

Ensuring minimum SHE Competences: a case study for manufacturing employees in a multinational

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Summary

Recent literature acknowledges or even emphasizes the importance of employee competences with respect to Safety, Health and Environment management. This study focuses on the production line managers and the SHE professionals of the worldwide manufacturing environment of a Life Sciences and Materials Sciences multinational. The focus is on the “content” part of competences (knowledge and skills), using the following definition of competence: “Competence (being acquired by learning) is the ability of a person to successfully execute a certain task”.

A focus group, supported by various additional interviews with job holders, characterized the working environment of both the SHE managers and the Line Managers, defined reference jobs and reference career paths. Subsequently, a consistent set of minimum SHE competences was defined. These sets of competences are generic and worldwide applicable within the company.

A set of 5 TRIPOD incident investigations were analyzed, using the Latent Failures and Basic Risk Factors, yielding supportive evidence for the competences as defined by the focus group.

The defined competences were translated into training courses, linked to the reference job profiles. This makes it easy to implement a system to ensure minimum SHE competences.

The zero SHE competence assessment of SHE professionals showed that the extent to which courses have already been followed, varies considerably. Having a measuring method can be a valuable tool in the implementation phase of a competence training program.

The study provides a sound method to analyze jobs, to define minimum SHE competences and to ensure such competences. It contributes to having, and maintaining, an adequate Safety Management System.

This manuscript is based upon the first author’s master thesis for the Management of Safety, Health and Environment (MoSHE) study at TopTech, Delft University of Technology.

Samenvatting

Het belang van Safety, Health en Environment (SHE) competenties van medewerkers wordt in recente literatuur erkend en benadrukt. SHE professionals en lijn managers binnen de manufacturing omgeving van een wereldwijd opererende Life Sciences en Materials Sciences multinational staan centraal in deze case studie. Hierbij ligt de nadruk op het “harde” gedeelte van competenties: kennis en kunde. De volgende definitie wordt gehanteerd: “competentie, verkregen door leren, is het vermogen van een persoon succesvol een bepaalde taak uit te oefenen”.

Een focus groep, in combinatie met interviews met functiehouders in het veld, heeft het werkveld van de SHE professionals en van de lijn managers gekarakteriseerd en referentie functies en een referentie carrière pad benoemd. Vervolgens is een minimum set van competenties gedefinieerd. Het betreft competenties die generiek zijn en wereldwijd toepasbaar.

Een vijftal TRIPOD ongevalsonderzoeken werden geanalyseerd onder benutting van de Basis Risico Factoren (BRF’s) en de Latent Failures. De resultaten ondersteunen de competenties zoals gedefinieerd door de focus groep. De competenties werden vervolgens gekoppeld aan trainingen, weergegeven per referentie functie. Hiermee is het mogelijk een systeem voor het borgen van deze minimum SHE competenties te implementeren.

Het zero SHE assessment van de huidige SHE professionals laat een grote variatie zien in de mate waarin cursussen daadwerkelijk gevolgd zijn. Deze ervaring leert dat het hebben van een “meet instrument” een belangrijk hulpmiddel kan zijn bij het implementeren van een competentie programma.

De studie geeft een aanpak, en benodigde basis elementen, om een minimum set van SHE competenties te kunnen borgen. Het draagt op deze manier bij aan het hebben en onderhouden van een adequaat Safety Management Systeem.

Dit artikel is gebaseerd op de scriptie van de eerste auteur voor de master studie Management of Safety, Health and Environment (MoSHE) bij TopTech, Technische Universiteit Delft.

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Introduction

Phrased in general terms, nobody will object to the statement that employees should have the right competences to do their job. Having said this, however, it's not that straightforward to make such a statement operational, especially if focusing on academic level employees. The challenge is how to define and ensure an adequate set of minimum Safety, Health and Environment (SHE) competences that supports proper functioning of the Safety Management System, leading to control of the SHE risks.

An early, and promising attempt to investigate management of SHE competences was made by van Kuijk (van Kuijk and van der Velden, 1998), linking competences to the management of business processes and the management of business risks. Within this study, SHE is seen as one of the business risk areas. The management of business processes and the aspect controls for the associated business risks, were described. Progress in competence management in each of the elements of the model was assessed through a survey. The study provides a conceptual approach, leaving opportunity for an attempt to define a consistent approach that includes the implementation of SHE competences.

Recent literature acknowledges or even emphasizes the importance of employee competences with respect to Safety (SHE) management (Baker, 2005; Health and Safety Executive, 2005; Janssen and Lugten, 2006; Jonkhoff and Roggeveen, 2006). The Baker report (Baker, 2005), on the BP Texas City Refinery explosion, recommendation no. 3 is quite illustrative "BP should *develop and implement a system to ensure that ...All U.S. refining personnel .. Possess an appropriate level of process safety knowledge and expertise*".

This study focuses on the worldwide manufacturing environment of a Life Sciences and Materials Sciences multinational. Within the manufacturing community, the production line managers and the SHE professionals are regarded to have high impact on SHE. Consequently, the study focuses on them. The worldwide scope implies that detailed elements concerning specific, local circumstances of jobs can not be taken into account. A minimum set of SHE competences will result, leaving it up to local management to fill in any specific, local aspects.

The research questions addressed in this study are:

- Which minimum SHE competences are required for SHE and Line managers?
- Which SHE competences deficiencies are contributing

factors in major accidents / incidents?

- How can required SHE competences be ensured?
- What is the current level of SHE competences?

Competences

In human resources literature, the term competence is commonly used for the combination of knowledge, skills and attitude. Weggeman (Weggeman, 2000) uses competence on an organizational level ("the ability of a group to achieve a certain shared goal or idea"). In this study, the focus is on job level. Four reference jobs for both SHE professionals as Line Managers are defined, covering the range of jobs that are present in practice.

The following definition for Competence is applied:

"Competence (being acquired by learning) is the ability of a person to successfully execute a certain task". The elements knowledge, skills and attitude define together competence. In this study, the focus is on the "content" part of competences (knowledge and skills), rendering the "attitude" part, dealing with personal development, outside the primary scope. This approach is motivated by the existence of mandatory Management Development programs that focus on personal development. It is, however, acknowledged that in reality these 3 elements are linked together and will influence each other.

Competences can, broadly speaking, be obtained via two different mechanisms: learning by doing (sometimes called "informal learning") and formal training. Over the last years, it's becoming more and more acknowledged that informal learning constitutes a substantial part of the total learning process of an individual (Borghnas et. al., 2006). The authors emphasize the very high positive effects of formal training by linking it to an informal learning environment. In their view, it's the combination of a working environment with learning opportunities (or perhaps needs), and formal training that is the most powerful.

Safety Management System

The Safety Management System as described by Hale (Hale, 2006) can be used for linking competences on an individual level on one hand and the SHE performance of an organization on the other hand (figure 1).

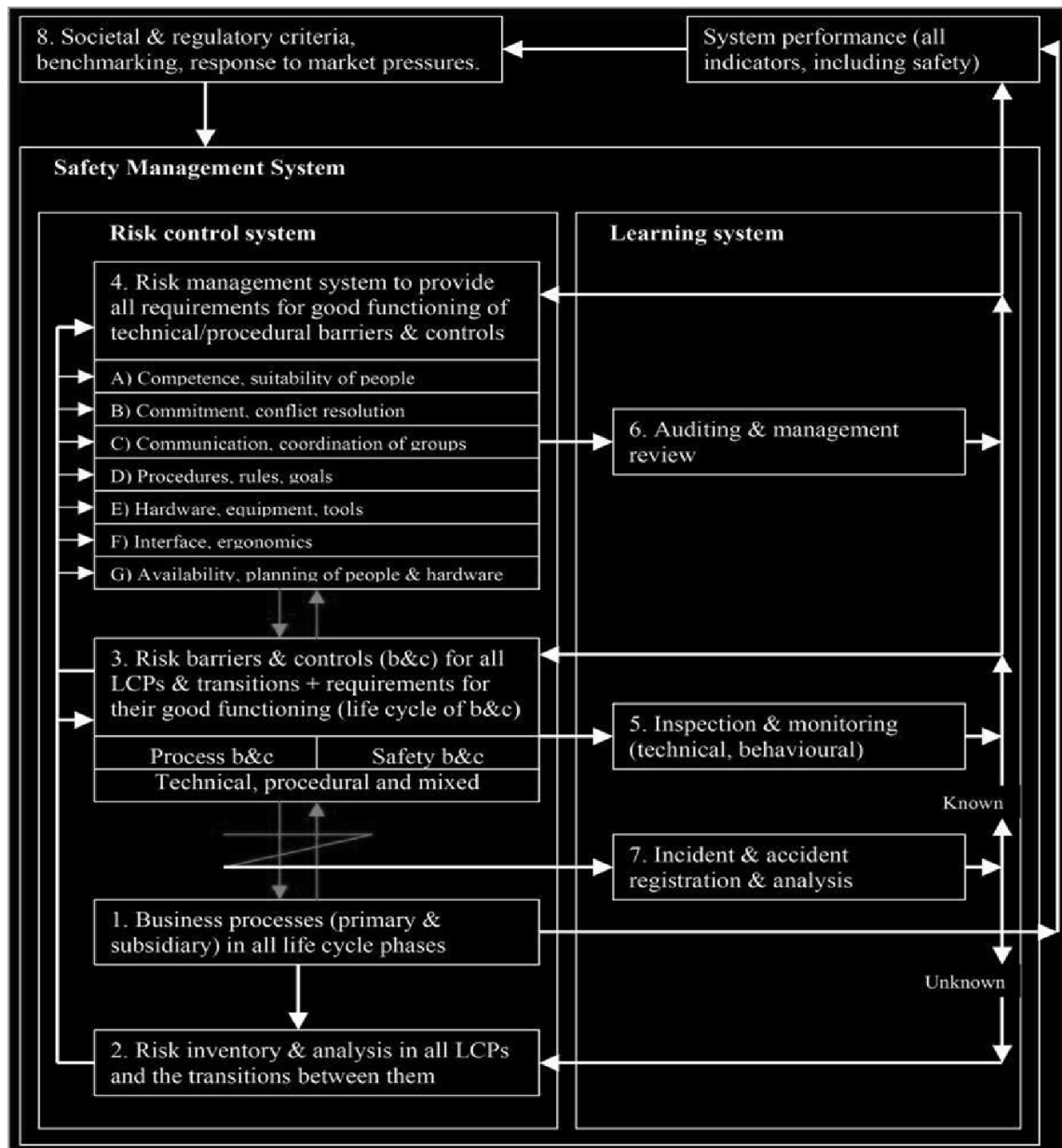


Figure 1: Safety Management System (Hale, 2006)

The Safety Management System presented revolves around controlling adequate barriers in all phases of the life cycle. It consists of 2 major sub systems: the risk control system and the learning system. The former one is aimed at providing all requirements for good functioning of technical/procedural barriers and controls. Competence of people is mentioned there explicitly as an important element (labeled 4 A) in figure 1).

In the model of Guldemond e.a. (Guldemond e.a., 2006) barriers between the hazard and the target consist of either hardware or human actions. Training and competence are considered management factors, contributing to the quality of said barriers.

Materials and Methods

In defining the required competences for the target groups under investigation, two approaches will be used: focus groups and incidents analysis.

Focus group

The focus group consisted of manufacturing employees, being supported by experts from the company's Business Academy and an external consultant. Depending on the competence field under evaluation (production line managers c.q. SHE professionals), dedicated additional members were allocated to the main focus group. The composition of the focus group reflects, to a large extent, the corporate signature of the training redesign project. The business repre-

representatives were specifically invited to ensure alignment with current needs and practices and to involve their colleagues where ever deemed necessary. The main focus group composition is shown below (table 1).

Table 1: main focus group composition

Focus group member
Business Unit Director
Corporate SHE Manager
Senior SHE Advisor
Business Group SHE Manager
Process Safety Manager
Maintenance Expert
Corporate Manufacturing Manager
Director Global Manufacturing Competence Center
Management Development Manager
DSM Business Academy expert
External consultant

Incident analysis

Additional to the focus group approach, a limited number of accidents / incidents were analyzed to determine if, and if so which, SHE competences were, or could be, linked to the incident. In terms of the SHE management model (figure 1), this would imply that lack of adequate SHE competences were identified as causes/pre-conditions/latent failures to breaches of barriers and/or controls.

The incidents chosen were of a high severity (either expressed in consequences or in learning effects), having had substantial impact within in the company, were investigated by the TRIPOD method (TRIPOD Beta User Guide, 2007) and were related to the Manufacturing discipline.

TRIPOD incident investigation is aimed at determining immediate causes for failing of barriers and subsequently goes backwards up the causation path to establish any pre-conditions, latent failures and fallible management decisions. The latter aspects are also referred to as underlying

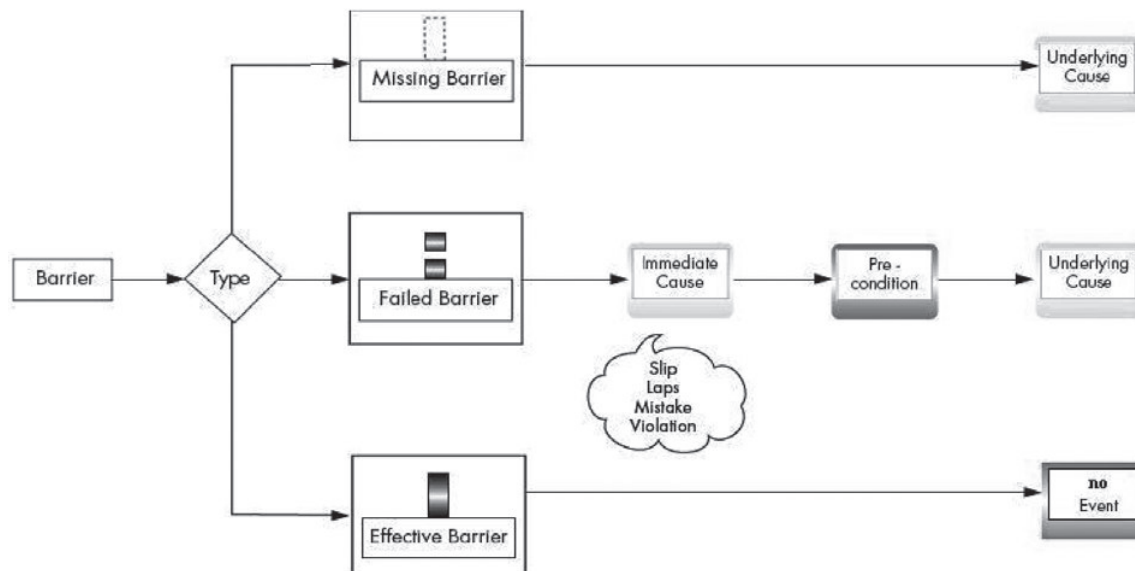


Figure 2: TRIPOD scheme (TRIPOD Beta User Guide, 2007)

Focus group meetings took place some 10 times, each 3 to 4 hours long, aimed at defining the overall project scope and approach, characterizing the SHE and Line Management competence fields, defining reference jobs, and defining minimum SHE competences. Guided discussions and brainstorming techniques were used in the focus sessions.

The competence fields themselves are defined and described not only by the focus group input but by interviewing employees on what they perceive as their “critical situations”(situations in which a person can really make a difference, e.g. when an incident occurs) as well. A total number of 11 interviews were conducted, employees ranging from various levels within the SHE and Line Management community. The interviewees could be looked upon as additional, imaginary focus group members.

causes (figure 2). These are categorized into 11 predefined Basic Risk Factors (BRF's) and refer to shortcomings in the SHE management system.

One of the BRF's is “Training”, being defined as “Deficiencies in the system for providing the necessary awareness, knowledge or skill to an individual or individuals in the organization”. In this context, training includes “on the job” coaching by mentors and supervisors as well as formal courses” (TRIPOD Beta User Guide, 2007). Clearly, this definition comprises competences as used in this study.

The number of times the Training BRF was mentioned in a specific TRIPOD analysis is taken as a measure. The relative importance of the Training BRF, compared to the 10 other BRF's, is indicated by expressing the percentage to which the Training BRF contributes to the overall number of BRF's identified. Although each BRF does not necessarily

Table 2: zero assessment on SHE competences

Assessment item	Explanation
Vocational SHE education	Bachelor or Master level, e.g. MoSHE, HVK
Risk Control System courses	e.g. HAZOP, SIL
Learning System courses	e.g. Auditing, TRIPOD
Company SHE Leadership Course	Company designed and delivered course

have to contribute equally to the causes of the accident, it is felt a prudent approach for arriving at a first indication.

Furthermore, the Latent Failures, as derived from the incident analysis, were reviewed and judged by the author as to whether or not they correspond to competences as defined in this study. The wording of a Latent Failure, as stated in the TRIPOD incident investigation report was used for this. Both the number of times a competence was identified and the contribution of this competence to the overall number of competences identified were determined.

Assessing current competence level

A questionnaire was used to assess the current level of competences of the SHE professionals as a zero measurement. Employees working in a SHE job that resembles one of the reference jobs of SHE Officer, SHE Manager or Business Group SHE manager, were identified and requested to fill in an excel survey sheet. It was measured to what degree respondents had followed defined (group of) courses (Table 2). Courses are partly grouped into two categories as defined in the Safety Management System of figure 1.

Results

Definition of required competences is achieved by two ways: focus group discussions, including results of the interview sessions, and analysis of incidents. Results will be presented in this paragraph.

Table 3: overview of generic SHE competences for the SHE Field²³

Competence item	component	SHE Officer	SHE Manager	Business Group SHE Manager	Corp. SHE Man.
General SHE related	K	X	X	X	X
Basic SHE knowledge e.g. legislation, process safety, Risk based thinking, product safety, occupational health, environment, behavioral SHE, operational controls: work permit system, etc.					
Incident Investigation e.g. TRIPOD	K, S			X	X
HAZOP / Safety Integrity Level	K, S	X	X	X	X
Auditing	S		X	X	X
Company SHE related					
Company SHE Overview	K	X	X	X	X
SHE Requirements	K	X	X	X	X
SHE Leadership	A, K		X	X	X
Sustainability	K		X	X	X

² K=Knowledge, S=Skill, A=Attitude, X stands for "applicable for this job"

³ SHE Officer is typically working in plant environment, a SHE Manager is typically the highest ranking SHE professional on a site, a Business Group SHE Manager is responsible for SHE staff in a entire Business Group.

Focus group

Reference functions for both fields were defined, as well as reference career paths. The reference jobs were subsequently analyzed by the focus group, resulting in a set of defined generic competences. Competences are grouped into two categories: General SHE related, and (more) company specific SHE related. Furthermore, it's indicated which of the 3 competence components (Knowledge, Skill, Attitude) are involved. Results for the SHE field, as well as the Production Line Management field are given here (table 3 and 4).

Incident investigation

The results of the TRIPOD analysis with respect to the identified Basic Risk Factors of the 5 selected incidents are summarized below (table 5).

The "Training" Basic Risk Factor is identified in all the incidents; however, the percentage of the Training BRF compared to the overall number of BRF's varies. The total score of 24 % suggest a relative high importance of the BRF Training, as based on existence of in total 11 different BRF's a score of around 11 % would be expected.

BRF's result as classification of the latent failures. It's therefore worthwhile to look at the latent failures themselves, providing more detailed information. As an example three latent failures, as described in the TRIPOD reports, are given here: "insufficient checking on working according to procedure", "Task, Authorities and Responsibilities unclear

Table 4: Overview of generic SHE competences for the Line Management Field

Competence item	Component	Process Engineer	Production Manager	Plant Manager	Site Manager
<i>General SHE related</i>					
Incident Investigation, RCA	K, S		X	X	X
Incident Investigation, TRIPOD	K, S			X	X
Auditing	S		X	X	X
<i>Company SHE related</i>					
Company SHE Overview	K		X	X	X
SHE Requirements	K	X	X	X	X
SHE Leadership	A, K		X	X	X

Table 5: Results TRIPOD analysis

Incident	No. times Training mentioned as BRF	% BRF Training of all BRF's
Incident a	n.a. ⁴	n.a.
Incident b	3	50 %
Incident c	2	22 %
Incident d	1	6 %
Incident e	2	67 %
Total	8	24 %

at certain points”, and “insufficient knowledge on dust explosion in plant”.

For each of the Latent Failures, out of a total of 40, as described in one of the TRIPOD investigation reports, it is judged whether or not it can be linked to one or more competences. The results are shown here as the number of times a competence was correlated to a latent failure in that analysis and to its contribution to the overall number of identified competences (table 6).

Ensuring minimum SHE Competences

The question how to get from defined competences for a certain job to employees having acquired those competences is addressed here. Furthermore, the results of the zero measurement of the current competence level of the company's worldwide SHE professionals are presented.

Ensuring

Using the concept of informal learning (Borghnas et. al., 2006), the focus group choose the approach to use the

Table 6: SHE competences and identified correlations to Latent Failures

Competence item	No. of times correlated to a Latent Failure	Relative occurrence
<i>General SHE related</i>		
General SHE related		
Basic SHE knowledge e.g. legislation, process safety, Risk based thinking, product safety, occupational health, environment, behavioral SHE, operational controls: work permit system, etc.)	4	8 %
Incident Investigation e.g. TRIPOD	0	0 %
HAZOP / Safety Integrity Level	6	12 %
Auditing	7	14 %
<i>Company SHE related</i>		
Company SHE Overview	9	18 %
SHE Requirements	12	24 %
SHE Leadership	13	25 %

Most of the defined competences correlate to multiple Latent Failures. The incident investigation information provides no opportunity for distinguishing between SHE competences for Line Managers or SHE professionals.

career path as the pivot point for ensuring competences. Formal training is most effective when the learnings can be applied in the job (the informal learning environment). A reference career path, going from SHE officer, via SHE

⁴ A full TRIPOD investigation was performed, although BRF's were not allocated. The Latent Failures were described and are used in this study

manager, to Business Group SHE manager, to Corporate SHE manager was defined. Assignments to positions outside the SHE competence field can be part of this (as well as inflow from other disciplines). A similar reference path for the Line Management field was defined.

Training is delivered when in a new job competences are required which have not been acquired in previous jobs. This leads to a set of training courses for the SHE Professionals (table 7) and one for the Line Managers (table 8). The table should be read keeping in mind that a standard career path is being followed. This means that for a certain reference job it is assumed that training courses earlier in the career (the columns to the left in the table) have been followed previously.

Table 7: Training Courses for SHE Professionals⁵

Training Course	SHE Officer	SHE Manager	BG SHE Manager	Corp. SHE Man.
Vocational Education	prerequisite	prerequisite	prerequisite	prerequisite
Company SHE orientation	X			
SHE requirements	X			
HAZOP / SIL	X			
TRIPOD			X	
Auditing		X		
Company SHE Leadership		X		

Table 8: Training Courses for Line Managers

Training Course	PROCESS Engineer	Production Manager	Plant Manager	Site Manager
Company SHE orientation		X		
SHE requirements	X			
TRIPOD			X	
Auditing		X		
SHE Leadership		X		

Assessing current competence level

The current competence level of the company's worldwide SHE professionals' population was assessed using a questionnaire. It was measured to what degree SHE courses were followed. The response rate of 78 % gives confidence in the data obtained.

The results of the questionnaire are grouped below. The extent to which courses were already followed is expressed as

Table 9: Participation rate (scaled)

(Group) of Course(s)	Overall
Risk control system courses	1
Learning system courses	1.9
Company SHE Leadership Course	1.8

⁵ X stands for "applicable for this function".

a scaled ratio (the course with lowest participation rate is set to 1) (table 9). Interpretation of the results is enhanced by grouping the majority of the courses into two categories as defined in the Safety Management System of figure 1.

Furthermore, data for the company SHE Leadership Course are shown separate.

The extent, to which courses have already been followed, varies considerably. Apparently, the Learning system gets substantially more attention than the Risk control system. The company SHE Leadership Course is high on the agenda as well, possibly influenced by the fact that it is mandatory for certain jobs.

The questionnaire revealed that a minority of the current SHE professionals has an academic level vocational education on SHE.

Discussion

The choice for the individual level for the competence study is motivated by the fact that it offers opportunities to align with, and connect to, existing performance and management development systems. It does, however, not take into account existence of required competences by any occupational group members (e.g. within a Management Team or in an engineering department). It can therefore be considered to be a "fail safe" approach.

The focus group approach, being added with specific interviews, draws upon a vast range of experiences available within the company. Some bias might be included due to the "inside-out" view. Having an external consultant as part of the focus team, can countermeasure this to some extent. This approach was applied to other competence fields

within the Manufacturing community as well (such as Projects, Maintenance, and Quality Assurance & Quality Control), proving that SHE can be treated just the same as other competences.

The TRIPOD investigation Latent Failures and Basic Risk Factors data originate from various incident reports, being produced by various investigation teams. Although teams are lead by qualified, experienced investigators, it can not be excluded that determination of both Latent Failures and BRF's is subject to individual judgment. The Latent Failures were directly related to competences defined in this study by the author, eliminating some of this bias (at the expense of possibly introducing another type of bias).

The zero assessment of the current competence level of the SHE professionals measures courses followed. By doing so, competences acquired by experience are not measured and therefore the results can be looked upon as a minimum value. On the other hand, following a course is not the same as having acquired the intended competences so this will to some extent off set potential under-measurement.

Conclusions and Recommendations

By looking to especially the knowledge and skills part of competences, craftsmanship gets explicitly attention. It can contribute to an appropriate balance of attention for "content" competences vs. "management" competences.

The focus group approach yielded a consistent set of minimum SHE competences for both SHE professionals as for Line Managers. These sets of competences are generic and worldwide applicable within the company.

Latent Failures and Basic Riks Factors from TRIPOD incident investigations, are supportive to the competences as defined by the focus group. It can be emphasized that incidents are safety cases that, regretfully, have materialized. For maximum use of investigation information, it would be best to have Latent Failures linked to competences by the investigation team itself (rather than trying to establish such a link afterwards).

The defined competences are translated into training courses, linked to generic job profiles. This makes it easy to implement a system to ensure minimum SHE competences.

In addition to the defined competence courses, detailed training on local aspects should be followed wherever appropriate (this could e.g. be based on local safety scenario's and be linked to transition protocols).

The zero SHE competence assessment for SHE professionals showed that the extent to which courses have already been followed, varies considerably. Having a measuring method can be a valuable tool in the implementation phase of a competence training program.

References

- Baker, J. A., The Report of the BP U.S. Refineries Independent Safety Review Panel, "the Baker Report", January 2007
- Borghnas, L., Golsteyn, B. en de Grip, A., Meer werken is meer leren, determinanten van kennisontwikkeling, ROA, Universiteit Maastricht, CINOP, 's Hertogenbosch, Maart 2006 (Dutch)
- Guldenmund, F., Hale, A., Goossens, L., Betten, J., Duijm, N.J., The development of an audit technique to assess the quality of safety barrier management, *Journal of Hazardous Materials* 130, 2006, 234–241
- Hale, A.R., Safety Management, what do we know, what do we believe we know, and what do we overlook?, *Tijdschrift voor toegepaste arbowetenschappen*, 2006, 18(3), 58-66 (in Dutch)
- Health and Safety Executive, Health and Safety Training - what you need to know, INGD345, 2005
- Jansen, H. and Lugten, B., Modernisering van de kwaliteit van arbeid, Rapport Marktverkenning Arbeidsveiligheid in opdracht van de Stichting PPM, versie 1.0, Overmars Organisatie Adviseurs, 18 april 2006 (Dutch)
- Jonkhoff, T. en Roggeveen, V., "Onder druk wordt alles vloeibaar", Rapportage van een Web-enquete gehouden onder de leden van de BA&O, NVvA en NVVK, concept versie 8, Stichting Preventie Project management, oktober 2006 (Dutch)
- van Kuijk, E., and van der Velden, J., Management of Competence in HSE and Application in Training Redesign, 1998 SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production held in Caracas, Venezuela, 7–10 June 1998.
- TRIPOD Beta User Guide, PO5334, September 2007, downloaded from www.TRIPODsolutios.net
- Weggeman, M., Kennismanagement: de praktijk, Scriptum, 2000