A Method for Assessing Health and Safety Management Systems from the Resilience Engineering Perspective

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Abstract. This article introduces a method for assessing health and safety management systems (MAHS) that has two innovative characteristics: (a) it brings together the three main auditing approaches to health and safety (HS) - the structural approach (which assesses the system prescribed), the operational approach (which assesses what is really happening on the shop floor) and the performance approach (which assesses the results of performance indicators); (b) it emphasizes the resilience engineering (RE) perspective on HS, which takes into consideration four major principles (flexibility, learning, awareness, top management commitment). Such principles underlie seven major assessment criteria, which in turn are divided into twenty-eight items (e.g. hazard identification from a RE perspective is an item that belongs to the production processes criteria). The items are sub-divided into statements, which are the requirements that should be assessed based on interviews, analysis of documents and direct observations. The selection of the elements assessed by the MAHS was made based on the standards OHSAS 18001 and ILO-OSH 2001, as well as based on a literature review which covered three areas: health and safety management systems (HSMS), RE and HS management systems audits.

1 INTRODUCTION

The challenge for health and safety (HS) management in the context of resilience engineering (RE) is to draw up prevention strategies which adequately address

complex, dynamic and unstable systems. In particular, strategies are needed to ensure that adaptations, despite their being necessary at any given moment, allow for the system to remain under control (Hollnagel, 2006).

Given that all control systems tend to deteriorate over time or become obsolete as a consequence of changes, the continuous performance measurement is essential for HS management, whether or not under the RE paradigm. A particular type of measurement, which is dealt with in this study, is auditing. Currently, the structural approach is the one most used to audit health and safety management systems (HSMS), as it is based on the analysis of documents which prove that the organization is meeting certain HS requirements which it itself has defined or which are defined by standards, like OHSAS 18001 (Occupational Health and Safety Assessment Systems). As to the operational approach, it verifies if the documented HSMS has in fact been implemented in practice, by means of observations and interviews with the company's operational and management staff. There is also the approach of auditing by performance, based on analyzing the results of normally reactive performance indicators (Cambon et al., 2006).

Although there are no models for auditing HSMS which explicitly embrace the principles of RE, some studies have re-interpreted models which originally did not take account of RE, with a view to verifying the extent to which its principles were indirectly borne in mind (Hale et al., 2006). Considering this context, this study aims to present a method for assessing HSMS (MAHS) with the focus on RE. Such a method takes account of the three main approaches to auditing HSMS.

2 RESILIENCE ENGINEERING

Considering that there is not a set of RE principles which is widely accepted in academic circles and also that there are differences in the terminology adopted by different authors, a effort with regard to this article was needed to compile a set of principles which would serve as a reference for the assessment method now put forward. Thus, based on various studies (Rasmussen, 1997; Hollnagel and Woods, 2005; Hale et al., 2006; Wreathall, 2006) four principles were identified, which have interfaces with each other and do not possess strictly defined limits:

a) Top management commitment: this implies demonstrating a devotion to HS above or to the same extent as the company's other objectives;

b) Increase flexibility (flexibility): a basic assumption of RE is that errors are inevitable because of individual and organizational pressures (e.g. workload and cost) (Rasmussen, 1997). Therefore, work system design must be flexible, recognizing that variability management is as important as variability reduction. In fact, design should support the natural human strategies for coping with hazards, rather than enforce a particular strategy. For instance, a mechanism to comply with this principle is to design error-tolerant boundaries. Wreathall (2006) also emphasizes that flexibility requires that people at the working level are able to make important decisions without having to wait unnecessarily for management instructions;

c) Learn from both incidents and normal work (learning): RE emphasizes understanding of normal work rather than just learning from incidents, in order to learn and to disseminate successful working strategies. Nevertheless, learning requires an organizational environment that encourages the reporting of incidents

and recognizes adaptive strategies, although not tolerating culpable behaviors (Wreathall, 2006). Also, learning must take into account the way procedures are implemented. In fact, monitoring the implementation of procedures should be considered as important as devising procedures, since it may contribute to reduce the gap between work as imagined by managers and work as performed by front-line operatives. The smaller this gap the greater the evidence that learning is taking place (Wreathall, 2006; Hale et al., 2006);

d) Be aware of system status (awareness): this principle implies that actors should be aware both of their own current status and the status of the defenses in the system. This is critical for anticipating future changes in the environment that may affect the system´s ability to function. Awareness is also important for the assessment of the trade-offs between production and safety (Hale et al., 2006). Rasmussen (1997) suggest two broad approaches to implement this principle: performance measurement based on proactive indicators and the design of visible and touchable boundaries of performance.

Of course, the presented RE principles overlap somewhat with principles of other safety management paradigms and they are are fully in line with general principles for the design of sociotechnical systems. For example, there is an overlap with the perspective of safety culture taken by Reason (1997), since he stands with the position that safety culture might be engineered and managed and it should encompass four subcomponents: a reporting culture, a just culture, a flexible culture and a learning culture. Nevertheless, this article assumes that the most distinctive characteristic of RE from other paradigms is that it emphasizes the positive side of safety (i.e. understanding how adaptive strategies ensure safe and productive work), although not neglecting learning based on incidents. Moreover, it is based on the assumption that resilience is a property of a system that may be consciously designed and managed, even though the development of a strong RE framework in terms of concepts, principles and methods is still an on-going process.

3 RESEARCH METHOD

The selection of the elements assessed by the MAHS was made based on the standards OHSAS 18001 and ILO-OSH 2001 (Guidelines on Occupational Safety and Health Management Systems), as well as based on a literature review which covered three areas: HSMS, RE and HSMS audits. An exploratory case study to assess a HSMS conducted in an agricultural equipment factory also contributed for constructing the audit model. The elements assessed by MAHS can be classified into criteria and items. The former correspond to the large categories of assessment and the items to the sub-categories, which, for their part, consist of the requirements to be assessed. Thus, seven criteria and twenty-eight items were established.

Since the framework of the MAHS was defined, it was applied and assessed by means of a case study, carried out over a three months period in 2007. The case study took place in the Brazilian company which is the market leader for replacing automobile exhaust systems. It was chosen because of the ease of access which the researchers had to it, as well as on account of its size (450 employees) and integration with a highly competitive supply chain, which were indicative of characteristics of complexity.

4 METHOD FOR ASSESSING HEALTH AND SAFETY MANAGEMENT SYSTEMS (MAHS)

4.1 Criteria and items of the MAHS

An overview of the scope of each item is presented below:

(1) HSMS planning

(1.1) HSMS policy and objectives: concerning RE, a requirement of this item is that policy and objectives emphasize continuous improvement, in order not to be complacent with the current situation, even though safety performance is good (Hale and Heijer, 2006).

(1.2) HSMS planning: this item has requirements such as establishing priorities for HS planning and establishing tasks, resources, deadlines and responsibilities for achieving the HS objectives.

(1.3) Structure and responsibility: it encompasses issues such as definition of HS responsibilities throughout all hierarchical levels of the organization and establishing mechanisms to let all those involved in it aware of their HS responsibilities.

(1.4) Documentation and records: it has requirements such as a way of easily finding out and tracking of documents which are distributed to company personnel.

(1.5) Legal requirements: that is a core issue to any HSMS and, at MAHS, it also has requirements related to emergency preparedness and response, since this is mandatory according to Brazilian regulations.

(1.6) Top management commitment: this item has requirements such as top management monitoring of HS metrics and managing production pressures over HS.

(2) Production processes

(2.1) Hazard identification from traditional perspective: it checks whether there are mechanisms to identify those hazards that are easily observable and that are usually emphasized by regulations, such as physical, chemical and biological hazards.

(2.2) Hazard identification from RE perspective: this item checks whether there are mechanisms to identify organizational hazards (e.g. production pressures, monotony, excessive labour division), which could be broadly understood as all hazards that make the traditional hazards riskier than they should be.

(2.3) Risk assessment: this item checks whether there are mechanisms to prioritise risks based on their severity and probability.

(2.4) Hazard responses from traditional perspective: it checks whether there is an action plan that is consistent with hazard identification (traditional focus) and risk assessment. For instance, it may be appropriate checking whether manual materials handling is properly dealt with by preventive measures.

(2.5) Hazard responses from RE perspective: it checks whether there are action plans for dealing with the hazards identified at item 2.2. Also, it is checked how the difference between real and prescribed work is managed, whether there are initiatives to design error-tolerant performance boundaries and whether there are formal guidelines for carrying out sacrificial judgments of production in favour of HS.

(3) People management

(3.1) Workers´ participation: this item is based on the assumption that workers´ participation concerning HS issues should imply in opportunities for increasing learning and awareness of the boundaries of safe performance.

(3.2) Training and competence: this item emphasizes that workers should receive training on non-technical skills (e.g. communication, error detection and recovery, development of proactive attitudes). It also requires the integration between HS and production training.

(4) Generic safety factors

(4.1) Management systems integration: it requires integration of HS, quality and environmental management systems.

(4.2) Management of change: this item has strong connections with RE, since it checks whether the organization has mechanisms to anticipate and manage any changes in the work environment, taking into account their HS implications as early as possible.

(4.3) Maintenance: since maintenance errors are well-known contributing factors for mishaps in complex systems, this item has requirements such as whether all risk management tasks mentioned in criteria 2 are also extended to maintenance.

(4.4) Procurement and contracting: from a RE perspective, this item is important because it implies anticipating HS issues during procurement and contracting of any resources, such as people, machinery and materials.

(4.5) External environment: in line with the sociotechnical approach underlying RE, this item has requirements such as whether the organization has mechanisms to be aware of threats and opportunities for HS imposed by the external environment, which in turn includes socioeconomic, educational, political, cultural and legal aspects (Hendrick and Kleiner, 2001). For instance, this item checks whether the organization maintains either an adversary or collaborative relationship with government agencies which are responsible for enforcing HS regulations.

(5) Planning of performance monitoring

(5.1) Reactive indicators: this item checks what are the adopted HS reactive metrics (e.g. frequency accident rates), why they are used, how they are collected and how they are analysed.

(5.2) Proactive indicators: it has similar requirements to the previous item, emphasizing proactive metrics (e.g. amount of hours dedicated to HS training). This item also requires mechanisms to monitor the trade-off between safety and production.

(5.3) Internal audits: this item is demanded by all major HSMS standards and it checks how HS internal audits are undertaken, such as regularity and use of multiple sources of evidence.

(6) Feedback and learning

(6.1) Incident investigations: this is a well-know item of any HSMS. However, at MAHS the requirements explicitly state that any situation of lack of safety should be investigated from a systems perspective.

(6.2) Real work investigations: in sharp contrast with other HSMS audits, MAHS requires real work to be regularly audited with the aim of understanding workers´ adaptive strategies and, consequently, reducing the gap between real and prescribed

work. For instance, such audits of real work could be undertaken in a similar way that audits are conducted in behavior observation programs. However, rather than enforcement of rules, which is the usual focus in behavior-based safety programs, audits of real work from RE perspective should emphasize both understanding of adaptations and identification of workers´ degrees of freedom.

(6.3) Preventive actions: this item stresses that preventive actions should be documented and monitored as well as aimed at closing the gap between real and prescribed work.

(6.4) Corrective actions: this item has similar requirements to item 6.3, though emphasizing corrective actions.

(6.5) Management review and continuous improvement: at MAHS, distinctive requirements of this item are that learning and continuous improvement should be based on understanding of adaptations and successful performances, based on data provided by item 6.2.

(7) Performance

(7.1) Reactive performance: this item assesses results and tendency of reactive HS metrics, as well as how they are benchmarked against external competitors and how they are disseminated throughout the organization.

(7.2) Proactive performance: this item is similar to item 7.1, though emphasizing proactive metrics.

4.2 MAHS assessment tool

Applying MAHS takes place by means of assessing each item based on a series of questions about the organization's management practices. Throughout the questionnaire, in each item, what are made explicit are the type of assessment approach and the sources of evidence recommended for assessing each requirement. Beside each requirement related to RE, the principle which is being assessed is presented. As an example, the following presents the requirements linked to item 3.1 (workers´ participation).

Approach: operational. Sources of evidence: interview with representatives from the HS department (requirements: a, b) interview with workers (requirements: a, b).

(a) To highlight what the participative approach of the workers is like. To check what the workers' degree of involvement is in improving everyday safety at work, by highlighting the modalities of participation, whether they are more active or passive, more formal or informal;

(b) To highlight if the workers' opinions are observed in the context of the work process design and what are workers´ degrees of freedom (awareness and learning).

MAHS includes the possibility that a score be attributed to each item, based on the scoring system adopted by the Brazilian Foundation for the National Quality Award. The scoring tables adopted for such an award have been widely tested in the practice of assessing quality management systems in Brazil.

5 CONCLUSIONS

The method proposed in this article contributes to filling gaps regarding the assessment of the HSMS. One of these gaps concerns the deficiency of the current

audits of HSMS when it comes to reconciling the structural, operational and by performance approaches in a single audit model. Besides this, the MAHS also contributes to adopting explicitly the focus of RE on HS. Concerning the drawbacks of MAHS, the need for examiners to know about RE stands out. The difficulty of assessment also springs, as it also does for other audits of management systems, from the MAHS not indicating how the requirements should be met, and thus what is required is an auditor with great experience. In fact, since RE is not yet a fully established discipline, as well as assuming that it is not being widely disseminated in the industry, it can be considered that there is not even a sufficient base of knowledge in the literature for establishing prescriptive requirements.

It is also worth noting that there is a correlation between some of the items of the MAHS. This characteristic is more evident with regard to the following items: (a) planning the monitoring of performance and reactive and pro-active performance; (b) hazards identification, risk assessment and hazards response. For example, since proactive indicators have not been planned, the result of the proactive indicators will also be non-existent. A characteristic such as this indicates that it is possible that the improvement in the result of an assessment based on MAHS may occur in large increments. These correlations also indicate which items should be prioritized since they are prerequisites for other items.

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