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How To Train Staff In Using Safety Management Systems In High Risk Industries

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Abstract

In high-risk industries it is common to have a Safety Management System with procedures and checklists, but the attention given to staff training in how to use these systems and procedures is often lacking. The purpose of this study is to analyze how the workers perceive the staff training and the management system, and how the training can be improved. The data material consists of in-depth interviews with operators and managers in two different companies in the gas and petroleum sector on the Norwegian shelf.
In general, the informants did not see the purpose of the management system and thought they could do their job without it. The informants who understood the purpose of the system had a much better use of it. The workers are offered only a short training course on how to use the management system, with no repetition or follow-up. The training should give the operators knowledge about the purpose of the system. Classroom training, web-based training, simulation training, and on the job training must all be considered not only with regards to costs, but also as an investment in learning outcome. A combination of theoretical instruction and practical training will be beneficial.

Keywords: safety management system, high-risk industries, staff training.

1. Introduction

In high-risk industries, it is common to use organized procedures, checklists, and work descriptions in various management systems (Goerlandt, Li, and Reniers, 2022; Li and Guldenmund, 2018; Wold and Laumann, 2015b). In the industry and the safety literature, these systems can be referred to by different names, like knowledge systems, safety systems, or information systems (Wold and Laumann, 2015a). Safety Management System is the preferred term in this study.

The technical and legal aspects of management systems are thoroughly covered in the research literature, but the attention given to training is lacking (Goerlandt et al., 2022; Wold and Laumann, 2015a). The European Committee for Standardization stresses that all staff should have careful introduction and training to all work systems (ISO, 2004), and studies suggest a correlation between training, safety culture, and the use of Safety Management Systems (Bottani, Monica, and Vignali, 2009; Dahl, 2013; Hughes, Zajac, Spencer, and Salas, 2018; Li and Guldenmund, 2018), so training should be prioritized.

Staff training represents a significant cost. In the US alone, it is estimated that 83 billion dollars are spent annually on formal training programs in professional organizations (Chung, Zhan, Noe, and Jiang, 2021). Staff training is also an investment in cognitive and interpersonal skills, and improves safety and overall organizational performance (Aguinis and Kraiger, 2009; Arthur, Bennett, Edens, and Bell, 2003; Chung et al., 2021; Hughes et al., 2018; Sitzmann, Bell, Kraiger, and Kanar, 2009). For this to succeed one must know who the workers are; what are their abilities, their experience, and their motivation to learn, and design the training to fit the characteristics of the workers (Casey, Turner, Hu, and Bancroft, 2021).

This study combines a cognitive-constructionist perspective on training and how people learn with social constructivism, with some elements from behaviorism (Laurillard, 2009; Schunk, 2014). This perspective on training stresses the importance of defining learning goals and analyzing who the trainees are and their

motivation to learn. This resembles Training Needs Analysis (TNA), and a central argument is that there is a correlation between training, safety culture, and the use of Safety Management Systems.

The data material consists of in-depth interviews with 27 workers in two different companies in the petroleum sector. This study aims to analyze how the workers perceive the staff training and the Safety Management System, and how the training can be improved. The research question that this paper tries to answer is: How can perspectives from cognitive constructionism and social constructivism help to design staff training to fit the workers?

2. Literature review

Training can be defined as planned and systematic activities to promote the acquisition of knowledge, skills, and attitudes (Salas, Tannenbaum, Kraiger, and Smith-Jentsch, 2012). This can include theoretical instruction and practical training (van Eerde, Simon Tang, and Talbot, 2008). A clear contract between trainee and educator, immediate feedback, active learning, and cooperation between trainees is generally known to increase training efficiency (Hughes et al., 2018). Different types of trainees learn in different ways, and this is closely related to perspectives on knowledge.

2.1. Perspectives of knowledge and learning

This paper uses a cognitive-constructionist perspective, combined with social constructivism, and some elements from behaviorism. From a behavioristic perspective, learning happens by creating associations between external impulses and results, and this learning can be measured (Skinner, 1954). For an industrial organization, this is relevant when the trainee must pass a knowledge test about the management system to get a permit to work on offshore installations. The replication of information can to a certain degree be measured this way, but the trainees' understanding of the management system cannot. Hence, behaviorism alone is not sufficient to understand learning in this context.

The cognitive-constructionist perspective emphasizes the mental processes that occur when we process information and impressions (Laurillard, 2009; Schunk, 2014). According to Piaget (1977), learning is not motivated by external rewards, but by the joy of exploring. Learning is considered an active and dynamic process where the trainee explores and interprets the surroundings (ibid). This means that for learning to happen, the trainees must be allowed to work actively, rather than just being presented with information (Schunk, 2014). It is also a prerequisite for learning to take place that the trainee has an inner motivation to seek new knowledge when facing a challenge or problem (Sylte, 2016).

The social constructivist perspective also views humans as active subjects but focuses more on the surroundings, and that learning happens through activity and social interaction (Laurillard, 2009; Schunk, 2014; Vygotsky, 1978). Discussion is an important learning strategy here. The trainee's interpretation and understanding build on the individual's experience, values, and interests, so these must be used actively in the learning process through discussion (Laurillard, 2009).

2.2. Identify the trainees

The cognitive-constructionist perspective and the social constructivist perspective both indicate that not all people learn in the same way. In any large industrial organization there are likely to be people with a variety of educational and professional backgrounds, and staff training should be designed to fit the characteristics of the employees (Blume, Ford, Baldwin, and Huang, 2009; Chen, Ping, Zhang, and Yi, 2022). This includes factors such as personality characteristics, motivation level, self-efficacy, and abilities.

For instance, do they have more experience with practical craftsmanship and less with theory? Active forms of learning are better suited for this group of trainees (Biggs and Tang, 2011; Skov, 2014). It can involve "peer presentation", where the trainees present or otherwise hold teaching elements for each other, and "peer and self-assessment", where the trainees evaluate their own and fellow trainees' work according to given criteria (Skov, 2014). In a professional organization, this can be done with simulations, workshops, and buddy systems which facilitate more practical learning and discussions among the trainees.

2.3. Identify the training needs.

A training needs analysis is a process to determine what the organization needs to do to further develop, and can clarify how this can be addressed through training, what the staff needs to learn, and how the content and the

form of the training should be designed to suit the staff (Arthur Jr, Bennett Jr, Edens, and Bell, 2003; Bell, Tannenbaum, Ford, Noe, and Kraiger, 2017; Hughes et al., 2018; Kirkpatrick and Kirkpatrick, 2006). This makes it easier to identify what the training priorities should be, and which resources and constraints, culture, and norms in the organization need to be considered (Aguinis and Kraiger, 2009; Bell et al., 2017; Hughes et al., 2018; Salas and Cannon-Bowers, 2001; Salas et al., 2012; van Eerde et al., 2008). This must be balanced with considerations of what is best for the educators, stakeholders, and the organization (Skov, 2014).

One important learning goal is that the trainee shall be able to use the Safety Management System effectively. He or she doesn't have to know everything in the management system but must be able to navigate to find the correct procedures and to keep oneself updated on relevant knowledge concerning work processes and safety. Hence, the training needs analysis should clarify what the workers need to know by heart, and what information they need to know how and where to access (Salas et al., 2012).

2.4. Old classrooms and new technology

Despite its reputation for being boring and inefficient, classroom training and lectures can be effective when it comes to teaching procedural knowledge (Arthur et al., 2003; Sitzmann, Kraiger, Stewart, and Wisher, 2006). It helps if lectures are combined with other types of classroom training, like discovery training, problem-based learning, and training in metacognitive skills (Salas et al., 2012).

There are several possible benefits of using diversified training methods, for instance, virtual reality technology, online training, relevant simulator equipment, e-learning, and video learning (Chen et al., 2022; Loosemore and Malouf, 2019). Web-based training saves time and money on traveling, so it is particularly interesting for organizations with multiple work sites, although one should keep in mind that it may involve investments in technology and technology support (Bell and Kozlowski, 2002; Hughes et al., 2018; Salas et al., 2012). In any web-based or technology-based training course, the trainee should get immediate feedback on his or her actions. It is also an advantage if the trainee is given control over the training, together with instructions on how to make use of this control (Bell and Kozlowski, 2002; Hughes et al., 2018; Salas et al., 2012; Sitzmann et al., 2009; Sitzmann et al., 2006). Web-based training is less effective when designed with total self-regulation or total program control and more effective when it guides individuals through computer-based instruction (Bell and Kozlowski, 2002; Salas et al., 2012). Web-based training has shown better results than classroom training, but when instructional principles were held constant, the difference was negligible (Hughes et al., 2018; Salas et al., 2012; Sitzmann et al., 2006).

Simulation training has been used for a long time with good results in areas like the military, the airline industry, medicine, law enforcement, and emergency management settings (Bell and Kozlowski, 2002; Salas et al., 2012). Well-designed simulation training creates a safe environment for learning by trial and error, instruction, and detailed feedback, particularly for tasks where actual mistakes can cause serious injuries or damage to equipment (Bell and Kozlowski, 2002; Hughes et al., 2018; Noe and Colquitt, 2002; Salas et al., 2012; Sætren et al., 2019).

Simulations can provide realistic training by using a model of reality that is abstracted, simplified, or accelerated (Galvao, Martins, and Gomes, 2000; Hughes et al., 2018). The model does not have to be an exact replication of reality, but it must be relevant for job performance; the psychological fidelity rather than the physical fidelity, so to speak (Salas et al., 2012). It ranges from low-fidelity simulations, like role-playing, to high-fidelity full-motion simulations. Simulation training gives the trainee a high degree of control, which will only be effective if the trainee is guided or otherwise supplied with information on how to make effective use of this control (Bell and Kozlowski, 2002). When properly constructed, simulation training enables exploration and experimentation in realistic and safe scenarios and incorporates practice, context-sensitive support, and feedback (Noe and Colquitt, 2002; Salas et al., 2012; Sætren et al., 2019).

2.5. Active learning

A common problem with new training technologies is that they are merely used as a new delivery mode, for example as a computerized version of traditional training, with little change in the training itself (Bell and Kozlowski, 2002). Well-designed instructions are of greater significance than the choice of delivery mode, so technology-based training should only not be chosen if the content can be learned effectively this way (Aguinis and Kraiger, 2009; Chung et al., 2021; Hughes et al., 2018; Salas et al., 2012).

Cognitive constructionism and social constructivism both point to the advantages of active learning, and the use of new technologies in training has proven to be more effective when they allow the trainee to work actively (Hughes et al., 2018; Salas et al., 2012; Sitzmann et al., 2006).

Active learning works because it creates associations between external impulses and results, and allows the trainee to explore and interpret the surroundings (Piaget, 1977; Schunk, 2014). The idea is that training will be more effective if the trainees are engaged effectively, cognitively, and behaviorally, and if the training is relevant to the job and individual needs (Casey et al., 2021). In other words, more hands-on training and examples that engages the participants in activities (Ricci and Nucci, 2022). Active learning can be built in the training program itself, for instance with simulations and interactive web learning, but can also involve discussion, peer presentation, workshops, and buddy systems.

2.6. Skill decay and need for repetition

After the training course is completed, there must be follow-up and repetition to avoid skill decay. «Learning by doing» as it was formulated by John Dewey, stipulates that people learn through activity and experience, and without these, there will be no learning (Bell et al., 2017; Schunk, 2014; Sylte, 2016). Cognitive skills decay quicker than physical skills, but both types of skills may decay if the trainees have to wait for a long time after the training program before they get to use their new skills and knowledge (Arthur et al., 2003; Hughes et al., 2018; Salas et al., 2012). A training program should be followed up by repetition, practice, and feedback to give the trainees the chance to use their new skills and abilities in their normal working conditions (Arthur et al., 2003; Colquitt, LePine, and Noe, 2000; Driskell, Copper, and Moran, 1994; Grossman and Salas, 2011; Hughes et al., 2018; Rienecker, 2021; Saks and Belcourt, 2006; Salas et al., 2012). This can be particularly useful in developing tacit and intuitive skills that are developed through experience over time, rather than formal training (Aguinis and Kraiger, 2009; Bell et al., 2017; Wold and Laumann, 2015b). Buddy systems and discussion sessions can make it easier for employees to use what they have learned, and to develop tacit skills (Grossman and Salas, 2011; Hughes et al., 2018; Saks and Belcourt, 2006; Salas et al., 2012; Schunk, 2014).

3. Materials and method

The data material consists of 27 individual semi-structured interviews in two different Norwegian companies in the petroleum sector. The informants represented different disciplines, like foremen, installation managers, mechanics, electricians, logistics, and automation. One of the companies manages offshore installations and was chosen because they have recently implemented a new Safety Management System and training program. The other company runs land-based operations and hires temporary contractors from companies who run offshore installations, so the workers must use different types of Safety Management Systems.

3.1. Data collection process

The informants were selected through a purposeful sample to get units rich in information (Morrow, 2005; Patton, 2002). The criteria were that the companies were operating in a high-risk industry and that the companies were using a Safety Management System. It was also desirable to have employees from various levels and disciplines. like onshore executives, offshore executives (installation managers and foremen), and offshore workers at the sharp end: automation, electricians, mechanics, and process workers. The informants were recruited in collaboration with the management of the companies, and they were either permanent employees or long-term contractors.

The age of the informants ranged from 25 to 64 years old, with 40 to 54 as the largest group. Age was not a criterion, but it was desirable to have a combination of experienced workers and workers who were quite new. Three of the informants were in their first year offshore, while the majority had been offshore for 5 to 19 years. Three of the informants were female, and 24 were male. The interviews were conducted during normal working hours in a separate room at the company's facilities.

The interviews followed a semi-structured interview guide with open-ended questions. At the start of every interview, the informants talked about an ordinary day at work and described the Safety Management System and its purpose in their own words. The questions then went into more detail about which procedures they used and in which situations, how they learned about the Safety Management System, the user-friendliness of the system, shortcomings, and advantages.

3.2. Data analysis

The data were analyzed using thematic analysis, using the six-step approach as described by Braun and Clarke (2006). The author of this paper conducted the interviews and transcribed them, as part of the first step; familiarizing with the data. Step two was an inductive thematic analysis, zooming in on themes related to training and motivation. The analysis is on the latent meaning of the data, in line with the constructivist perspective, which opens for interpretation of the underlying meaning of what the informants are saying (Braun and Clarke, 2006). For instance, when they talk about how they dislike working with computers and would rather just do the job, this suggests they lack motivation for using an IT-based management system and how they prefer more practical work and more practical training.

3.3. Ethics

The informants were informed and gave consent, that the interview data would be used for scientific publication. They were also informed that their answers would be anonymized. The sound recordings and transcriptions were stored on a hard drive with password access, and which was kept in a locked room. Sound recordings and other personalized data were deleted after use.

4. Results

The analysis resulted in three main themes and nine sub-themes, as presented in Table 1.

Table 1. Themes and sub-themes.

Main theme	Sub-theme
Training program	
	Learning outcome
	Practical training
	Repetition
Purpose of the Safety Management System	
	Motivated to learn
	Dislike computers
Follow up	
	Learning by doing
	Formal discussions
	Informal discussions
	Skill decay

4.1. Training program

The training both companies give their employees on how to use the Safety Management System is similar. It consists of a web-based course with a multiple-choice test, where they need to score 8 out of 10 points to pass the course and get a license to work offshore. They can take the test several as many times as they need. There is no repetition or other types of follow-ups. The course is supposed to last for two hours, but both executives and operators said it takes about half an hour.

Learning outcome

The executives said that the operators should learn the purpose of the Safety Management System, and how to use the basic structures to find the information they need.

> *3: They should know the background of the management system. Why do we have it? And they need to understand the structure, and that every object is clickable.*

The operators were familiar with the basic idea of navigating in the system by clicking on icons but could only give vague descriptions about the purpose of the system.

16: There are some boxes and different columns and such that we can click through, but in the daily work I don't use them at all. I'm not very good at it.

It seems there is room for improvement when it comes to the learning outcome of the training program.

Practical training is preferred.

All the informants in both companies said they preferred practical training, and to go through specific tasks on their own.

19: You learn to use it by using it. (…) So less technical training on everything that's in the management system, and more on how to use it in practice.

Informants in both companies said that they had to "fiddle about with it for a while" to get familiar with the Safety Management System and to be confident in using it.

Repetition

The companies did not repeat the training course. One of the informants said he decided to take the training course over again after his first rotation offshore on his initiative. He found this to be very rewarding.

25: [The training course] did not give me anything. It was much better to be out in the field and use [the management system] for a bit, and then go through the course again. That gave me a lot more.

The informants agreed that the only way to learn how to use the Safety Management System was through practical use.

4.2. Purpose of the Safety Management System

The executives in both companies said the Safety Management System was an important tool for safe conduct. They could explain what the purpose of the Safety Management System was and saw it as helpful. The operators, on the other hand, often thought that they could do their job just as well without it.

10: Well, yeah, the management system is there, and we're supposed to use it. But when it comes to regular operations, we know the old rut and how we should do the job.

The operators were generally not able to say much about the purpose of the system and thought it was designed to keep the backs of the management safe in case of accidents. They acknowledged the need for safety measures but thought their own experience was more important for safe conduct than the management system. It seems from this that if the training succeeds in giving the workers a better understanding of the purpose of the Safety Management System, it will improve their motivation to use it. The informants who expressed an understanding of having a management system pointed out that it benefitted them.

11: It has to do with the information. If the [managers] can communicate to us why we should spend time on this, it might become more interesting for us, if we understand the purpose of it.

Motivation to learn

The executives expected that the operators were motivated to learn about the Safety Management System, but the operators seemed less motivated. Several operators stated a general dislike towards using computers, and that they did not find the system to be useful, and did not understand its purpose. Both operators and executives said they had problems navigating the Safety Management System. They thought it was difficult to find the checklists and procedures they needed, and expressed irritation that they had to skim through a lot of material they thought they didn't need to find the exact documents they needed.

20: You have to read a lot. (…) It's a big lump of all kinds of stuff, and some of it's relevant and some of it isn't, so you have to figure out what is relevant for you and not.

Dislike computers

The executives assumed that the operators were able to use computers. This study cannot estimate the IT competence of the operators, but several of the operators certainly disliked using computers, and preferred to "just get the job done".

19: I have seen people just start a process, without checking it, because they think the computer is too much hassle.

This can have a negative effect on their motivation to spend time in front of a computer, and for learning about the Safety Management System.

Several informants had found alternative ways of getting the job done. A few of the informants had printed out a stack of checklists which they kept in the workshop, so they didn't have to use the Safety Management System. A drawback is that they would miss out on possible updates or changes in the checklists. They acknowledged this, but still found it to be a more practical solution.

4.3. Follow up

The training program is not repeated or otherwise followed up, but there are some formal and informal attempts to develop knowledge about the Safety Management System.

Learning by doing

After the training course, it was learning by doing, according to the informants. The informants said it took some time to get used to the system this way.

15: To begin with it was difficult to find what I needed. You had to feel your way, and it was difficult to find the various procedures and checklists (...). When you have worked with it a bit, you know the flow, and you know where to look.

Several of the informants perceived the user-friendliness of the system to be poor, but some of them hoped this would improve after they had used it for some time.

Formal discussions

The companies reviewed the procedures routinely. They select two of the most relevant procedures and report on a list when these are reviewed. The executives seemed to be more aware of this than the operators. Some of the operators said they would like more discussions or meetings about the Safety Management System and the procedures.

18: If we, for instance, had some safety meetings, maybe one meeting on each rotation, where we could work with some cases from the part of the management system that we use. We could do some cases and work through them together.

Informal discussions

When the Safety Management System becomes a topic of discussion among operators at the installation, it is usually with a negative focus. Sometimes just to blow off some steam.

10: Many people are negative about it. (...) They say it's crap (laughs). (...) when we talk about the management system and the layout and these buttons to click yes and no, it is usually with a bit of negativity, yes.

It also becomes the topic for discussions when the operators run into a problem and need help to find what they need. In general, the Safety Management System is a topic for discussion only when they run into problems. They never talk about what works well with the system.

5. Discussion

Executives in both companies saw the Safety Management System as a collection of best practice principles guided by many years of collective industry experience. The operators related to the system in vague terms and said they could do their job without it. The informants who knew the purpose of the Safety Management System had much better use of it than those who could only give vague descriptions.

Both companies have a short web-based introductory course to the Safety Management System, with a multiple-choice test. There is no repetition or practical exercises. The informants said that they had to "fiddle about" with the Safety Management System for a while to figure out how it worked. This "learning by doing" takes place during their normal working day when they have specific and safety-regulated tasks to perform. Surely it would be better if they could familiarize themselves with the management system in a training situation first.

The short training course with no follow-up can by the workers be interpreted as a signal that the system isn't that important. This can be improved with better training. Training comes with a cost but is an investment in organizational performance, knowledge, and human capital. The quickest, and cheapest way is to require that everyone repeats the existing training course, but a more revision of the training program would be necessary in the long run.

A more thorough revision of the training program can be done using the perspectives of cognitive constructionism and social constructivism. Both perspectives stress the importance of clearly defined learning goals and understanding who the trainees are and their motivation to learn (Laurillard, 2009; Schunk, 2014). This resembles Training Needs Analysis (TNA) and should define the desired learning outcome and clarify which competencies the organization needs, the specifics of the job tasks, and the persons involved (Aguinis and Kraiger, 2009; Arthur Jr et al., 2003; Dierdorff and Surface, 2007; Hughes et al., 2018; Salas et al., 2012). Training should enable the workers to find the information they need when they need it (Salas et al., 2012). The workers should not trust the procedures blindly, but the training should give them knowledge about the purpose of the management system so they can understand when and how to adapt the procedures to the immediate situation (Dekker, 2003; Wold and Laumann, 2015b).

It's important to identify which type of training suits the workers best. The informants in this study have given several statements suggesting they prefer practical tasks to theoretical ones, so workshops with peers, practical assignments, simulations, and buddy systems can be helpful for them. Motivation to learn increases if the trainees perceive the training as relevant and useful (Bell et al., 2017; Chung et al., 2021; Grossman and Salas, 2011), and if the workers understand the purpose of the management system and why it is useful for them (Wold and Laumann, 2015b).

According to these perspectives and learning goals, training should be a combination of theoretical courses and practical exercises. The theory course can be done in a classroom or be web-based: The companies should choose the more practical option, as the content of the training is more important than the delivery mode. Lectures and classroom training can open for dialogue-based learning but can be inconvenient and costly to set up for geographically dispersed organizations.

Practical training is necessary to familiarize with the Safety Management System. Classroom training, simulations, workshops, or on-the-job training are the options here. On-the-job training can help to develop tacit skills and establish communities of practice where the workers can use each other as learning resources (Aguinis and Kraiger, 2009; Salas et al., 2012). Simulation training could be set up, either as a web-based course or as workshop sessions on the worksite.

Repetition and follow-ups of training are needed to give the workers a combination of practical knowledge and theoretical understanding of the Safety Management System and will also reduce skill decay. On-the-job training, buddy programs, workshop sessions, and simulations can be useful here and can help to ensure support from supervisors and peers (Grossman and Salas, 2011; Hughes et al., 2018; Salas et al., 2012).

6. Sum up and conclusion

The executives saw the Safety Management System as a fundamental tool for safe conduct, but the operators were more likely to think they could do their job without it. They acknowledged the need for safety measures but didn't see the purpose of the Safety Management System in this matter, and hence. Hence, they are less motivated to learn about it.

The learning outcome from the training should be that the trainees understand why and how the Safety Management System was constructed and that it is based on experience accumulated over many years. The trainees need to understand the purpose of the system, and the limitations of the system, and to develop the skills needed to be able to evaluate when and how they should adapt the procedures to a given situation.

Training must be designed to fit the trainees and their preferred way of learning, and what motivates them. Motivation can be driven by material things like having a good job, being safe at work, possibilities for promotion, and so on, but in a training program one must also facilitate the inner motivation driven by the joy of learning and personal development. Further research should aim to identify how training programs can be designed to fit the inner motivation of operators in industrial settings.

7. Limitations

The interview data is a bit old. Interviews were conducted in 2015, but for personal reasons, I have not been able to publish this article earlier. One must therefore take into consideration what might have changed since

then. The data is context-bound to the Norwegian gas and petroleum sector. In qualitative research, one must always consider whether the findings are relevant in other contexts. Hopefully, the data description is rich enough to evaluate their usefulness for training programs in similar contexts.

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