Slutrapport för projektet (fri version)

Lärande från incidenter för säkerhet inom farliga verksamheter
LINS

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LUCRAM
Lunds universitets centrum för riskanalys och riskhantering
Lunds universitet

Ett LUCRAM-projekt i samarbete mellan

Ergonomi och aerosolteknologi
Lunds Tekniska Högskola
Lund

Ledarskap och management
Försvarshögskolan
Karlstad

Brandteknik och systemsäkerhet
Lunds Tekniska Högskola
Lund

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Vetenskaplig slutrapport för MSB-projektet (fri version[a])

Lärande från incidenter för säkerhet inom farliga verksamheter (LINS)

med projektnummer SRV 07_66

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Deltagande institutioner

Projektet är ett LUCRAM[b]-projekt utfört som ett samarbete mellan avdelningen för Ergonomi och aerosolteknologi och avdelningen för Brandteknik och systemsäkerhet båda vid Lunds Tekniska Högskola, Lunds Universitet samt Institutionen för Ledarskap och management, Försvarshögskolan (Karlstadsdelen).

Övergripande målsättningar med projektet

Syftet med projektet var

1. Att söka kunskap för effektivare lärande från incidenter i teori och praktik
2. Att utveckla rutiner och verktyg för effektivare lärande från incidenter
3. Att sprida kunskap för effektivt lärande till olika organisatoriska nivåer

Projektperiod

2008-01-01 – 2010-12-31

Resultat i form av dokument

Rapporteringen av det vetenskapliga resultatet från projektet utgörs av två artiklar publicerade i vetenskapliga tidskrifter (bilagorna 1 och 2, här endast abstracts), sammanfattningar av två manuskript inskickade för vetenskaplig publicering (bilagorna 3 och 4, manuskriptet i bilaga 3 är accepterat för publicering), en rapport om ledarskap och säkerhetskultur (bilaga 5), två redovisningar (bilagorna 6 och 7) av preliminära resultat som också utgör bas till manuskript för vetenskaplig publicering, en avisering av ett manuskript under utarbetande, som ska bygga på vidare analys av empiri insamlad under LINS-projektet (bilaga 8), samt denna 'kappa'.

Bilagorna 1-4 (inklusive referenserna 1 och 2) kommer också att utgöra basen i Anders Jacobssons doktorsavhandling som han planerar att lägga fram under våren 2011. Marcus Börjesson har påbörjat en doktorsavhandling och beräknar att ha med 1-2 artiklar som bygger på projektet.

Projektet har också resulterat i ett utkast till handledning "Att lära stort från små incidenter" med Anders Jacobsson som huvudförfattare.

[a] Fri version innebär att fulltextartiklarna (med copyright) i bilagorna 1 och 2 har ersatts med abstracts så att versionen är fri att spridas.
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Metod

1 Marsdatabasen

Innan ansökan till detta projekt lämnades in träffades en överenskommelse mellan SRV, NCO och EU's Joint Research Centre (JRC) i Ispra, Italien, angående en djupanalys av den europeiska s.k. MARS[c]-databasen angående olyckor inom området för Seveso-lagstiftningen. En avsikt var att skaffa underlag för ett effektivare lärande. Analysen har genomförts som ett samarbete mellan LINS-projektet (för SRV och NCO) och JRC/ISPRA.

Kompetent myndighet i respektive EU-land rapporterar Seveso-olyckor till MARS-databasen. För rapporteringen har de tillgång till en lista med orsaker som ska användas i rapporterna. Det ansågs viktigt att studera informationen i databasen.

För att få en uppfattning om det fanns mer att lära från SEVESO-olyckorna än vad som explicit framgår av rapporterna utvecklades en metod för identifiering av sannolika underliggande orsaker till SEVESO-olyckor. Metoden tillämpades sedan på alla rapporter inkomna till mitten av 2007 (Bilaga 1).

För att utvärdera lärandet från de rapporterade olyckorna utvecklades också en metod, som tillämpades på samma material (Bilaga 2).

2 Sex företag inom processindustrin

Andra delen av projektet bygger på empiri från sex företag inom processindustrin. Tillvägagångssättet har varit detsamma vid alla. Empiriinsamlingen har skett på tre sätt.

1. En omfattande säkerhetsrevision baserad på intervjuer, dokumentgranskning och anläggningsbesök utförd av 2 forskare.
2. En analys av ett stort antal incidentrapporter samt
3. En undersökning av säkerhetsklimatet och ledarskapet med en enkät.

För god kvalitet på empirin har vi haft en stor fördel av att huvudpersonen i momenten 1 och 2 ovan och i kontakterna med företagen har unikt goda domänkunskaper (Anders Jacobsson har bland annat varit chef för en processindustri och arbetat många år som konsult inom processindustrin med fokus på säkerhet). För att få en djupare kunskap om respektive företags säkerhetsarbete och deras artefakter har vi genomfört en säkerhetsrevision.

Beroende på den undersökta verksamhetens storlek genomfördes 15-50 semistrukturerade intervjuer på varje företag. För några nyckelpersoner var vi två intervjuare, men oftast var vi en intervjuare per person. Varje intervju tog cirka en timme. Som intervjupersoner ingick personer från ledning på olika nivåer, operatörer inklusive underhållspersonal samt personer med ansvar för säkerhet, hälsa och miljö. Intervjuarnas samlade omdömen skrevs ner, lämnades till företaget och diskuterades i en grupp inom företaget. Utöver intervjuerna i säkerhetsrevisionen fördes utökade diskussioner med fokus på incidenthanteringen med vissa nyckelpersoner.

För varje företag analyserades två års incidentrapporter med metodik framtagen i projektet.

För att studera säkerhetsklimatet, ledarskapet och säkerhetsbeteenden konstruerades och testades en enkät. Enkäten användes vid alla sex företagen och ställdes till alla medarbetare inom vissa utvalda delar av företaget. Svarsfrekvensen blev god (73 %; 434 svar).

Projektet genererade en mycket stor mängd av intressant empiri. Allt har därför inte kunnat analyseras inom projekttiden, men mer än tillräckligt för att vi ska anse att vi uppfyllt projektets målsättning.

Resultat

De vetenskapliga resultaten av projektet utgörs av bilagorna 1-8. De sammanfattas nedan.

[c] MARS = Major Accident Reporting System

A sequential method to identify underlying causes from industrial accidents reported to the MARS database (Bilaga 1)

Bilaga 1 är abstractet i referens 1.

En bakomliggande målsättning med detta arbete och nästa var att ge underlag för ett förbättrat lärande från Seveso-olyckor med hjälp av MARS-databasen. Huvudmålsättningen med detta arbete var att presentera en metod att utröna vad som finns mer att lära från rapporter till MARS-databasen utöver vad som framgår explicit av rapporterna.

Som underlag för metoden att analysera rapporterna rapporterade till MARS-databasen utvecklades en modell för olyckor som bygger på tidigare publicerade modeller av bl. a. Kjellén och Hollnagel. I modellen och metoden utgår man från direkt orsak (orsak 1) och fortsätter med möjliga underliggande orsaker (orsaker 2), underliggande orsaker till orsaker 2 (orsaker 3) och slutar med orsaker till orsaker 3 (orsaker 4). För en direkt orsak finns det som regel flera underliggande orsaker på nivåerna 2, 3 och 4.

För rapportering till MARS-databasen finns och används en lista med orsaker. Dessa orsaker används i modellen, men de räcker inte till för en djupare analys. Författarna har därför infört ytterligare underliggande faktorer.

Modellen och de ingående underliggande orsakerna bedömdes av en expertgrupp. Modellen fick ett mycket starkt stöd (medelbetyg 4,9 (Max 5,0)). Gruppen styrkte också att de föreslagna orsakerna är möjliga underliggande orsaker (medelbetyg 4,6 (Max 5,0)).

En tillämpning av metoden på information i MARS-databasen fram till mitten av 2007 (653 olyckor) visar att det finns mycket mer att lära om underliggande orsaker än vad som explicit framgår av rapporterna. Exempel på underliggande orsaker som ofta missats i rapporterna är brister i riskbedömningar, procedurer, träning, underhåll, utformning och ledning. I denna artikel rapporteras inte brister i säkerhetskultur och ledningsorganisation – det avhandlas i nästa artikel. I nästa artikel presenteras också en utförligare analys.

Författarna konkluderar att rapporterna till MARS ofta är undermåliga. Lärandet kan förbättras avsevärt med rapporter som bygger på en djupare mera fullständig analys t.ex. med hjälp av den här utvecklade metoden.

Underlying causes and level of learning from accidents reported to the MARS database (Bilaga 2)

Bilaga 2 är abstractet i referens 2.

En bakomliggande målsättning med detta arbete och föregående var att ge underlag för ett förbättrat lärande från Seveso-olyckor med hjälp av MARS-databasen. Målsättningar med detta arbete var att identifiera mönster av underliggande orsaker till rapporterade olyckor uppdelat på land och typ av industri, undersöka förekomsten av brister i säkerhetskultur och ledningssystem som underliggande orsaker samt att bestämma lärandenivå uppdelat på land och typ av industri.

För bedömning av lärandenivå utvecklades ett klassificeringssystem med 6 nivåer – 0-V. Systemet lägger högst vikt vid den ’geografiska’ spridningen av lärandet, därefter läggs vikt vid grad av organisatoriskt lärande och som tredje led det organisatoriska minnet.

De vanligaste underliggande orsakerna var brister i riskbedömningar och procedurer följt av brister i träning eller utformning, oberoende av industrityp. Analysen visade också att det fanns variationer mellan olika länder när det gäller rapporterade underliggande orsaker – vad gäller i projektet identifierade orsaker såväl som av länderna rapporterade och det totala antalet orsaker. För en stor andel av olyckorna i olika länder (50-80 %) identifierades brister i säkerhetsledningssystemet och brister i säkerhetskulturen som underliggande orsaker. Lärandenivån bedömdes som låg – den geografiska spridningen var ringa – och detta i stort sett oberoende av industrityp. För den

petrokemiska industrin var lärandenivån något högre än för övriga industrityper. Vid en jämförelse mellan lärandenivåerna för de olika länderna erhölls ganska stora skillnader.

Resultaten från detta arbete torde utgöra ett värdefullt underlag till förbättrande av lärandet från Seveso-olyckor dels för förbättringar av MARS-databasen (regler för inrapportering), dels för rutinerna i de rapporterande länderna.

Method for evaluating learning from incidents using the idea of "level of learning" (Bilaga 3)

Bilaga 3 är en sammanfattning av referens 3.

I detta arbete togs en metod fram för bedömning av lärandet från incidenter. Den utvecklade metoden består av 6 steg.

1. Bestämning av nivån av det faktiska lärandet utgående från lärandet från de individuella incidentrapporterna
2. Bestämning av nivån för det potentiella lärandet utgående från de individuella incidentrapporterna
3. Bestämning av förhållandet mellan faktisk och potentiell lärandenivå
4. Korrektion för icke rapporterade incidenter – mörkertalet
5. Justering av resultaten från steg 1-4 för faktiskt och potentiellt lärande från analys av aggregerade incidentrapporter
6. Justering av resultaten på grund av andra sätt att lära från incidenter tillämpade inom respektive företag. Resultatet benämns 'lärandenivån'.

Metoden testades på empirin från de fem först undersökta företagen – det sjätte var vi inte klara med. Resultaten gav en intressant insikt i respektive företags lärande från incidenter – insikter användbara för åtgärder. Det finns osäkerheter i de olika stegen, vilket speciellt kan göra kvantitativa jämförelser mellan olika företag mycket tveksamma. Däremot kan en bedömning av de olika stegen ge värdefull information för förbättringsåtgärder. Jämförelser mellan likartade verksamheter, t.ex. olika avdelningar inom samma företag, eller inom samma entitet vid olika tidpunkter, kan ge underlag för lärande för effektivare lärande från incidenter.

Learning from incidents – method for assessing the effectiveness of the learning cycle (Bilaga 4)

Bilaga 4 är en sammanfattning av referens 4.

Detta arbete beskriver en metod för bedömning av de olika stegen i cykeln för lärande från incidenter. Lärcykeln består av två loopar – den första består av stegen rapporterande, analys av individuell incident, beslut, implementering och uppföljning; den andra loopen består av stegen analys av aggregerade incidenter, beslut, implementering och uppföljning. För varje steg i första loopen betraktades dimensionerna omfattning (scope), kvalitet, timing och informationsspridning och för varje dimension definierades relevanta aspekter. För varje aspekt konstruerades skalor att användas för bedömning av lärprocessen.

Metoden testades på två års incidentrapporter på sex företag inom olika typer av processindustrier. Metoden fungerade bra och gav intressant information om effektiviteten i de olika stegen av lärcykeln. Skillnader i utfall mellan företagen kunde ofta förklaras med skillnader i företagen t.ex. skillnader i ledningens engagemang, resurser allokerade för säkerhet, säkerhetsträning av anställda o.s.v.

Förutom för att ge indikationer på behov av specifika förbättringar är metoden avsedd att användas för att studera samband mellan lärcykeldimensioner/-aspekter och t.ex. säkerhetsklimatsaspekter, ledarskapsaspekter samt aspekter från revision av säkerhetshantering (Se bilaga 7 och 8).

Leadership and safety culture (Bilaga 5)

Marcus Börjesson deltog tidigt i projektet i en forskarutbildningskurs, "Frontiers in leadership research" vid Karolinska institutet. I examinationen ingick en uppsats som efter lite bearbetning bifogas som bilaga 5.

I uppsatsen reflekterar författaren över ledarskapsrollen i relation till säkerhetskulturen/säkerhetsklimatet med en litteraturgenomgång som bas. Rubriker i uppsatsen är bl. a.: 'Safety culture', 'Leadership and safety culture',' The role of the supervisor', 'Who is coaching the supervisor', 'Time, group processes and safety', och 'Methodological considerations'.

Med stöd av litteraturen lyfts ledarskapets betydelse för säkerhetskulturen fram. Vikten av ett bra samspel mellan högsta ledningen och övrig ledning betonas. Genomgången har utgjort en god grund för det fortsatta arbetet i LINS-projektet.

Measuring safety climate, safety-specific leadership and safety-related behaviours within the Swedish process industry (Bilaga 6)

Denna rapport presenterar övergripande preliminära resultat. Målsättningen med arbetet var a) att utveckla ett frågeformulär för mätning av olika dimensioner av säkerhetsklimatet, säkerhetsspecifikt ledarskap och säkerhetsrelaterat beteende, b) att testa frågeformuläret och c) att studera relationer mellan säkerhetsklimatet, säkerhetsspecifikt ledarskap och säkerhetsrelaterat beteende.

Frågeformuläret utvecklades och användes på de sex processindustrierna som deltog i projektet. Svarsfrekvensen blev i medeltal 73 % (434 svar). Frågeformuläret testades med konfirmatorisk faktoranalys och relationerna mellan säkerhetsklimatet, säkerhetsspecifikt ledarskap och säkerhetsrelaterat beteende testades med strukturell ekvationsmodellering.

Analysen visade signifikanta samband mellan säkerhetsklimatet, säkerhetsspecifikt ledarskap och säkerhetsrelaterat beteende. Säkerhetsspecifikt utvecklande ledarskap visade en positiv effekt (signifikant) medan passivt ledarskap visade en negativ effekt (också signifikant) på säkerhetsklimatet. Associationerna var särskilt starka mellan utvecklande ledarskap och säkerhetsklimatdimensionerna säkerhetskommunikation och medverkan från anställda. Dessutom hade ledarskapet en indirekt effekt på de anställdas säkerhetsrelaterade beteende via säkerhetsklimatet. Resultaten visar på vikten av arbetsledarnas ledarskap.

Det utvecklade frågeformuläret med 13 frågor för ledarskap och 34 frågor för säkerhetsklimat bedöms som mycket användbart för organisationer som vill utveckla sitt säkerhetsarbete.

Relationships between leadership, safety climate and learning from incidents, within the process industry (Bilaga 7)

Denna rapport presenterar övergripande preliminära resultat. Målsättningen med arbetet var 1) att studera relationer mellan olika ledarskapsbeteenden och olika dimensioner av säkerhetskulturen, samt 2) att studera dessa dimensioners relativa inverkan på lärandet från incidenter.

Frågeformuläret som vi utvecklat användes i sex processindustrier för att mäta sju säkerhetsklimatdimensioner, en dimension relaterad till tillit, två ledarskapsdimensioner och tre dimensioner relaterade till säkerhetsrelaterat beteende (samma datainsamling som beskrivs i Bilaga 6). I de säkerhetsrelaterade beteendena ingår dimensionen säkerhetskunskap som inbegriper kunskap om säkerhetsrisker på arbetsplatsen och kunskap om procedurer för att hantera dessa risker och nödsituationer (exempelvis brand). Lärandet från incidenter kvantifierades med metoden beskriven i referens 2 (sammanfattad i bilaga 4). En hypotetisk modell som sammanlänkar ledarskap, säkerhetsklimat, säkerhetsrelaterat beteende och lärande från incidenter testades med strukturell ekvationsmodellering.

Resultaten visar att kommunikation om säkerhet, säkerhetsutbildning, tillit och kunskap om säkerheten korrelerar starkast med lärandet från incidenter.

Relationship between learning level, learning cycle effectiveness and results from safety audits in six Swedish process industries
Samband mellan lärandenivå, lärcykeleffektivitet och resultat från säkerhetsrevision i sex företag inom svensk processindustri (Bilaga 8)

För sammanfattning se bilaga 8!

Bilagor. Kärnan i den vetenskapliga slutrapporten

1. Jacobsson, A., Sales, J. and Mushtaq, F. (2009). A sequential method to identify underlying causes from industrial accidents reported to the MARS database.
   Sammanfattning av artikel publicerad i internationell vetenskaplig tidskrift, referens 1 nedan.
2. Jacobsson, A., Sales, J. and Mushtaq, F. (2010). Underlying causes and level of learning from accidents reported to the MARS database. Sammanfattning av artikel publicerad i internationell vetenskaplig tidskrift, referens 2 nedan.
3. Jacobsson, A., Ek, Å., and Akselsson, R. (2010). Method for evaluating learning from incidents using the idea of "level of learning".
   Sammanfattning av manuskript accepterat för publicering i *Journal of Loss Prevention in the Process Industries.*
4. Jacobsson, A., Ek, Å., and Akselsson, R. (2010). Learning from incidents - method for assessing the effectiveness of the learning cycle
   Sammanfattning av manuskript inskickat till internationell vetenskaplig tidskrift
5. Börjesson, M. (2008). Leadership and safety culture. Rapport. Institutionen för ledarskap och management, Försvarshögskolan, Karlstad
6. Börjesson, M., and Enander, A. (2010). Safety climate, safety-specific leadership and safety-related behaviours within the Swedish process industry. Sammanfattning av artikel som är under utarbetande
7. Börjesson, M., Enander, A., Jakobsson, A., Ek, Å., and Akselsson, R. (2010). Relationships between leadership, safety culture and learning from incidents within the process industry. Sammanfattning av artikel som är under utarbetande
8. Ek Å., Jacobsson, A., and Akselsson, R. (2010). Relationships between learning level, learning cycle effectiveness and results from safety audits in six Swedish process industries (Samband mellan lärandenivå, lärcykeleffektivitet och resultat från säkerhetsrevision i sex företag inom svensk processindustri.) Frågeställningar till insamlad empiri. Analys pågår. Ska bli vetenskaplig publikation.

Referenser

1. Jacobsson, A., Sales, J. and Mushtaq, F. (2009). A sequential method to identify underlying causes from industrial accidents reported to the MARS database. *Journal of Loss Prevention in the Process Industries*, 22 (2), 197-203.
2. Jacobsson, A., Sales, J. and Mushtaq, F. (2010). Underlying causes and level of learning from accidents reported to the MARS database. *Journal of Loss Prevention in the Process Industries*, 23 (1), 39-45.
3. Jacobsson, A., Ek, Å., and Akselsson, R. (accepterad). Method for evaluating learning from incidents using the idea of "level of learning".
   Manuskript accepterat för publicering i Journal of Loss Prevention in the Process Industries. För sammanfattning se bilaga 3.
4. Jacobsson, A., Ek, Å., and Akselsson, R. (submitted). Learning from incidents - method for assessing the effectiveness of the learning cycle
   Manuskript inskickat till internationell vetenskaplig tidskrift. För sammanfattning se bilaga 4.

Abstract

A sequential method to identify underlying causes from industrial accidents reported to the MARS database.

Jacobsson, A., Sales, J. and Mushtaq, F.
Journal of Loss Prevention in the Process Industries, 22 (2), 2009, 197-203.

A sequential method to identify underlying causes from industrial accidents reported to the MARS database

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Abstract

This paper presents a method designed to identify underlying causes leading to industrial accidents. The method developed intends to facilitate the learning process from accidents by identifying possible causes related to the accidents that were not directly stated in an accident report, but that can be deduced following the description of the event, in particular with regard to the quality of the safety management systems in place at the industrial establishment at the time of the accident. The method has been prepared following a sequential approach, although a combination of the philosophy behind other existing accident models has been taken into consideration. The starting point to develop the model is the causes for accidents included in the MARS database of the European Commission. These causes have been extended by considering typical operational or organisational failures that are normally related to the original reported cause. The extension of causes has been performed by adding three follow-on levels of possible underlying causes. The first level could be considered as a direct cause of the accident and, the last level being more applicable to the foundation of establishing safety: ‘‘Safety Management System or the Safety Culture’’.

In order to check the applicability of the method developed, it has been validated by a group of experts of the European Federation of Chemical Engineering, in order to reinforce the strategy adopted by the authors. Moreover, the method has been used to analyse the total set of accidents reported to the MARS database. The objective is to determine the efficiency of the method in identifying underlying causes, and to establish a link between the results obtained and the actual causes stated in the reports. In this way, it is possible to establish a system to go deeper into the analysis of past accidents, in order to obtain lessons learned, and to avoid recurrence of similar accidental scenarios in the future, as well as to give directions for a better reporting system of industrial accidents.

För full text se

Journal of Loss Prevention in the Process Industries 22 (2009) 197–203

Abstract

Underlying causes and level of learning from accidents reported to the MARS database.

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Abstract

MARS is the system established and maintained by the European Commission in order to collect information related to major industrial accidents in EU Member States in the context of the Seveso II Directive. One of the main purposes of the MARS database is to provide information for learning from the accidents to avoid similar events. Probably, the most important issue for the learning is the determination of the causes, particularly the underlying causes, of the accidents. One objective was to find possible patterns of underlying causes per industry type and per country. Another objective was to determine the occurrence of weaknesses in safety management systems and in safety culture as underlying causes. A further objective was to determine the level of learning from the accidents, as it appears from the reports, per industry type and per country. A sequential method, presented by us in a previous paper in this publication, was used to make it possible to go beyond the causes given in the original reports and to find more underlying causes. To determine the level of learning from the accidents, using the actions/lessons learned given in the reports, a classification method was developed. This method establishes the level of learning of the lessons learned from each case description, essentially from the organisational point of view. This paper presents the results of an analysis regarding underlying causes of all the accidents of the MARS database reported up to mid 2007. The results are expressed per industry type and per country. The main results are that as much as three times as many underlying causes can be found when applying the method developed compared with what is given in the original reports. The most important underlying causes are found in weaknesses in process analysis (risk assessment) and in procedures, regardless of industry type. Weaknesses in safety management systems and in safety culture contribute as underlying causes in a very high percentage of the accidents. The quality of reporting, measured in terms of analysis of underlying causes, vary considerably between various countries. The level of learning, as determined from the information in the reports, is found to be in general rather low, especially from some of the countries. This study has given rise to ideas of improvement of the MARS system. It has also raised many questions, some of which would be suitable for further research.

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Method for evaluating learning from incidents using the idea of "level of learning"

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Abstract

Learning from incidents is considered as one very important source of learning in many businesses and there is currently a lot of interest in this topic in the process industries. Most companies have some kind of incident learning system, nowadays mostly computer-based, with features for reporting, analysing and acting on individual incidents. However, the effectiveness of such systems is largely dependent on how the employees report incidents and how the management acts on those incidents reported. Therefore, it is of large interest to be able to evaluate the effectiveness of the learning from incidents, and for that purpose we need methodologies and tools.

The learning from incidents would have to be essentially organisational learning to be effective. Depending on the incident and its causes the learning from it will have to take place on various organisational levels. The model of a company as a socio-technical system (Rasmussen, 1997) will therefore be suitable to use here. The lessons learned that are extracted from the incidents should be put into the organisational memory of the company in terms of categories such as Personnel, Procedure and Plant (Nertney, 1987).

The level of learning could be expressed in dimensions of how broad the lesson learned is applied geographically, how much organisational learning that is involved and how long-lasting the learning is.

In this paper is described a methodology for evaluation of the effectiveness of learning, based on level of learning. For evaluating the level of learning we have used a 6-level system, based on the dimensions just mentioned.
The methodology consists of 6 steps.

1. Evaluation of Actual level of learning, based on the lessons learned for individual incidents reported.
2. Evaluation of Potential level of learning for individual incidents reported.
3. Relationship between Actual and Potential level of learning for a larger number of incidents.
4. Correction of the results from 1-3, considering incidents that are not reported (the "hidden number").
5. Adjustment of the results from 1-4, considering any possible action and additional learning from an agglomerated material of incidents, the 2nd round

6. Adjustment of the results from 1-5, considering any other ways of learning from incidents in the company.

Tools for assistance to make concrete numerical evaluations have been developed. The methodology has been tested on the incident reporting material of two years from five companies from various types of process industries. It was found that the methodology and the tools worked very well in practice. The results gave interesting insights into the effectiveness of learning from the incidents. Differences between companies could often be explained by specific circumstances in the companies.

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Learning from incidents – method for assessing the effectiveness of the learning cycle

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Learning from incidents - method for assessing the effectiveness of the learning cycle

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Abstract

Learning from incidents is considered as one very important source of learning for safety, and there is currently a lot of interest in this topic in the process industries. Most companies have some kind of incident learning system, nowadays mostly computer-based, with features for reporting, analysing, decision-making, and acting on individual incidents. However, the effectiveness of learning from such systems is largely dependent on the employees reporting incidents and how the management acts on those incidents reported. Therefore, it is of major interest to be able to evaluate the effectiveness of the learning from incidents yielding the opportunity for improvement, and for that purpose we need methods and tools. This paper describes a method for assessing the effectiveness in the steps of the learning cycle: the 1st loop with reporting – analysis – decision – implementation – follow-up and the 2nd loop on an aggregated basis. For each step, the dimensions which are considered the most relevant for the learning process (scope, quality, timing and information distribution) were defined. For each dimension the most relevant aspects (e.g. completeness and detail) were defined. By using these dimensions and aspects a method for a semi-quantitative assessment of the effectiveness of the learning cycle was developed. The assessment is carried out by comparing the actual information for an incident with the requirements for various ratings according to the scales of the method. The output from using the method is a measure of the effectiveness of the learning from incidents. The method can give clear indications of areas for improvement. The measures of the method can also be used for correlating results from learning from incidents with other safety parameters, e.g. results from safety audits and safety climate inquiries. The method is intended to be used on a sample of the broad range of incidents normally seen in process industry companies.
The method was tested on a two-year incident reporting material from six companies from various types of process industries. It was found that the method and the tools worked very well in practice. The results gave interesting insights into the effectiveness of learning from the incidents. Differences between companies could often be explained by specific circumstances in the companies, e.g. concerning management involvement, resources for dealing with safety issues, and safety training of employees.

Leadership and safety culture.

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Rapport

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Leadership and safety culture

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Introduction

My topic of interest is risk and safety issues from a psychological perspective. In my research I am studying peoples risk and safety attitudes in everyday life, in military settings as well as recently focusing on safety culture in industrial settings. In this essay I am going to focus on the latter and my purpose is to reflect upon the leadership role in relation to safety culture/safety climate (in this paper I use these two concepts interchangeably). In my discussion I will try to highlight some empirical findings in this research domain, as well as apply more general theories of leadership presented in the literature from the course *"Frontiers in leadership"*. My purpose is not to reach definitive conclusions, rather to find bridges between the general research field of leadership and my specific research area. By doing that I hope to generate research questions that are relevant for coming research projects in this field.

Discussion

Safety culture

Safety culture is a complex issue which has been given lots of different definitions in the literature. One of these is that a safety culture reflects the attitudes, beliefs, perceptions and values that employee´s share in relation to safety (Cox & Cox, 1991). Safety culture is often seen as a subset of organizational culture and the distinction of these concepts as well as safety climate is not clear (Ek, 2006). There is however a common understanding that safety culture is a multidimensional concept. But, there is no consensus which dimensions best capture this phenomenon. The number of constituent factors range from 2-19 but almost always include such factors as management responsibility, job satisfaction, individual responsibility, leadership style and communication, risk awareness, and risk taking (Flin et al., 2000). The dominating instrument to measure these factors has been through questionnaire survey within the target organization or parts of it. Most research has concentrated on strongly regulated organisations (e.g. nuclear, air traffic) where the salience of safety is high. A closer look at these questionnaires reveals that a great deal of the items focus on how subordinates experience their supervisor or closest superior (see for example Ek, 2006; Johnson, 2007; Evans et al., 2007; Diaz-Cabrera et al., 2007). Leadership is in general given great importance for safety culture. Ek (2006) states that the safety culture in an organization could be said to be influenced by two important components: a) the type of work that is conducted b) the

leadership and management system. Flin (2003) further concludes that management commitment is one of the major factors in the managing of an organizations safety. However, few studies have focused on the direct influence of different types of leadership on safety culture (Börjesson, Lajksjö & Enander, 2007)

Leadership and safety culture

As mentioned above safety culture is often seen as a subset of organizational culture. In other words it is the organizational culture that shapes the perception of safety and the employees activities regarding safety (Ek, 2006). According to Schein (1992) culture could be seen *" as those elements of a group or organization that are most stable and least malleable. Culture is the result of a complex group learning process that is only partially influenced by the leader"* (p. 5). However, he argues that the most important aspect in leadership is to create and manage culture. He even postulates that the ultimate challenge of leadership is the ability to perceive the limitations of one´s own culture and to develop the culture adaptively in such way that the group can survive in a changing environment. From these statements several questions arise, such as: what is characteristic of a healthy safety culture and what are desirable qualities in leaders in terms of creating such culture?

Ek (2006) states that a positive safety culture depends on the development of trust, commitment and mutual understanding, between all organizational levels. As mentioned above factors such as management responsibility, individual responsibility, job satisfaction and communication are seen as important factors to contribute to this positive safety culture. Although aspects of leadership are present in these contributing factors, to my knowledge, little work has been done to study and compare the influence of different leadership models. From the definitions above and the dimensions frequently used in safety culture research I find that the Developmental leadership model developed by Larsson et al. (2003) seems to capture many relevant aspects.

The developmental leadership is influenced by and closely resembles the model of transformational leadership and also shows similarities with The Sandahl Partners Interactive Model (Sandahl et al., 2004). Developmental leadership consists of exemplary model, individualized consideration and, inspiration and motivation. Each of these factors has facets that highlight relevant leadership behaviors in creating a positive safety culture. The facets of

exemplary role model such as expressing values, setting high ethical and moral standards, and taking responsibilities contributes to mutual trust (Larsson et al., 2003). The facet of responsibility is also highlighted by Sandahl et al. (2004) who say that it is important in order to create safety and trust that managers are held accountable for the work of subordinates. According to Reason (1997) trust is critical in order to create a willingness in employees to report accident, which then is important in creating a positive safety culture. He also states that trust and commitment foster individualized responsibility in that sense that employees looking for safety problems on their own. The support and confronting facets in the individualized consideration factor and the facets promote participation and creativity in the inspiration and motivation factor seem also to highlight important aspects. Reason (1997) states further that it is important for employees that they get quick feedback on their reports, as well as feedback on well defined safety related behaviors. Studies have also showed that support, involvement in decisions, and influence in the design of work are essential factors in order for employees to adapt safety values and behaviors (Ek, 2006). The importance of continuously questioning the present culture, and to have the ability to transform the work organization in order to manage changing demands are also seen as central factors in a positive safety culture (Reason, 1997). These aspects seem to be captured within the factor promote creativity. Sandahl et al. (2004) also emphasize the ability to manage change and development.

There are dimensions in the research of safety culture that shows similarities with the developmental leadership model. Johnson (2007) has shown that Caring, Compliance and Coaching are desirable qualities in supervisors in creating a positive safety climate. In his study he also found that these dimensions were connected to employees safety behaviours. In my mind this makes it even more interesting to test the developmental leadership model in futures studies.

Although the transformational leadership seems appealing, there are some aspects of transactional leadership that I think is necessary for leaders to use, particularly in industrial organizations, such as nuclear and chemical industries. Especially the transactional behavior *active management by exception* (looking for mistakes and enforcing rules to avoid mistakes) seems like an important dimension for safety culture in this type of organizations, where employees fail to follow safety regulations could have fatal consequences. Yukl (2005) also states that an effective leader uses a combination of transformational and transactional leadership. Therefore, I find it important to consider dimensions of transactional leadership when studying safety culture in industrial organizations. In these studies it would also be

interesting to consider the gender factor. Eagly and Carli (2003) note that female leaders tend to be more transformational in comparison with male leaders. According to them this is because the female gender role fosters more of considerate and supportive behavior than the male gender role does. Could it be that females in leading position in an organization have a positive impact on the safety climate?

A positive safety culture is characterized by a shared perception of the value of safety at all organization levels (Ek, 2006). However, Ek (2006) refers to a study by Thomson et al. (1998) that notes that leaders at different levels within the organization influence safety and values in different ways. Top managers do this indirectly by affecting the politics of communication and supervisors do this directly through the interaction with the employees. This finding closely resembles the signification of the model of indirect leadership (Larsson et al., 2005). This model describes how the visions, goals and intentions of the top managers communicates to a link (action oriented influence), that usually consists of a subordinate chief (e.g. supervisors). The link mediates the message to the lower organizational levels. The top manager can also influence the lower levels in the organization by being a good or a bad role model (Image oriented). Both these ways of influence are exposed to a filter, which means that information could be excluded or distorted. Trust in the top management and the link by the employees creates necessary conditions for engagement and participation. Lack of trust creates risks that the message will be redefined by the employees. In that case punishment and rewards could be necessary strategies in order to obtain obedience. This model captures several relevant aspects that I find important to reach a deeper understanding of the leadership in the organization and the ways managers influence their employees. The important role of the supervisors (links) in industrial organizations is emphasized in this model. But the model also indicates that it is equally important to understand the relations between the supervisors and higher level of management. This is an aspect that to me seems to be missing in the safety culture research. Focus has rather been on the relations between supervisor and employees (see for example Johnson, 2007). The model also highlights the importance of trust in creating a shared perception between all levels in the organization. One could also think that the model also explains under which conditions a transformational leadership (high trust) or a more transactional leadership (low trust) is plausible. Moreover, Larsson et al. (2005) notes from a qualitative study on the Swedish air force that the safety culture of the organization constitutes a filter for the messages. The higher chiefs messages in this type of organizations are influenced by the perceived obligation to implement a safety way of thinking in the

organization. Nevertheless, the answers from the respondents in this study indicate that even in these strongly regulated organizations, norms could develop that are contrary to the rules and regulations. Once again, this shows that it is crucial both from a practical as well as a scientific point of view to reach knowledge of all the levels in the organizations in order to truly understand the safety culture. Both the indirect (top management) and direct (e.g. supervisors) leadership should be taking in consideration in future studies on safety culture. Yukl (2005) concludes that the indirect leadership influences the shared values and beliefs of the members and that the indirect and direct leadership should be used in a consistent way to magnify their effects.

The role of the supervisor

From the discussion above one could presume that the links in an organization, for example the supervisors, have an important role in establishing a positive safety culture. As a supervisor you have direct influence and responsibility over work teams/operator teams. In that sense you are functioning as a role model and mediator of the organization culture. You also function as a coach for the individuals in the group. This raises two essential questions, namely how does these expectations affect the supervisor?, and what are the critical aspects in order for the supervisor to fulfill his or hers role?

In order for the supervisor to fulfill his role he must know what the expectations as well as what the boundaries are for the role. Weak boundaries create role ambiguity (Sievers & Beumer, 2006). Role ambiguity has been found to increase tension and decrease job satisfaction as well as to create decreased participation in decision making (Wheelan, 2005). Role clarity seems therefore to be an important aspect for the supervisor to function as a good link for the top managers. Larsson et al. (2005) emphasizes the significance of a good communication between higher chiefs and their links in order to reach an understanding of the goals and implementations. The interaction between the higher chief and the link has an overreaching purpose to form a common mental model of what should be done, and how it should be done (Larsson et al., 2005). Reed and Bazalgette (2006) also emphasize the necessity of a common mental construct between managers, or a common Organization-in-mind and Institution-in-mind, using their terms. According to them Organisation-in-mind refers to emotional experience of for example tasks, roles, purposes, boundaries and accountability and institution-in-mind refers to emotional experience of such things as ideals, values and beliefs.

Different pictures of these aspects between managers produce problems because each one has their own perception of what action should be taken (Reed & Bazalgette, 2006). Without a common mental model at all manager levels, it seems impossible to give rise to a shared perception of safety values, from the top to bottom (operator level). It would be of great interest to compare the mental models (e.g. goals and values regarding safety) of leaders on different levels within the organization.

The supervisor could be seen as a coach for the employees. In that sense the supervisor directly influences the employees by monitoring their behaviors, give support and mediates goals and visions from the higher chiefs. The coaching aspect of the role of the supervisor and the influence on safety climate, has been stressed by Johnson (2007). He points to coaching behaviors (e.g. uses explanations to get the employees to work safely) that specifically concerns safety. However, positive supervisor behaviors in terms of such things as communication, consideration, social support, organizing and group maintenance also have a positive effect on employees' well-being and decrease the risk of burnout among employees (Gilbreath & Benson, 2004). Moreover, the mood of the leader of self-managing groups (e.g. supervisor and operators team) has a direct influence on the affective tone within the group. Positive mood by the leader, in comparison with negative mood, give rise to a positive affective tone within the group, and the group also exhibit more coordination and less effort (Sy et al., 2005). Clearly, the supervisor has a great impact on the working situation of the employees. The working situation experienced by employees has been shown in previous studies (Ek, 2006) to be an important dimension for safety culture. However, it seems to me that in these studies, this dimension has been measured with more general questions (e.g. Do you get on well with your coworkers?) and not specifically given attention to the importance of the supervisors. The studies presented above indicate that supervisor behaviors not only concerning safety could be of much relevance for the safety culture.

Consider the supervisor behaviors mentioned above such as coaching, consideration and social support I once again find close similarities with the transformational leadership. The transformational behaviors *individualized consideration* (support, encouragement, coaching) and *inspirational motivation* (communication vision, using symbols, modeling appropriate behaviors), (Yukl, 2005), seem to be in particular desirable qualities in supervisors in order to be a good provider of the safety values and provide a satisfying work situation for employees. As for supervisors in highly regulated organizations (e.g. chemical industries) the transformational behaviors seems a highly significant aspect to emphasize. I think that these

types of organizations have a tendency to be bureaucratic, by the fact that they are influenced by a high degree of rules and regulations. This could inhibit the enthusiasm and inspiration of the employees (Yukl, 2005) and without an inspirational leadership (i.e. transformational), one could assume that this will have negative impact on the work situation.

Who is coaching the supervisor?

From the discussion above one could say that the supervisor has the responsibility in his role to satisfy the needs of the organization (expressed by top managers) as well satisfy employee's needs. But, who is coaching the supervisor and satisfying his needs? Seeing the supervisor as a coach I find the article by Giges, Petitpas and Vernacchia (2004) of relevance in regard of this question. The authors conclude that coaches deal with many of the same stressors (for example job insecurity and time management) as athletes do, but little has been offered to help them with their own needs. From an organizational perspective I find that the top managers have an important role when it comes to satisfying the supervisor's needs. Aspects such as give reward, social support, being fair and discuss values seem to be of particular relevance for top managers in their interactions with supervisors. Also, lack of these aspects has been connected to burnout (Hjälm et al., 2007). In addition, psychological techniques could also serve as functional strategies for the supervisors to handle stressors. Giges, Petitpas and Vernacchia (2004) emphasize the importance of Self awareness in coaches. The authors state that this knowledge is highly important as it gives an ability to adjust our behaviors to the situation and to respond to others more effectively. They further conclude that the field of sport psychology offers techniques that could develop self-awareness in coaches. Moreover, I find that the Focused Group Therapy presented by Sandahl and Lindgren (2006) is an interesting approach in this matter. Although, my opinion is that this type of intervention would be suitable in the "daily work" of supervisors. Being able to discuss ones problems and experiences (focus) with other supervisors in the same organization, could generate self-awareness, social support, problem solutions as well as an exchange of relevant knowledge and experiences in order to handle the demands of the daily work. Particular in high risk organizations (e.g. chemical industries) exchange of experiences should be provided to give the individual (e.g. supervisor) opportunities to reflect on how to handle critical situations. The importance of previous experiences of complex critical situations has been emphasized in previous studies (Sjöberg et al., 2006). I think that reflecting upon these situations, although one have not experienced them

oneself, could better prepare the individual for the situation. In conclusion I find that it would be interesting to study how intervention as those mentioned above influences the affectivity of supervisors. One could assume that satisfying ones own needs is necessary to be able to satisfy other needs, both organizational and individual ones.

Given the demands placed on the supervisor and the importance of this role in regard to safety culture, it is highly important to find a suitable person who has the qualities to fulfill this role. According to Sandahl et al. (2004) personality questionnaires have little to offer in this respect. Instead they mean that performance-based tests might be more useful in the selection of managers. However, in order for these tests to be effective one needs to have a model of the actual work situation for the specific manager position in question (Sandahl et al., 2004). The studies presented above give some insights of a plausible model for supervisors, and so does The Sandahl Partners interactive model, which takes into account both personality and the social context (Sandahl et al., 2004). However, more studies are needed in order to really understand the specific demands on and qualities of supervisors in a industrial organizational context, in order to develop such a model.

Time, group processes and safety

In his book ”Sovereigns of Time” Tyrstrup (2005) deals with the concept of time in relation to leadership. He refers to Chester Barnard who states that failures are rather a norm than an exception in organizations. These failures results in selection which generates more reliable and functional procedures. In other words, organizations could from this perspective learn from these failures. However, much depends on the ability of the leader to in a daily basis interpret and classify problems and plans that ought to be implemented and goals that sometimes need to be revised or even discarded (Tyrstrup, 2005). I find these ideas appealing in regard of leadership and safety culture. Reason (1997) states that in order for an organization to have a proactive approach to safety, it needs to develop a *learning culture,* which means collecting, monitoring, and analyzing relevant information on safety and thus having updated knowledge how work and safety are functioning. Schein´s (1992) statement that the ultimate challenge for leaders is the ability to perceive limitations in one’s own culture and develop the culture adaptively also resembles the ideas put forward by Tyrstrup (2005). It would be of interest to shed light on how industrial organizations learn from accidents and anomalies in order to create a proactive approach to safety. Do they have the ability to have a look at the past to

understand what happen in the present and to learn from this in order to work more safely in the future?

In the challenge for the leader to develop a positive safety culture lies also the ability to interpret and monitoring processes that affect the behaviors and values of different work teams within the organization. Culture is the result of a complex group learning process (Schein, 1992). In this regard I find that the concept Leader-member relations and The integrated model of group development are of much relevance. Leader-member relations focus on the social exchange processes between leader and subordinate. More specific, this exchange has been described in three stages i) initial testing including motive, attitudes, resources, role expectations; ii) development of mutual trust, loyalty, and respect; and iii) development of mutual commitment to organizational/unit goals (Graen & Uhl-Bien, 1991). Elkins and Keller (2003) further conclude that one of the most important initial aspect of the exchange processes is the relationship between subordinates and supervisors. This once again confirms the importance of the supervisors as mediators of values and goals in the organization as well as coaches for the employees. However, the "efficiency" of this exchange process could be assumed to be dependent on the relation between supervisors and higher chiefs and their ability to create a shared mental model to be communicated to lower organizational levels.

Wheelan (2005) describes group development in five stages: 1) Dependency and Inclusion, 2) Counterdependency and Fight, 3) Trust and Structure, 4) Work, 5) Termination. She means that during the first stage the members are highly dependent on the leader to show them direction. According to Wheelan, clarifying of goals, values and norms by the leader, speeds up the development process in stage 1 and 2 and moving the group more "softly" to stage 3, in comparison with if these factors are vague. It is not until the group has reach stage 3 that the members can begin a mature discussion and negotiation process about goals, values and norms. It is important for the leader to facilitate these discussions in order to create a consensus about these aspects in the group. This is not an easy task for the leader, but it is essential in order to move the group further to stage four, which is characterized by a shared perception of goals, values and norms (Wheelan, 2005). However, she also states that such things as change in membership, external demands and internal conflicts could affect the structure of the group and produce regression to earlier stages in the process.

In my mind this model captures several crucial aspects that are relevant for leaders to understand the challenge to create a positive safety culture. First of all, the model gives some practical consideration for leaders on how to behave during different stages in the development process of the group and what the needs are for the members. Secondly, it emphasizes once again the importance of clear goals, values and norms and that these aspects must frequently and consciously be discussed, where these aspects could change in the group, due to factors outside the leaders direct control. Finally, the model emphasizes the need for leaders to be very clear about their intention (goals, values, norms) in new groups or groups that faces new demands etc., in order to create trust between themselves and there subordinates. We already know how important trust is in regard of creating a positive safety culture. Moreover, one could assume that many of those aspects already discussed such as the role of the supervisor, communication between the supervisor and higher chiefs and transformational leadership are contributing factors to group development.

Methodological considerations

The above discussion has generated several research questions that I find interesting to shed light on in my future studies on safety culture in industrial organizations. However, in conducting such studies it is important to consider methodological issues.

As mentioned above research on safety culture has been dominated by quantitative research. However, according to Bryman (2004) this could be problematic, particular when it comes to understanding leadership. Bryman means that quantitative research builds on previous quantitative studies and therefore tends to be more cumulative than qualitative research. He also states that quantitative research tend to overlook the importance of the social and organizational context where the leader operates in. Bryman means that it is of significant importance to take into account the context in order to truly understand leadership. With this regard he states that the qualitative research results in more contextualized findings and could make important contributions to understand how styles of leadership have to be or tend to be in a particular context or circumstances.

It seems to me that it could be the case that the dominating quantitative research in safety culture has overlooked the importance of context in the study of which dimensions are most relevant to safety culture. This could be why the results are so contradictory, and that one

often could not replicate factor solutions extracted in previous studies. Therefore, one could assume that qualitative studies are suitable in an early stage of the project in order to identify key aspects (including leadership) that underlie the safety culture in the specific organization of interest. Quantitative studies could then investigate if these key aspects are significant contributing factors to safety culture in this type of organizations.

Yammarino et al. (2005) emphasizes the importance of specifying the level-of-analysis when conducting studies. It seems to me that this is not the case in many of the studies I have taking part of in the field of safety culture. Many of these studies are gathering their data from the operator level in the organization and then interpret this as findings of the safety culture in the organization. However, by doing so they don't consider inter-level-differences (Yammarino et al., 2005). Ek (2006) compared safety attitudes among managers and non-managers in an organization and found that these attitudes differed to a great extent. This shows that it is problematic to draw conclusion of the safety culture in an organization, just by gathering data from one level in the organization. One could assume that to truly understand the safety culture, one should take a multiple-level approach. However, by doing so one should strictly follow Yammarino´s et al. (2005) guidelines of specify level of analysis in theory formulation, construct/variable measurement, data analytic techniques, and inference drawing.

Finally, Zaccaro and Horn (2003) emphasizes the importance of a dialogue between practitioners and researchers early on in the research project in order to produce measurements, theories and models that are contextualized. I find such a dialogue highly important in the study of safety culture. In order to find those key aspects contributing to safety in a particular organization, such a dialogue is assumed to be necessary, because practitioners are the ones who implement the safety management system in the organization and practitioners also evaluate the safety in an organization. Therefore, practitioners have a great impact on the safety behaviors in the organization. Moreover, they also have knowledge regarding how management works with safety, and what aspects that often fails in the safety work within a particular organization. In conclusion such a dialogue could generate more relevant dimensions of safety.

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Safety climate, safety-specific leadership and safety-related behaviours within the Swedish process industry

Börjesson, M., and Enander, A. (2010).

Sammanfattning av artikel som är under utarbetande

Safety climate, safety-specific leadership and safety-related behaviours within the Swedish process industry

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During the last decade, an extensive number of studies have been published within the field of safety culture. Despite this amount of research, there is still an ongoing debate about how to define concepts such as safety culture and safety climate, and also how to distinguish between these concepts (see for example Flin, Mearns, O´Connor & Bryden, 2000; Choudry et al., 2007; Guldenmund, 2007 for an overview). However, most definitions of safety culture share common features, focusing to varying degrees on the way people think and/or behave in relation to safety (Choudry et al., 2007). According to Cooper (2000) safety culture could be seen as "the observable degree of effort by which all organizational members directs their attention and actions toward improving safety on a daily basis" (p. 115). The term safety climate relates, according to Zohar (2008), "to shared perceptions with regard to safety policies and practices" (p. 1). A common opinion among researchers is that safety climate could be seen as a "snapshot" of the safety culture (Flin et al., 2000), and could be defined as a subcomponent of safety culture (Cooper and Phillips, 2004).

The common method to capture the safety climate within organizations is by questionnaires. These questionnaires include different scales that are supposed to measure different dimensions related to safety climate. However, to measure the concept of safety climate has been shown to be a great challenge for researchers, and according to Guldenmund (2007) most studies have not been able to replicate a factor solution from a previous study. One reason for this ambiguity may be that these structures are specific to particular organisations (Cooper & Phillips, 2004), and may also differ between different cultures.

Besides challenges of measuring safety climate, researchers have also been interested in factors influencing safety climate in different organizations and also the effect of safety climate on safety related outcomes. One important factor has been shown to be leader behaviours within the organization, especially leader behaviours practiced by supervisors seems to be significantly related to safety climate (e.g. Zohar, 2002; Zohar & Luria, 2003; Johnson, 2007). Furthermore, studies by Barling, Loughlin and Kelloway (2002) and

Kelloway, Mullen and Francis (2006) show that transformational leadership behaviours, aimed towards safety, seem to be an effective leadership style to influence safety climate in a positive way. Moreover, these studies also show that safety-specific transformational leadership has an indirect influence on safety-related outcomes via the influence of safety climate. This style could be compared to a more passive safety related leadership style, which Kelloway et al. (2002) showed had a direct negative influence on safety climate and indirectly on safety related outcomes.

The present study has the intention of examining the relationships between safety-specific leadership, safety climate and safety-related behaviours among six Swedish companies within the process industry. In more specific terms the aims are a) to develop a questionnaire measuring different dimensions of safety climate, safety-specific leadership as well as safety related behaviours within the process industry b) to test the hypothesized dimensional structure of these aspects c) to examine the relationships between safety-specific leadership, safety climate and safety-related behaviours.

Method. Data collection was conducted at six different companies within the process industry. A questionnaire was developed in order to measure the safety climate within the organisations. Based on a literature review of relevant dimensions, scales and items used in previous studies, question themes were generated that were expected to capture different aspects (dimensions) of safety climate and safety-related behaviours. The choice of dimensions was the result of an interactive process between safety researchers and persons with great practical knowledge within the process industry. The goal was to generate hypothetical dimensions which were theoretically interesting as well as took into consideration the specific context of the process industry. A greater part of the items in the questionnaire were adopted from work done by Ek (2006) and Diaz, Hernandez and Isla (2007) as well as from the Safety Climate Questionnaire for Process Industry (SCQPI). The latter developed within the framework of the EU project ARAMIS. In addition, two constructs of safety-specific leadership were measured in the present study: *safety-specific transformational leadership* (10 items) and *safety-specific passive leadership* (3 items). The scales used to measure these constructs were adopted from Kelloway, Mullen and Francis (2006).

The questionnaire was distributed to the employees via a contact person (HSE representatives) at each company. Participation was voluntary and respondents were informed

that data would be treated in confidence. To ensure confidentiality an envelope was enclosed with each questionnaire. Four hundred and thirty four employees on the shop floor level completed the questionnaire, leaving a response rate of 73.2 %. The sample consisted of 86 % males and 14 % females, aged 45.0 years in average. The mean length of time in the company was 16.6 years, and in the present position, 13.4 years. The questionnaire was tested by means of Confirmatory factor analysis (CFA) and the relationship between leadership, safety climate and safety-related behaviours was tested using Structural equation modeling (SEM).

Results. Preliminary results revealed the presence of a seven-factor solution measuring safety climate; *safety communication*, *safety practice*, *management commitment*, *employee involvement*, *safety education routines, safety education quality and priority* and *reporting* and three factors measuring safety-related behaviours; *safety compliance* (e.g. following instructions), *Safety participation* (e.g. communication safety issues to co-workers) and *safety knowledge* (e.g. perceived knowledge about safety risk and safety procedures).

Furthermore, the analyses showed that significant relationships exist between safety-specific leadership, safety climate and safety related behaviours. Safety-specific transformational leadership and safety-specific passive leadership seem to have opposite effects on safety climate, as transformational leadership showed a significant positive effect on safety climate and passive leadership showed a significant negative effect on safety climate. Furthermore, leadership has an indirect effect on employee's safety-related behaviours via the impact on safety climate.

Discussion. The results of the study clearly highlight the importance of leadership among supervisors in the organisations.

The scale used in this study to measure safety-specific transformational leadership and safety-specific passive leadership consists of 13 items and could rather easily be applied to capture leadership behaviours within the organisation. The results could be used for educational purposes as well as for coaching and support to those supervisors scoring low on the safety-specific transformational scale. Furthermore, the safety climate questionnaire developed within this study offers an opportunity for organisations within the process industry to monitor safety climate and to introduce interventions when needed. The safety climate questionnaire consists of 34 items and gives a general measure not only of safety climate but also of different key dimensions within the safety climate. Thus, these scales may contribute to the safety work conducted within these organizations.

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Relationships between leadership, safety culture and learning from incidents within the process industry

Börjesson, M., Enander, A., Jakobsson, A., Ek, Å., and Akselsson, R. (2010)

Sammanfattning av artikel som är under utarbetande

Relationships between leadership, safety climate and learning from incidents, within the process industry.

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The present paper focuses on the relationship between leadership, safety climate and learning from incidents, based on a study among organizations within the Swedish process industry. Although an extensive body of literature has been published on each of these concepts, the relationship among them is not yet fully understood. However, from a theoretical point of view the relationship between safety culture and organizational learning seems to be reciprocal. Learning in an organization stems from a continuing process of collecting, monitoring and analyzing relevant information on safety (Ek, 2006), drawing lessons from the information gathered and introducing changes when needed (Reason, 1997). This process is dependent on a positive safety culture where both management and employees have a proactive stance to safety, and where employees are willing to communicate safety issues both verbally and in writing. According to Reason (1997) trust is a critical component to create this kind of safety motivation among employees´. Effective learning then results in new courses of action to minimize or prevent further incidents (Ramanujam & Goodman, 2010), and in this way could result in changes of the safety culture. Furthermore, according to Westrum (2004) a key aspect in cultural changes is leadership. Although the relationship between leadership and safety culture has been fairly well established, less is known about the indirect impact of different leadership behaviours on organizational learning.

The aims of the present study are to examine the relationship of different leadership behaviours with different dimensions of safety climate and trust, as well as to examine the relative impact of these dimensions on learning from incident.

Method. Data collection was conducted at six different companies within the process industry. Four hundred and thirty four employees on the shop floor level completed the questionnaire on safety climate and leadership (Börjesson & Enander, 2010), leaving a

response rate of 73.2 %. The sample consisted of 86 % males and 14 % females, aged 45.0 years in average. The mean length of time in the company was 16.6 years, and in the present position, 13.4 years. Employees were asked to answer a questionnaire measuring seven different dimensions related to safety climate; *safety communication*, *safety practice*, *management commitment*, *employee involvement*, *safety education routines, safety education quality and priority* and *reporting*, two different types of leadership behaviours; *safety-specific transformational leadership* and *safety-specific passive leadership,* one dimension measuring *trust* and finally three safety-related behaviours; *safety compliance, safety participation and safety knowledge* . Measurements of learning from incidents were collected by using methods developed by Jacobsson, Ek and Akselsson (submitted 1 and 2). Data was analysed using a multi-level approach and a hypothesised model linking leadership, safety climate, safety-related behaviours and learning from incidents was tested by the means of Structural Equation Modelling.

Results. Preliminary results show that safety communication, safety education, trust and safety knowledge have the highest correlations with learning from incidents. These relationships and their practical implications are to be further discussed in the paper.

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Relationships between learning level, learning cycle effectiveness and results from safety audits in six Swedish process industries (Samband mellan lärandenivå, lärcykeleffektivitet och resultat från säkerhetsrevision i sex företag inom svensk processindustri.)

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Preliminär titel

Relationship between learning level, learning cycle effectiveness and results from safety audits in six Swedish process industries

Samband mellan lärandenivå, lärcykeleffektivitet och resultat från säkerhetsrevision i sex företag inom svensk processindustri

Ek, Å., Jacobsson, A. and Akselsson, R.

I LINS-projektet har det utvecklats utvärderingsmetoder som fokuserar på lärande, säkerhet och säkerhetskultur. Med användande av dessa metoder har datainsamling skett i sex företag inom processindustrin. Genom analys av insamlade data kan vi få större kunskap om lärandet för säkerhet i företag och hur lärprocesser kan förbättras. Syftet med denna artikel är att utröna samband mellan funna resultat från tre metoder vilka gett: 1) mått på lärandenivån i företagen, (learning levels 0-V); 2) mått på effektiviteten i lärcykelns sex respektive steg: Reporting, Analysis, Decisions, Implementation, Follow-up, 2nd loop; samt 3) bedömning av områdena säkerhet/hälsa genom utförda revisioner innehållande ca 90 element eller aktiviteter som påverkar områdena säkerhet/hälsa/miljö i ett företag. Genom funna samband och tendenser i resultaten är syftet att få svar på följande frågeställningar: Företag som har en högre lärandenivå, hur effektiva är de i de olika stegen i lärcykeln? Vad säger revisionsresultaten och kan dessa vara ett mått på utfallet av lärandet? Kan revisionsresultaten förklara varför företag är olika effektiva i de olika stegen i lärcykeln?