Learning from HSE-MS based incident investigation

Requirements for a successful application of a database approach

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Samenvatting

Het onderhavige artikel onderzoekt of het lerend vermogen van een organisatie verbeterd kan worden door de database van het incidentensysteem te koppelen aan die van het HSE-managementsysteem. Hiertoe wordt onderzocht of er eisen zijn voor, en de mogelijke effecten ervan op, het leren van incidenten, daarbij gebruik makend van moderne ICT-technologie. Er blijkt een onderscheid gemaakt te kunnen worden in organisatie- en databasegerelateerde eisen; deze komen aan bod in onderhavig artikel.

Het lerend vermogen dat een organisatie kan halen uit incidenten blijkt te bestaan uit:
- Lessen in een organisatie hoeven slechts éénmaal geleerd te worden
- Niet alleen de geschreven procedures worden aangepast, maar ook de dagelijkse praktijk (theorieën-in-gebruik)
- Ook andere leden van een organisatie leren van de lessen die door een individu geleerd zijn

Indicatoren voor het lerend vermogen van een organisatie zijn o.a. de prestatie-indicatoren, aantal incidenten en het aantal gelijksoortige incidenten.

De belangrijkste voorwaarden voor een strategie om te kunnen leren van incidenten bevatten: betrokkenheid van het management, aanwezigheid van voldoende middelen om lessen te produceren en distribueren, rapportage van incidenten zonder de angst voor beschuldiging en een aantal eisen aan de database. Van secundair belang zijn: het gebruik van deugdelijke 'bow-ties', een goede veiligheidscultuur, een gebruikersvriendelijke database die gekoppeld is aan het opleidingsproces en de zgn. enkele en dubbele leercurve.

Alhoewel de studie zich toespitst op een onderzoeks- en technologiecentrum kunnen de bevindingen ook toegepast worden op andere locaties van het bedrijf. Hierbij is het wel van belang dat gebruik wordt gemaakt van vergelijkbare IT-instrumenten, bij voorkeur gekoppeld aan dezelfde database van de organisatie. Als aan de bovenstaande voorwaarden wordt voldaan kan - op basis van de literatuurbevindingen en een kort onderzoek onder HSE-adviseurs - door koppeling van de database van het incidentensysteem aan die van het HSE-managementsysteem het lerend vermogen van een organisatie verbeterd worden.

Het gepresenteerde onderzoek maakt deel uit van een afstudeerproject van de post-academische opleiding 'Management of Safety, Health and Environment' (MoSHE) van de Technische Universiteit Delft.

Summary

The present study investigates if the organisational learning effect can be increased by linkage of the incidents system database with the database of the HSE Management System. To this end it is investigated if there are requirements for, and the possible effect on, the learning from incidents using modern ICT technology. It appears that a split can be made into organisational and database related requirements; these are presented in this study.

The organisational learning effects from incidents include:
- Lessons in an organisation only have to be learned once
- Not only the written procedures are changed, but also the daily practice (theories-in-use)
- Other members of the organisation learn too from lessons learned by an individual member

Indicators for organisational learning might be the company HSE performance indicators, number of incidents and the number of similar incidents.

The most important conditions for a strategy to increase learning from incidents include commitment of leadership, availability of resources to produce and distribute learnings, reporting of incidents without fear of blame and a number of database requirements. Of secondary importance is: the use of sound bow-ties, the right safety culture, a user-friendly database linked to the training process, feedback to the reporter and single and double loop learning.

Although focusing on a research and technology centre, findings might also be applied to other locations of the company. To this end, it is important that compatible IT tools are used, preferable linked to the same database of the organisation. If the above mentioned requirements are met, it is possible – according to literature and a short survey among HSE advisors – to increase the organisational learning effect by linkage of the incidents system database with the database of the HSE Management System.

The research presented in this article is part of a final report of the post graduate master course 'Management of Safety, Health and Environment' from Delft University of Technology.

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Introduction

The present study investigates the learning from incidents (LFI) process at the research facilities of an international company that specializes in the exploration and production (E&P) of oil and gas. The location studied in this article houses a centre of technology, in which some 60 research locations (laboratories) are accommodated. Incidents in this study are defined as undesirable events and involve both process and individual safety.

Implementation of the learnings from incident investigations and embedding the findings appears to be a complex activity in such a global company. In 2007, a three-day workshop was held dedicated to the improvement of incident investigation and learning from incidents. The workshop was held amongst ca. 10 HSE (Health, Safety & Environment) advisers from the global company that are involved with incident investigations. The main objective of the workshop was to identify obstacles in current incident investigation/analysis processes in the company, as well as improvement possibilities on organisational LFI. Possibilities were investigated to avoid re-occurrence of significant incidents by enhancement of the learning process and provision of the right information to the right people. The workshop identified that the following items have to be improved to increase the learning effect from incidents:

- Maintenance of bow-ties. After significant incidents, bow-ties should be updated adequately.
- Systemic causes that are identified as cause of an incident should lead to adequate improvements in the organisation.
- Clarity to whom the investigation outcome and lessons learned are applicable

In that same period several global reviews in the company were held on the subject 'Learning from Incidents'. The reviews were carried out by the global Learning from Incidents Coordinator amongst local Incident Review teams. Main objective of the reviews was to identify how LFI takes place at the company and to identify good practices as well as gaps. It appeared from the reviews that often incident alerts are sent around, but that the dissemination process is not effective enough to provide structural learning. It also appeared that distribution to the work force – mainly contractors- is inadequate; this is unfortunate as that is where the most serious incidents occur at the company. Because the reviews were held globally and the locations under study use the same processes for dissemination of information, the outcome is fully representative for the location in this study.

In 2004, in the company a global roll-out was started with an electronic HSE Management System (HSE-MS) and an electronic incident management system. In short, the electronic HSE-MS is based on bow-ties; see Figure 1.

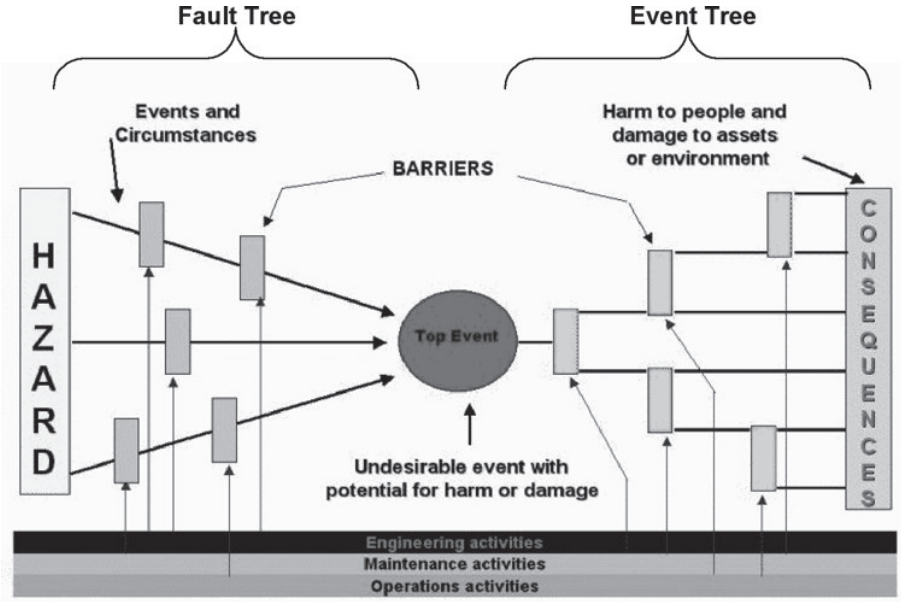

Figure 1: Bow Tie concept

The bow-tie is a combination of a fault tree, leading from various hazards to a top event (often defined as 'loss of containment'), and an event tree leading from the top event to different sorts of damage as is shown in figure 1. The fault tree is commonly referred to as the 'left hand side', while the event tree is the 'right hand side' (Zemering and Swuste, 2005). The so-called 'barriers' prevent that hazards lead to a top event and that the top event leads to undesired consequences. For each bow-tie in the company's HSE-MS, the barriers are summarized in a list and linked to mitigation tasks; this overview is called a 'Hazard Sheet'. These mitigation tasks are linked to so-called 'roles' to take action. Besides the Hazard Sheets there are 'Activity Sheets'. These Activity Sheets consist of lists of HSE critical tasks per subject and the accompanying roles. All roles are linked to actual employees and an employee can have more than one role. The software filters the relevant tasks from the Hazard Sheets and Activity Sheets (via the roles) and represents them to the employee. The system also represents the status of a task to the employee (whether he or she carried it out or not). This status is also represented to the supervisor of the employee. The strength of this system is the integration of database and web technology to make HSE information available globally to all employees.

The incident management system is a commercially available package for notification, registration and follow-up of incidents. The software is also designed to register learnings from incidents and is designed to exchange them globally. The software package is easily available via the electronic HSE-MS.

A status report of the incident management system indicates that most incidents that occur in the global company have occurred before or show great similarity with other incidents. This shows the problem and the need to create a clear process to improve learning from incidents Issues that are relevant for a more effective LFI process are (De Wit, Peuscher, 2008):

- Is it known exactly why the incidents happened and how to avoid them in the future?
- What is the most effective way of capturing the lessons and disseminating them?
- Who are the actors in this process and how can they best be stimulated to play their role such that effective actions result that avoid future incidents?
- How can it be ensured that learning is not a one-off exercise of sending out alerts (that get lost over time)?
- How can it be known if the relevant organisations and processes to avoid incidents are effective

Because the company's HSE-MS and the incident management system are both software based, new opportunities might arise to improve the LFI process. These opportunities could be applied globally, but the scope of this study is to investigate local opportunities first. To this end it is questioned if linkage of the incident database with the HSE-MS database can increase the organisational learning effect. To be able to answer this question, the following research questions are defined:

1. What are the requirements for an organisation to learn from incidents?
2. What is an organisational learning effect from incidents and how might it be measured?
3. What are the principles for a strategy to increase learning from incidents?

Material and Methods

Literature

To be able to answer research questions 1 and 2, a search into international magazines was carried out with SwetsWise (http://www.swetswise.com), Science Direct (http://sciencedirect.com) and Science.gov (http://www.science.gov). Use was also made of the search engines Google (http://www.google.nl) and Google Scholar (http://scholar.google.com). With all search engines, the used keywords were:

a) incidents AND organisational learning
b) incidents AND organisational learning AND information
c) incidents AND organisational learning AND knowledge management

With the outcome of this primary research, a further detailed research was carried out on the following keywords:

d) incidents AND organisational learning AND communication
e) incidents AND organisational learning AND culture
f) incidents AND organisational learning AND database
g) incidents AND organisational learning AND bow-tie

All searches were general, no limitations were set with regards to timeframe, language or file formats. The word 'organisational' was searched on as spelled with an 's' as well with a 'z'. Triggered by the results of this search, secondary literature was consulted if necessary.

Field work

To be able to answer research question 3, the outcome of the above mentioned literature search was used to identify criteria for a successful application of databases for organisational learning. These criteria were structured into groups and these groups were translated into survey questions. The resulting survey was conducted amongst 20 HSE advisers 'in daily practice' at the location to measure their expert judgement on the value of these criteria. The survey was issued to the HSE advisers in hardcopy with the request to answer the questions within two days. Because of this relatively small population, special care was paid to the statistical analysis of the questionnaire. To this end, use was made of a non probability sampling technique (Saunders and Lewis, 2007) to have a proper statistical interpretation.

Results

Below, the literature results are described which were found after the search as described in the previous chapter. Throughout the literature results, various requirements (in total 69) are mentioned for an organisation to learn from incidents. The organisational learning effects, that are sought after as answer on research question 2, are also mentioned

throughout the theory.

Requirements for Organisational Learning

General organisational requirements

Dixon (1994) states that an organisation can only learn because of the learning by its individuals and hence the organisation will only learn after the individual has learned. Individual learning can be described as the processing of data by the human mind from data to wisdom (Cleveland, 1982; Ackhoff, 1989). Argyris (1992) states that learning should be embedded in the whole organisation as part of its normal operation. It is not an add-on extra. This means, in terms of safety, that there must be an intimate link between the risk assessment process, the management process, the operational process and the learning process. Another key organisational requirement is described by Argyris (1992); he makes a clear distinction between 'espoused theories', which the organisation writes down in its manuals, and 'theories-in-use', which describe what actual practice is. What matters in organisational learning is that the theory-in-use is changed (Schein, 1992). However, the espoused theory should change too in order to have consistency between documentation and practice and to ensure that new employees are not taught incorrectly. The learning process 'ends' when the consequences of action match the expectations according to the applied theory-in-use.

The notification process

Koornneef (2000) contrasts and relates individual and organisational learning. Individual learning has taken place if the individual detects an operational surprise (incident, near miss) and changes the way of working as a result. However, for organisational learning the individual must notify a relevant learning agency. This process of notification needs to have as low a threshold as possible (Metselaar and Cozijnsen, 2005), so that it takes little time and effort. Such obstacles are e.g. fear of blame, undue administrative burden and experiences of hearing nothing from previous notifications. Notification by the individual members of the organisation is crucial for organisational learning. Without detection of an operational surprise, there is nothing to notify to a learning agency. Flanagan (1954) adds that lack of context in the notification process should be avoided.

The learning agency

A learning team is required to ensure both organisational single and double loop learning (Dick and Dalmau, 2000). With single loop learning, mainly specific problems are solved and certain mistakes are prevented from happening again. With double loop learning, underlying norms, values, methods are changed: this ensures learning in a broader sense. The learning team consists of people who learn on behalf of the organisation and ensures that the learning experience becomes embedded in the organisation. This learning agency has a crucial role in recapturing and preserving the contextual information lost in the notification process (Lipshitz et al., 2002). Koornneef (2000) describes the Systematic Incident Notification System (SINS) –concept. This concept is relevant for this study, because it focuses on a database approach. This concept consists of components for (low-threshold) incident notification, a learning agency (Review Team), a 'lessons-learned memory system' and an expert system for identification of systemic causal factors underlying (a class of operational) surprises. These components are configured such that scarce resources for learning from incidents are deployed efficiently. Koornneef draws the following conclusions:

1. The members of the Review Team preferably have to be members of the organisational units where the surprises occur. Thus, notifications can be kept relatively simple, because the Review Team is able to interpret the message within its operational settings.
2. Lessons learned need to be stored and made available when appropriate. The more lessons learned, the simpler the notification messages can be if appropriate cases in memory are retrieved effectively and efficiently.
3. The SINS-concept provides a key mechanism for cost-effective organisational learning from small-scale incidents. The known surprises (and countermeasures) stored in memory are classified by the learning agency in risk control categories. An incidence-trigger value IncT can be assigned to each validated event in memory.
4. The propagation of lessons that are learned by the learning agency for the organisation must return to the organisational unit(s) concerned along routes that the Organisational Learning - model depicts as single - or double closed loops. The communication channels to the management of the unit are important to make single-loop learning effective.
5. It is crucial to minimize variety in notification messages and compensate efficiently for this loss of variety, e.g. by means of a carefully assigned learning agency.
6. Organisational learning capability is negatively influenced when the variety of messages is not handled adequately. The management in charge may suffer from data overload, as also may the communication channels, which inevitably have limited capacity.
7. The coding of the relevant situational context of the incidents that resulted in the learning of a particular lesson needs close attention in order to avoid trying to re-use a lesson in an unsuitable situation and to prevent the reporter from describing extensive situational contexts (Koornneef and Hale 2001).

Learning efficiency

Swieringa and Wierdsma (1990) state that "efficiency of knowledge sharing and knowledge creation must be visible. It is important to respond / act corporately; information and results must be shared in a clear way. The organisation must therefore have a corporate opinion, based on sharing and creation of knowledge, experience and attitude." One obvious objective, related to efficiency, is that a lesson should only have to be learned once, given a particular type of incident and its operational context. In this way, re-occurrence of reported and 'learned' incidents is avoided, as was exactly one of the reasons for the underlying study (see introduction).

Using the bow-tie principle for organisational learning

Chevreau et al (2006) studied how the bow-tie representation can be appropriate to experience learning, see Figure 2. They distinguish between global bow-ties concerning generic risks of the organisation and local bow-ties representing accident scenarios specific to each workplace. When incidents or accidents are analysed, knowledge that is gained is added to existing local bowties. Regularly, local bow-ties are compared to the global bow-ties by the learning agency in order to revise them; this is the filter in figure 2. In this way, knowledge on safety at the global and at local levels is as accurate as possible and memorized. Maintained by a company learning agency, bow-ties can contribute to organisational learning by memorizing updated safety data. As it is also possible to locate in the bow-tie diagram where (on which barrier) an incident or accident stopped, one can compare the observed and the potential consequences. The gap between the two shows the capacity of safety barriers to stop this event (if barriers existed), if they were active, which one failed, which one was able to stop the event, etc. The analysis of similar accidents can therefore create knowledge on the efficiency of barriers. Bow-tie representation contributes to the development within an organisation of common understanding of its experience. As each person, whether it is an HSE expert or an operator, can be involved in the bow-tie construction process, the explicit knowledge will be displayed (in the bow-ties) and can be transferred from one to the other.

Database notification and learning from incidents

Once the pre-conditions for a successful learning organisation and the possible learning options from bow-ties are identified, the next step is the exploration of database notification and learning from incidents. In this way, the link to software systems can be established. The American Centre for Chemical Process Safety (CCPS) carried out a study related to the learning from incidents by a database approach (Sepeda, 2006). They published their lessons learned from process incident databases and the process safety incident database (PSID) approach. The CCPS study came to the conclusion that an effective database must have goals and must be structured to meet those goals. Key aims of a process safety incident database are:

- Prevent incidents;
- Reduce the risk of incidents (reduce the probability of occurrence and/or the consequence severity of incidents) by making information available on known hazards and risks;
- Function as a mechanism to learn from peers;
- Capture and share key learning's from past incidents and near misses;
- Educate today's workforce so that yesterday's failures are not repeated;
- Help meet legal requirements to share incident information, including root causes (without revealing the source);
- Provide information in a way that it can be found and extracted easily and quickly as needed.

A list of common and valuable uses is given by CCPS:

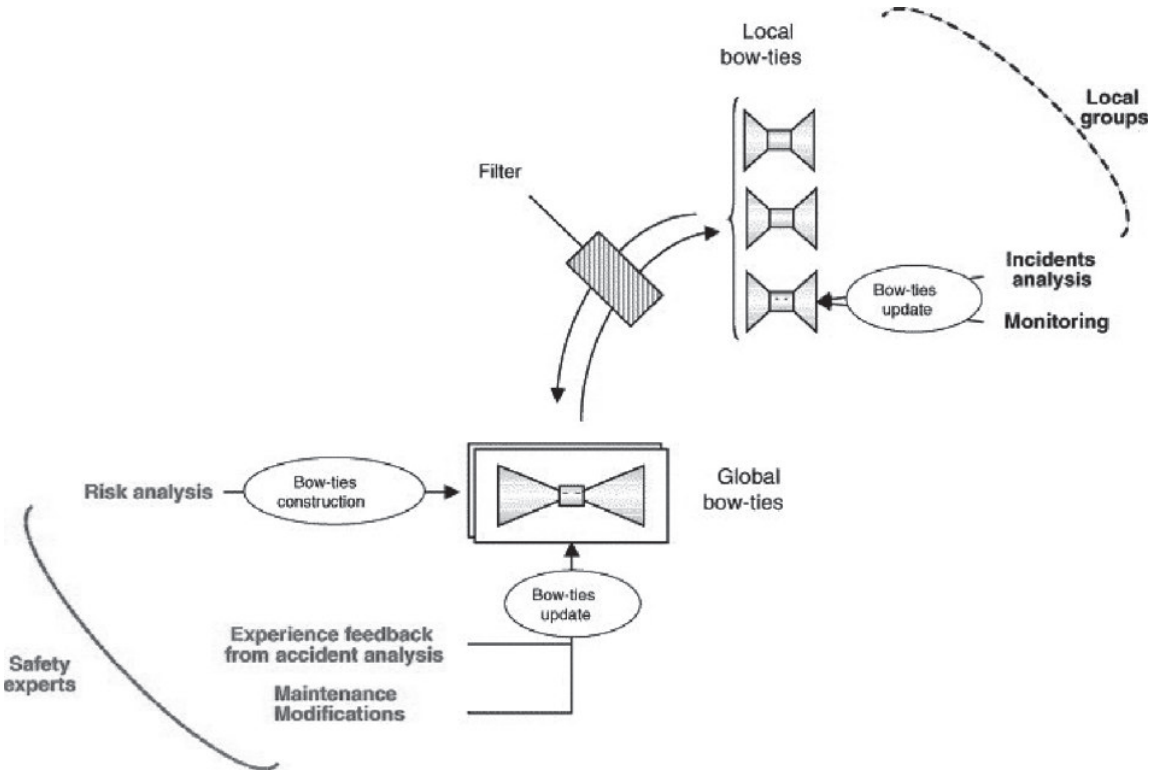

Figure 2: Feedback loop between global and local safety experts

1. *Process Hazards Analysis.* A search of the database before the PHA or revalidation PHA is conducted may yield hazards the team would otherwise not recognize.
2. *Identify high-risk activities, operations, and procedures.* Sometimes it is unknown what the risks are that are associated with the processes. An incident database can provide the keys to which risk activities are actually present in the facility.
3. *Mechanical integrity improvements.* By matching listed equipment failures with similar types of equipment in another facility, predictions and alerts can be generated based on in-service time, mean time between failures (MTBF), chemicals handled, temperature and pressure ranges, etc.
4. *Operator training.* Investigation findings often point to operational errors caused by failures in training systems. Real life examples of how these failures resulted in significant losses can provide senior management the justification needed to allocate resources to improve training systems
5. *New chemical screening.* By reviewing the experiences others have had with the particular chemical being considered for importation, manufacture, or use in the facility, a preview of the expected and unexpected hazards involved in its use can be understood.
6. *Incident investigations.* An incident database should include a listing of incident investigations and the associated findings. The database user knows how to extract those findings and how to recycle them so that they relate to potential hazards in his organisation.
7. *Emergency planning and response.* An analysis of what mitigation actions did and did not work for others and why, provides a checklist of things to review and improve upon.
8. *Safety alerts.* When combined with a "lessons learned" communication system, incident databases function as the source for valuable lessons and are of great use in safety meetings. While most of the aforementioned uses are somewhat technical in nature, one of an incident database's most exciting potentials is the ability to be used as a teacher or a learning tool.

Database-required attributes

Sepeda (2006) also describes the requirements for process incident databases to meet the in the previous paragraph mentioned expectations. How many attributes the database has and how well these attributes are endowed determine the true usefulness of the incident database.

a. *Accessibility.* Web- or LAN-based versions are usually more accessible than stand alone versions.
b. *User friendliness.*
c. *Accuracy.* Avoid options to 'colour' the incident, introduce technical inaccuracies or incomplete data. It might guide the next user to the wrong conclusion or solution for his or her particular hazard.
d. *Sufficient volume.* Databases built as an industry-wide participative effort have the best chance of success since they can provide sufficient quantity of varied data.
e. *Standardization.* A template and instructions must clearly define how and where the components of an incident and the ensuing investigation findings are to be entered into the database. This standardization also enhances the query capability of the database.
f. *Query system/search engine.* To quickly and efficiently get information out of the database, a comprehensive query system is needed - one that not only answers the query itself, but also suggests other potential paths to failures.
g. *Data security and confidentiality.* Data in a database must be secure and the database must provide the confidentiality the participants expect.

From the above, it appears that the 69 requirements can be split into organisational ones and database related ones. All requirements are presented in Table 1 (with source reference).

Table 1: Requirements for organisational learning; question groups for survey

Criterion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 1
1	Dick and Dalmau (2000)	New information on the learning from incidents will be added to the database of the organisation.	Database maintenance by usage of a bow-tie.	How important is it to you in your role as an HSE-adviser that …
2	Chevreau et al (2005)	Bow-ties to represent up to date hazard scenarios.		When investigating an incident, you have the availability of a complete set of well maintained bow-ties to which you can enter data from your investigation?
3	Chevreau et al (2005)	Maintenance of the bow-ties by the company learning agency.		
4	Chevreau et al (2005)	Involve HSE expert and operators in the bow-tie construction process for knowledge transfer.		
5	Sepeda (2006)	The incident database should help meet legal requirements to share incident information, including root causes (without revealing source).		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 2
6	Argyris (1992)	If the safety culture is poor, individuals will have great difficulty to recognise an emerging operational risk ('zero-learning'), and will be disinclined to notify.	Safety Culture	How important is it to you in your role as an HSE-adviser that …
7	Argyris (1992)	Espoused theory of policy of safety culture to match with policy of safety culture in use.		When investigating an incident, you can easily identify the failed barrier, but without the names of individuals that have responsibilities for these barrier(s)?
8	Lipshitz et al (2002)	Issue-orientation (focussing on the relevance of information to the issue under consideration regardless of the social standing or rank of source or recipient).		
9	Lipshitz et al (2002)	Inquiry (persisting in investigation until full understanding is achieved).		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 3
10	Koornneef (2000)	Notification of incident by individual should take little time.	User-friendliness	How important is it to you in your role as an HSE-adviser that …
11	Koornneef (2000)	Notification of incident by individual should be without administrative burden in addition to the workload.		The database enables info to be found or entered easily and quickly?
12	Sepeda (2006)	The database should provide information in a way that it can be found and extracted easily and quickly as needed.		
13	Sepeda (2006)	The database must be accessible and easy to get to when needed.		
14	Metselaar and Cozijnsen (2005)	Threshold for incident reporting must be made as low as possible.		
15	Sepeda (2006)	Easy for a user to both enter data into the system and extract data. Frustration level must be kept low.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 4
16	Flanagan (1954)	To avoid lack of context in the notification.	Format of notification	How important is it to you in your role as an HSE-adviser that … Information from and notifications into the database are of a fixed format?
17	Koornneef and Hale (2001)	Use coding to avoid the individual to describe the violated theory-in-use.		
18	Koornneef (2000)	Lessons learned, need to be stored and made available when appropriate. The more lessons learned, the simpler the notification messages can be.		
19	Sepeda (2006)	There must be a standardization of reporting format and investigation-of-causes philosophy for the system to be workable. Pull-down menus are very helpful in standardizing the input language and minimizing the use of different words to describe the same event or equipment.		
20	Sepeda (2006)	Colouring the incident with editorial comments, technical inaccuracies, or incomplete data potentially nullifies the effectiveness of the lesson to be learned and can guide the next user to the wrong conclusion or solution for his or her particular hazard.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 5
21	Swieringa, Wierdsma (1990)	Efficiency of knowledge sharing and knowledge creation to be visible.	Vision leadership (resourcing, security and confiden-tiality)	How important is it to you in your role as an HSE-adviser that … Knowledge sharing is properly resourced and led by leadership, in such a way that security and confidentially is guaranteed?
22	Swieringa, Wierdsma (1990)	Information and results must be shared in a clear corporate way.		
23	Swieringa, Wierdsma (1990)	A corporate opinion should be based on sharing and creation of knowledge, experience and attitude.		
24	Koornneef (2000)	Organisation and investment of adequate time and resources for organisational learning.		
25	Sepeda (2006)	Data in a database must be secure, and the database must provide the confidentiality the participants expect.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Questions 6 & 7
26 27	Sepeda (2006) Swieringa, Wierdsma (1990)	The database should prevent incidents. A lesson should only have to be learned once, given a particular type of incident and its operational context. In this way resources for learning from incidents can be managed effectively.	Vision of leadership (support by leadership, credible database)	How important is it to you in your role as an HSE-adviser that … 6. The improve-ments identified by the database are supported by leadership? 7. The database is credible: it's use leads to impro-vement in the individual HSE performance?

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 8
28	Koornneef (2000)	Notification of incident by individual without fear of blame.	No fear of blame	How important is it to you in your role as an HSE-adviser that … Staff can report an incident without fear of blame?
29	Swieringa, Wierdsma (1990)	(Avoid poor) good safety culture		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 9
30	Koornneef (2000)	The individual to receive feedback after reporting an incident.	Reporter to receive feedback	How important is it to you in your role as an HSE-adviser that … The incident reporter receives feedback on his notification (confirmation, outcome of investigation and recommendations) ?
31	Koornneef (2000)	The individual to recognise an operational surprise (incident).		
32	Argyris (1992)	Reward incident reporting and restrict disciplinary action.		
33	Koornneef and Hale (2001)	The report must lead to follow-up action or another action to close the loop back to the notifyer.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 10
34	Lipshitz et al (2002)	Transparency (the willingness to expose one's thoughts and actions to others in order to receive feedback)	Behaviour, transparency, change	How important is it to you in your role as an HSE-adviser that … You receive information why a new rule (change in the work process) is important, instead of just receiving a new rule.
35	Lipshitz et al (2002)	Integrity (the willingness to seek and provide information regardless of its implications)		
36	Lipshitz et al (2002)	Accountability (the willingness to assume responsibility for learning and for the implementation of lessons learned.		
37	Schein (1992)	The theory in use (behaviour) is changed		
38	Metselaar and Cozijnsen (2005)	Make employees enthusiastic to changes. Avoid that forth coming changes are only announced by the top management.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 11
39	Koornneef (2000)	The learning agency to review an accident and to generate lessons to be implemented directly by the organisation.	Role of the learning agency	How important is it to you in your role as an HSE-adviser that … A learning agency will generate lessons learned which will be send to you via your roles in Fountain Insight?
40	Koornneef (2000)	Incident database to include an incidence trigger (IncT).		
41	Koornneef (2000)	This learning agency has a role in recapturing and preserving the contextual information lost in the notification process.		
42	Swieringa, Wierdsma (1990)	A memory that can be accessed from within the organisation and to share lessons learned.		
43	Koornneef (2000)	A learning agency to generate lessons to learn, to send these back to the incident operational unit and to add the new case to the organisational memory.		
44	Koornneef (2000)	The Review Team includes members of the organisational units where the surprises occur.		
45	Koornneef (2000)	Minimise variety in notification messages and compensate efficiently for this loss of variety, by means of a carefully assigned learning agency.		
46	Koornneef (2000)	Handle variety of messages adequately by learning agency. Avoid data overload and communication channels, which inevitably have limited capacity.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 12
47	Koornneef (2000)	The learning agency to review an accident and to generate lessons to be implemented directly by the organisation.	Change of procedures (single loop)	How important is it to you in your role as an HSE-adviser that …
48	Sepeda (2006)	The database should function as a mechanism to learn from peers.		The Lessons Learned that YOU create are shared with others?
49	Koornneef (2000)	Must have communication channels to unit management to make single-loop learning effective.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 13
50	Koornneef (2000)	The learning agency to review an accident and to generate lessons to be implemented indirectly by changing values, norms, standards, for the functioning of the organisation.	Change of norms and values (double loop)	How important is it to you in your role as an HSE-adviser that …
51	Koornneef (2000)	The lessons learned must return to the organisational unit(s) concerned along routes that the OL-model depicts as single- or double closed loops.		Not only the incident owners receive feedback, but also
52	Argyris (1992)	There is a consistency between documentation and practice so new employees are not taught incorrectly.		organisational norms and standards are changed?

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 14
53	Sepeda (2006)	The database should educate today's workforce so that yesterday's failures are not repeated.	Link FIM to learning process	How important is it to you in your role as an HSE-adviser that …
54	Sepeda (2006)	The ability to be used as a teacher or a learning tool., incident databases function as the source for valuable lessons and make great safety meeting.		Learning from incidents are disseminated through our training processes?
55	Sepeda (2006)	Incident database should have a link to the training process of operators.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 15
56	Sepeda (2006)	Incident database should have a link to Process Hazards Analyses.	Link FIM to operational	How important is it to you in your role

57	Sepeda (2006)	Incident database should have a link to the process of identifying high-risk activities, operations, and procedures:e.g PTW system	processes	as an HSE-adviser that … Once involved in or studying a hazardous activity, that you are prompted automatically with the applicable Lessons Learned for that activity (e.g. via Fountain Insight)?
58	Sepeda (2006)	Incident database should have a link to the process of improvement of mechanical integrity.		
59	Sepeda (2006)	Incident database should have a link to the process of handling chemicals on site.		
60	Sepeda (2006)	Incident database should have a link to the process of Emergency planning and response.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 16
61	Koornneef (2000)	Organisational learning to be the linkage between the operational level and with management that can effectively influence the residual risks.	Position of learning in the organisation	How important is it to you in your role as an HSE-adviser that … Organisational learning must be close to the day to day operational processes of the organisation, contractors included.
62	Sepeda (2006)	The database should capture and share key learnings from past incidents and near misses.		
63	Sepeda (2006)	The database should reduce the risk of incidents by making information available on known hazards and risks.		
64	Argyris (1992)	An intimate link between the: 1. Risk assessment process 2. Management process 3. Operational process. 4. Learning process		
65	Koornneef (2000)	Organisational learning must be close to the primary processes of the organisation, so that it involves and rewards the efforts of people working there.		

Crite-rion #	Reference in literature	Requirement for organisational learning	Question Group for survey	Question 17
66	Koornneef (2000)	The coding of the relevant situational context of the incidents that resulted in the learning of a particular lesson needs close attention in order to avoid trying to re-use a lesson in an unsuitable situation.	Functional requirements of the database	How important is it to you in your role as an HSE-adviser that … You can easily find relevant Lessons Learned from incidents via a search engine?
67	Sepeda (2006)	Incident database should have a search engine to search for Incident investigations and associated findings: The database user knows how to extract those findings and how to recycle them so that they relate to potential hazards in his organisation.		

68	Sepeda (2006)	Sufficient volume. Databases built as an industry-wide participative effort have the best chance of success since they can provide sufficient quantity of varied data.		
69	Sepeda (2006)	To quickly and efficiently get information out of the database, a comprehensive query system is needed and also be able to suggests other potential paths to failures.		

Table 2: Survey results

Scores per question (n= 18)*					
How important is it to you in your role as an HSE-adviser that …	Most important	Very important	Important	Somewhat important	Not important
1. When investigating an incident, you have the availability of a complete set of well maintained bow-ties to which you can enter data from your investigation?	3	10	3	1	1
2. When investigating an incident, you can easily identify the failed barrier, but without the names of individuals that have responsibilities for these barrier(s)?	4	6	5	2	1
3. The database enables information to be found or entered easily and quickly?	6	7	5	0	0
4. Information from and notifications into the database are of a fixed format?	0	4	10	4	0
5. Knowledge sharing is properly resourced and led by leadership, in such a way that security and confidentially is guaranteed?	8	6	3	1	0
6. The improvements identified by the database are supported by leadership?	8	8	2	0	0
7. The database is credible: it's use leads to improvement in the individual HSE performance?	2	7	9	0	0
8. Staff can report an incident without fear of blame?	11	4	3	0	0
9. The incident reporter receives feedback on his notification (confirmation, outcome of investigation and recommendations)?	7	9	2	0	0
10. You receive information why a new rule (change in the work process) is important, instead of just receiving a new rule?	5	5	8	0	0

11. A learning agency will generate lessons learned which will be sent to you via your roles in Fountain Insight?	3	6	7	2	0
12. The Lessons Learned that YOU create are shared with others?	4	9	5	0	0
13. Not only the incident owners receive feedback, but also organisational norms and standards are changed?	6	7	4	0	1
14. Learning from incidents are disseminated through our training processes?	3	9	4	2	0
15. Once involved in or studying a hazardous activity, you are prompted automatically with the applicable Lessons Learned for that activity (e.g. via Fountain Insight)?	3	5	9	1	0
16. Organisational learning must be close to the day to day operational processes of the organisation, including contractors?	6	9	3	0	0
17. You can easily find relevant Lessons Learned from incidents via a search engine?	7	5	5	1	0

* Highest rankings in bold.

Field work

Eighteen of the twenty HSE advisers returned their questionnaire after completion; resulting in a response of 90%. The results of the survey are presented in Table 2.

From this table it can be seen that in general all HSE advisers judge the criteria for successful learning from incidents identified from literature as important items, because the ranking options 'somewhat important' and 'not important' hardly scored. The highest ranked survey items are no. 5, 6,

Table 3: Most answered results per survey question

Question	Most important	Very important	Important	Somewhat important	Not important
5, 6, 8, 17	•				
1, 2, 3, 6, 9, 12, 13, 14, 16		•			
4, 7, 10, 11, 15			•		

8 and 17. Scoring 'very important' are no. 1, 2, 3, 9, 12, 13, 14 and 16 (6 scores equally). Scoring 'important' are no. 4, 7, 10, 11 and 15.

Discussion and conclusions

Requirements for Organisational Learning and Learning Effects

The 69 requirements that were found in the previous chapter are the answer on the first research question. Three learning effects were identified in literature as an answer on the second research question. They are:

- Lessons in an organisation only have to be learned once
- Not only the written procedures are changed, but also the daily practice (theories-in-use)
- Other members of the organisation learn too from a lesson learned by an individual member

These learning effects might be measured by the organisational and individual performance and reduction in amount and recurrence of incidents. Indicators for these might be the company's HSE performance indicators, number of incidents and number of similar incidents: these would have to decrease. It has to be realized that these parameters are indicators only and could be influence by other processes. No quantitative parameters were found however in literature.

Fieldwork and principles for strategy

To be able to answer research question 3, the above mentioned 69 criteria for effective organisational learning were used. To be able to work with them, the author structured all criteria into 17 subject groups; each group containing a set of similar criteria. The groups are:

- Database maintenance by usage of a bow-tie
- Safety culture
- User-friendliness of database
- Format of the notifications
- Resourcing, security and confidentiality
- Support by leadership
- Credible database
- No fear of blame
- Reporter to receive feedback
- Change, behaviour and transparency
- Role of the learning agency
- Change of procedures (single loop)
- Change of norms and values (double loop)
- Link of database with the learning process
- Link of database with the operational process
- Position of learning in the organisation
- Functional requirements of the database

It needs to be realized that this classification was set up by the authors of the present study. Other authors might have come up with a slightly different classification (e.g. some fewer or more groups or a combination/split of groups). This should be no problem for the present study however, because results are not statistically processed, but divided into categories. Subsequently, the author translated each subject group of criteria into one survey question (in Table 1 the accompanying criteria per question can be traced).

Because of the relatively small population, the absolute response numbers are presented instead of percentages. The way of sampling is referred to as purposive or judgemental (Saunders and Lewis, 2007). This implicates that no statistical characters of the population can be produced. Because of the careful selection of the sampling group however, conclusions still can be drawn. To come to a strategy to increase learning from incidents (research question 3), the survey results were ranked by the author: see Table 3.

Because the ranking options 'somewhat important' and 'not important' hardly scored, it can be concluded that the willingness to learn from incidents is high amongst HSE advisers at the company. To be able to define a strategy to increase learning from incidents, the highest ranked survey results are taken as a basis. They are: vision of leadership in relation to resources they need to make available, vision of leadership re. to commitment, no fear of blame and functional requirements of the database (mainly: coding of the situational context, a sound search engine and industry-wide participation). Scoring 'very important' are the use of sound bow-ties, the right safety culture, a user-friendly database linked to the training process, feedback to the reporter and single and double loop learning. Answering research question 3, these principles are the dominant factors in developing the strategy. If there are resources left, attention could be paid to the other factors (format of notification, credibility of database, etc.).

Main conclusion and future learning

With the above conclusions and recommendations, the main research question can be answered. Literature and results of the short survey indicate that linkage of the incident database with the HSE-MS database can indeed increase the organisational learning effect. To reach the learning effects as mentioned, it is essential that the organisational and database requirements as mentioned are in place.

With this knowledge, it would be interesting to know if these requirements are present in the company under study. This could be subject of further study. Research question could be: are the requirements to learn from incidents in place at the company or its location in this study?

Once the requirements will have been established in the company and the HSE-MS database is linked to the incident database, real incidents can be linked to barriers in the company bow-ties (which are part of the HSE-MS). The benefit of this is that in this way real scenarios can be built and bow-ties can be tested on their validity. It is expected that these bow-ties have to be adjusted thoroughly and that new bow-ties have to be added, because a well-embedded validation process has not been implemented yet.

After implementation of the above, it would be interesting to study if the intended learning effects are indeed reached, resulting in less or less serious incidents. Research question could be: does the linkage of the incident and HSE-MS databases indeed lead to an improved learning effect, resulting in less or less serious incidents?

Long-term analysis of the research-related incidents at the location is described in De Bruin and Swuste (2006) and subsequent classification into scenarios and an overview of failing barriers is presented in De Bruin and Swuste (2008). Because they presented the scenarios in bow-tie style, these scenarios could well serve as input to the HSE-MS database in the company, which is also based on bow-ties. An active link to the incident database has not been established yet. As soon as this will be the case, there will be a starting point for successful linkage of the HSE-MS and incident databases. Because both databases were set-up by different parties, this will require a cooperation effort in which the learning agency might play a key mediating role. No reasons were found in the study why findings would not be suitable for other locations too, hence in principle all findings are. To enable linkage of databases however, it is essential to use compatible IT tools.

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