a Nordic study is reported in Malmén et al. (1992).

One example of a country with many different authorities responsible for the surveillance of accident risks is Norway. To coordinate safety work, a superordinate directive on internal control has been issued (Kommunaldepartementet, 1991). The directive is designed to promote safety in the occupational environment, protection against health and environmental damage caused by products, protection of the outdoor environment against pollution, and improved waste treatment. By internal control is meant the taking of systematic measures to ensure that the requirements laid down in legislation and directives are fulfilled. The directive has prompted authorities, which previously had poor contact with each other, to start to collaborate in a variety of ways (Hovden, 1991).

In relation to this directive, a study was conducted of seven different Norwegian inspectorates and how they work in the field of internal control (Skaar and Sklet, 1992). The Norwegian study was undertaken at the same time as the Swedish one described here. It takes up themes such as strategies of the authorities, the goals of inspection, priorities and forms of working. Examples of its general findings are as follows:

- Some authorities have goals that are superordinate by nature. Others have a goal hierarchy with targets for activities broken down to the level of the individual responsible.
- Some authorities have concentrated on quantifiable targets.
- Strategies vary. Some authorities concentrate on educational courses and training, others on motivational campaigns. A third group focuses on auditing and verification.
- There are many differences between the various authorities.

Olsen (1992) has compared the handling of styrene by labour inspectorates in six different countries (Sweden, Denmark, Norway, Finland, Italy, and the United Kingdom).

For the purpose of comparison and in order to explain the differences, the author utilized a variety of different perspectives. Ideas on “regulation” vary considerably according to differences in theoretical traditions, and both our findings and those of the Norwegian study confirm this.

2. Design of the study

This paper is based on a more wide-ranging report in Swedish and an already-published brief description in English (Harms-Ringdahl and Ohlsson, 1993a; Harms-Ringdahl and Ohlsson, 1993b). In the reporting of results and in the discussion, we have confined ourselves to a selection of subareas from within the overall study.

2.1. Aim

The original desire was to obtain an overall picture of the nature of risk management within different kinds of organized activities, such as nuclear power, civil aviation and industry, and then make cross-sectoral comparisons.

For practical reasons, we restricted the gathering of information to a selection of authorities, concentrating on their views on approaches and problems. The primary aim of the study was to obtain an overall perspective. It was considered that more detailed and in-depth issues might be taken up in a possible continuation project. Thus, the concrete goals of the project were to obtain:

- A general view of the work of the authorities.
- Compilations of views within the authorities on their field of activities and the problems they faced.
- A summary of research in progress.
- An identification of issues of importance in several areas of activities, and to more than one authority.

2.2. Theoretical background

Our approach primarily involved seeing how the authorities regarded hazards and risk management at the companies they supervised. It was expected that there would be major differences between the authorities with regard to both the terminology they employed and their theoretical perspectives on how accidents should be prevented. For this reason, we have been hesitant to work with a strict body of terms, and have avoided placing excessive emphasis on how issues are formulated scientifically. This also means that the reader should be cautious in interpreting the responses.

It should be mentioned that we had a holistic risk management approach in mind. Such an approach has been advocated by many authors (e.g., Haimes, 1989). Risk management and safety culture are regarded as being affected by a multitude of factors in complex interaction. A simple model of accidents and risk management was utilized (Harms-Ringdahl, 1987; Harms-Ringdahl, 1993). Basic elements in this model are:

1. A systems view in which an accident is regarded as being due to technical/physical factors, individuals' behaviour and organizational frame conditions.
2. The view that accidents have multiple causes and are frequently induced by initially small deviations or latent errors (e.g., Reason, 1990), which might be serious under specific circumstances.
3. A simple feedback model of risk management, which might be applicable to both companies and authorities.

Throughout this paper the concepts "company" and "company-level" are employed. These terms are used in a wide sense, applying here not only to a private industrial company, but also to public transportation, nuclear power stations and even the health service.

Earlier empirical research (e.g., Reason, 1990; Harms-Ringdahl, 1993) had given an indication of some of the central issues that arise in the field of accident prevention. Accordingly, special attention was paid to the handling of human errors, problems with computer-controlled installations and the scrutiny of companies' risk management.

2.3. Method

The project was implemented in collaboration with the authorities listed in Table 1 below. Their active participation has been essential. The project comprised the following main stages:

- Preparations and contacting the various authorities.
- Seminar to discuss proposals for a questionnaire.
- Administration of the questionnaire to the authorities.
- Seminar to discuss the results of the survey.

Table 1
The eleven authorities investigated

Authority	Budget ^a	Employees	Relevant ministry
National Board of Civil Preparedness	52	195	Defence
National Board of Health and Welfare, Hospital Division	196	418	Health and Social Affairs
National Board of Occupational Safety and Health	350	900	Labour
National Inspectorate of Explosives and Flammables	13	30	Industry and Commerce
National Maritime Inspectorate	100	140	Transportation and Communication
National Railway Inspectorate	12	20	Transportation and Communication
Swedish Board of Rescue Services	1251	720	Defence
Swedish Civil Aviation Administration, Flight Safety Department.	105	115	Transportation and Communication
Swedish Environmental Protection Agency	420	450	Environmental and Natural Resources
Swedish Nuclear Power Inspectorate	97	90	Environmental and Natural Resources
Swedish Radiation Protection Institute	68	130	Environmental and Natural Resources
Total	2664	3208	(Six separate ministries)

^aIn million Swedish Crowns for the financial year 1990/1991.

- Compilation of a report.
- Seminar to discuss the report.

The cornerstone of the study is a questionnaire administered to representatives of the authorities. Areas of responsibility and ways of working varied widely between the authorities, which made it essential to design a questionnaire that would function satisfactorily for all those involved. Terminology within the different areas and a draft questionnaire were discussed at the first seminar. Later seminars were held to discuss first the results, and then the final report.

The questionnaire contained 72 questions, of which 15 invited open responses. The themes covered were as follows:

- Background information on the authority in question.
- Strategies and philosophy with regard to how accidents are to be prevented.
- Working methods of the authority.
- Assessment of different kinds of specific problems.
- Key problems in achieving effective risk management at company level.
- Research, both needed and already in progress.
- Future development prospects.

The authors are responsible for the final selection of questions, although this was influenced by the views of the representatives of the authorities. The questionnaire was distributed to the authorities at the end of 1990. The last responding authority delivered its responses one year later, at our urgent request.

3. Results

3.1. The 11 authorities

All the 11 authorities invited to take part filled in the questionnaire. They were given opportunities to make amendments to their responses at the two final seminars, the last of which was held in November 1992. Thus, the responses can be regarded as reflecting the situation at the end of that year.

The participating authorities are listed in Table 1, which also provides some general information about them. For seven of the authorities, the prevention of accidents is a key part of their activities. For others, it is relatively insignificant.

3.2. Philosophy and strategy

An open question was posed on the authority's accident-prevention philosophy. Four stated that they regarded the responsibility of the operator of the system as central. Two had a more technical perspective, offering damage/injury limitation and limitation of probability and consequence respectively. Two other responses were "to increase the account taken of risk in public planning" and "to analyze vulnerability and attempt to reduce it".

A second question concerned strategy for the prevention of accidents. Six authorities stated that it was to ensure that the employer took his responsibility, for example through

surveillance of internal control. Three provided responses on the theme of disseminating information.

The terms ‘‘philosophy’’ and ‘‘strategy’’ were not defined in the questionnaire, and the responses demonstrated a moderate degree of divergence in approach to and attribution of meaning to the concepts. At the final seminar it emerged that the majority subscribed to the view that responsibility (or commitment) was fundamental with regard to both philosophy and strategy. Thus, it seems that issues related to the responsibility of the ‘‘owner of risk’’ are of basic importance, both in principle and in terms of strategy.

3.3. The authorities' own working methodologies

The work and methods of the authorities were taken up in several questions. These applied both to current practices and areas in which development was underway. A selection of questions and a summary of responses to them are provided in Table 2 and Table 3. The questionnaire allowed the respondent to mark more than one forced-response alternative, so the row totals in the two tables exceed 11 on some occasions.

The distribution of ‘‘well-developed’’ methodologies varies between areas. Nine authorities state that they lack developed methods for the scrutiny of safety analyses and their

Table 2
Eleven authorities' perceptions of having a methodology of their own in certain areas

Do you have a specific methodology?	Yes, well developed	Some guidelines	No, not relevant	Varies ^a
Accident investigation regarding				
– role of the technical system	5	5	1	–
– role of the entire system	2	6	3	–
Surveillance, inspection of				
– the technical system	6	5	2	–
– the entire system	4	4	3	–
Safety analyses				
– scrutiny of their results	2	4	0	5 ^a

^aThis response option was offered only for the final question.

Table 3
Eleven authorities' perceptions of ongoing methodological development in certain areas

Is development work in progress?	Yes	To some extent	No, but needed	No, not relevant
Accident investigation regarding				
– role of the technical system	4	3	2	2
– role of the entire system	5	3	2	1
Surveillance, inspection of				
– the technical system	2	6	0	3
– the entire system	4	4	0	3
Safety analyses				
– scrutiny of their results	7	1	2	1

results. An equal number state that they lack a well-developed method for examining the role of the system as a whole in the investigation of accidents.

At a majority of the authorities there is ongoing development work within all the areas taken up. The greatest number of positive responses was received for the development of methods for the scrutiny of safety analyses. This was followed by accident investigations in which the role of the entire system was to be considered.

In the questionnaire and in the study there was an emphasis on formal approaches such as inspections, investigations, etc. From some of the open questions indications were given also on informal approaches. Information service was an important issue for all authorities involved; for two of them it appeared to be the most important one.

3.4. Assessment of acceptable risk

A fundamental question in all risk management is how to assess which risks are acceptable and which are not. The questionnaire contained a number of questions on this issue. The rather simple definition provided on the questionnaire form was that an identified hazard is accepted if no counter-action has been demanded. One question was ‘‘Is judgement of risk acceptance a problematic issue?’’. Of the ten authorities which offered a response to this question, four answered ‘‘Yes’’ and four ‘‘In some cases’’. The issue, however, is complex, and a cautious approach to interpreting the responses must be adopted.

It would have been interesting to go in greater depth into issues surrounding acceptable risk, since the approach generally implies that a clear decision has to be taken. Such an in-depth examination should more clearly be based on decision-making as a key component of risk-management procedure (e.g., Taylor, 1989; Hale et al., 1990).

3.5. Safety problems

One reason for conducting the survey was to identify problem areas that the various authorities had in common. Three issues were considered in the questionnaire, which it was presumed might be the concern of several authorities. These were computer control of technical equipment, demands placed on individuals (in relation to skills and human error) and risk management at company level. The responses are summarized in Table 4.

In general, the study confirms that problems are to be found in the areas to which specific attention had been drawn. The most clearly affirmative responses concerned demands on individuals, and these were regarded as the greatest problem. A separate question sought examples of accidents in the different areas covered by the various authorities. In the cases where it was possible to identify an accident cause given by the authority, human error predominates. Nearly all the authorities consider they have tools available for how demands on individuals are to be handled.

Computer control and risk management are regarded as problem areas by nearly all the authorities. There is a particularly great methodological deficiency with regard to how safety related to computer-controlled equipment is to be managed. Only one of the authorities states that methods for how such systems should be scrutinized is already available.

Table 4
Assessment of three areas with potential problems

Problem/methodology	Computer control	Demands on individual	Risk management
Is this an area with safety problems?			
Yes	6	7	6
In some cases	4	4	3
To a small extent	1	0	0
Do you have principles for handling the area?			
Well developed	1	4	0
Quite well developed	3	5	7
Not so well developed	7	2	2
Is a methodology available for how your authority should scrutinize safety?			
Yes	1	5	2
In some cases	2	2	6
No	8	4 ^a	1
Number of responses	11	11	9

^aOf these, two were negative responses and two non-responses.

Note: The column headings have been abbreviated. The wordings in the questionnaire were: Computer-controlled equipment or other advanced automated installation, Demands on individuals, e.g., on skills, Risk management.

3.6. Key problems

The questionnaire concluded with open-ended questions seeking the overall views of the authorities on a variety of accident-related themes. Summaries of responses on two of these themes are provided, namely key problems, and how research and development might be an aid to their solution.

The question on ‘‘key problems’’ was worded as follows: *What key problems do you face in achieving effective risk management in your authority’s area of responsibility?* Six of the responses referred to **deficiencies in the taking of responsibility and safety consciousness** on the part of ‘‘the object’’. In no case did an authority refer to a lack of inspection procedures or the absence of guidelines for risk management.

The Nuclear Power Inspectorate and the Civil Aviation Administration took the view that there was a problem in that personnel **might become complacent as a result of high reliability** and the occurrence of very few near-accidents. This is a very similar problem to the one referred to above, but an explanation is also offered in this case.

Thus, in eight cases the key to the problem of safety is regarded as lying in deficiencies in responsibility or consciousness, or in staff complacency. Nevertheless, there is probably a great deal of variation with regard to the state of practice in the different areas.

The National Maritime Inspectorate took up the issue of **the role of the authorities**. A body of international regulations has been built up —among other things, on the basis of accidents that have occurred —and no genuine risk analysis has been conducted. We interpret this response to imply that there are suspicions that the regulations have deficiencies which may involve unnecessary risks. That this is a general problem was confirmed by several other authorities in the course of discussion at the final seminar.

The Swedish Civil Aviation Administration highlighted **human malfunction** as the cause of the majority of the crashes that had occurred in civil aviation.

3.7. *How research can help*

The wording of the subsequent question was as follows: What efforts in the field of research and development can help solve these problems? The response pattern was highly varied, and it was difficult to group responses. In fact, the largest group comprised three authorities which offered no response to this question, while a general approach was reported in two cases. The key problems of deficiencies in safety consciousness and responsibility were not referred to in relation to what research and development might achieve in the accident arena. However, it is possible that they form a part of the Swedish Nuclear Power Inspectorate's list of research projects in progress, albeit expressed in a different way.

4. Discussion

4.1. *Methodological problems*

There was a varying attitude to the survey on the part of the representatives of the authorities who filled in the questionnaire. In some cases the responses had been thoroughly considered, in others they were less extensive. For some authorities the questions were rather natural, for others they may not have been fully compatible with the way in which they usually work. There were also differences with regard to the depth of experience possessed in different areas. A further aspect concerns differences between ‘‘how things ought to be’’ and what they are actually like in practice. In the survey, no questions were posed on this issue. For this reason, the responses must be interpreted with caution.

A certain validation of the answers to the questionnaire was obtained by means of the two last seminars. The participants were informed of the results and what the other authorities had answered. Differences and interpretations of answers and questions could be discussed. It was also possible for those who wished to change the answers before the report was published. Less than one percent of the answers were changed in this process.

4.2. *Problem areas*

The study addressed three specific problem areas which, we had supposed, would be the concern of several of the authorities: computer control of equipment, demands on individuals, and risk management at company level (see Table 4). The majority of the authorities agreed that these were indeed problem areas. Moreover, it was emphasized by virtually all the authorities that development work was in progress. That these three areas are of key importance for the Swedish authorities can therefore be regarded as having been established.

The quality of risk management at company level was also specifically taken up in responses to the open question on ‘‘key problems’’. In eight cases, inadequate quality was attributed to deficiencies in responsibility or safety consciousness, or to complacency.

Despite this, the nature and size of the problems can be expected to vary considerably from area to area.

4.3. *Collaboration and forums for concerted action*

It emerged from the seminar discussions that cross-sectoral collaboration with regard to the prevention of accidents was limited. There was an absence of concrete forms of cooperation between inspectorates, and also a lack of joint development work. Nevertheless, there seems to be a growing interest in cooperation on methodological issues related to the more effective prevention of accidents. This was demonstrated, for example, by the fact that so many authorities were prepared to participate in the project.

One explanation for the lack of collaboration so far may lie in the absence of any suitable forum for the discussion of methodological issues. The legislation and operative frameworks that have been laid down for the authorities do not encourage such cooperation. There is a form of collaboration with regard to accidents related to chemicals but, at the time of completion of the study, this had only a formal and legal focus. During 1993 collaboration in greater depth was initiated between five authorities affected by the Seveso Directive (CEC, 1982). In addition, there is a lack of organized collaboration even at regional level (Harms-Ringdahl, 1992).

4.4. *Poor linking to research*

It is seldom that there is organized cooperation with the research community in the safety field, although there seem to be exceptions in the cases of the Swedish Nuclear Power Inspectorate, the Swedish Board of Rescue Services and the National Railway Inspectorate.

One interpretation of this may be that most of the authorities are unfamiliar with research issues, and they may even doubt that research can be of much assistance in their work. This view was not expressed explicitly, but there were certain indications of it in the responses. For example, there was a weak link between what was regarded as the key problem (taking responsibility, safety consciousness or complacency) and where research was required.

Moreover, the researchers proposed that an in-depth continuation study could be conducted in a specific area. The questionnaire had showed a number of areas regarded as problematic, and also areas where several of the authorities were already involved in development work. Examples were management commitment, risk management audits, and risks associated with computer control. There was little interest in this suggestion which was discussed at the seminars. However, during 1994 some of the authorities started discussion on developing a research program, partly based on considerations in this study (Lundström, 1995).

A weak link between research and the work of the authorities in the field of risk management is probably not unique to Sweden. The authors of the paper have discussed this issue with colleagues from a variety of countries, and a majority have obtained a similar impression.

4.5. *Motives for collaboration*

Cooperation over methods and inspection philosophy seems beneficial from several perspectives. Some of the motives for it are as follows:

1. Companies are not kept under surveillance by all 11 authorities simultaneously, but each company is the concern of two or more authorities. A harmonization of rules and inspecting procedures would be of benefit.
2. An improved base in experience would be obtained by crossing sectoral boundaries.
3. Quality can be improved by paying greater attention to both methodology and the work of the authorities.
4. Utilization of resources for development can be improved. Collaboration requires greater efforts, but the net cost should be reduced.
5. The problem of ‘gaps’ between the coverage of the various authorities can be addressed. Such gaps can be identified and closed through appropriate collaborative action.

4.6. The need for cross-sectoral collaboration and research

The general view expressed by the seminar participants was that there was a need for improved cooperation. This applied, for example, to both methodological development and research. Some of the authorities pointed to the need for greater coordination of research efforts. This would resolve a number of questions related to the formal distribution of responsibilities.

A need was also expressed by the authorities for research in the field of risk management, and there was an interest in matters of education and training. The view taken was that the benefits of research would be long-term. Research and development would also stimulate new forms of thinking and approaches. There are several areas which are the concern of a number of different authorities, such as hazards in complex systems, man–machine interaction and internal control. It was also regarded as important that overall studies at societal level should be conducted.

5. Summary of conclusions

5.1. A major social investment

The study covered 11 authorities with a combined budget of around 2700 million Swedish Crowns. In addition to these 11 authorities, there is a variety of organs at county and municipal level, which are concerned—in one way or another—with aspects of accident prevention. How large a proportion of the economy is involved in accident prevention is hard to estimate, but can be regarded as substantial. Thus, the collective effort made by society in accident-related activities is of considerable size.

5.2. Differences

There were major differences between the authorities according to their areas of responsibilities, traditions, operating conditions, etc. These differences were reflected in the terminology the authorities employed, their views on accidents and how they should be prevented, the roles they ascribed to themselves, etc. Similarly, attitudes to the benefits that could be obtained from research and development varied considerably.

5.3. Common positions and attitudes

There are several issues and problems which are the common concern of the authorities. A majority state that the problem lies in getting their ‘‘object of inspection’’ to take responsibility, show commitment and work systematically. Also, nearly all state that there are safety problems related to computer-controlled equipment and to the demands (particularly in terms of skills) placed on individuals.

5.4. Development activities

At a majority of the authorities, some kind of development work on safety issues was being undertaken. This applied, for example, to accident investigations, surveillance and inspection, and the authority’s own scrutiny of the results of safety analyses.

5.5. Cooperation lacking on methodological issues

There seemed to be no appreciable degree of collaboration across sectoral boundaries with regard to development work on safety issues. Organized cooperation with researchers on such issues is rather rare in this field.

Concrete forms of cooperation had been established to only a very minor extent. There was no suitable forum for the discussion of methodological issues. The laws and operative frameworks governing the activities of the authorities do not encourage such cooperation. But there is a growing interest in cooperation on methodological issues to promote improved accident prevention.

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