Total Safety Management: What are the Main Areas of Concern in the Integration of Best Available Methods and Tools

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"BP released findings from its own internal investigation of the oil spill in the Gulf of Mexico, revealed inefficient Organization interfaces among BP management, the rig crew and well site leader. Also according to the investigation, one important contributor to the accident was inadequate guidelines for critical tests and operations". (Pires and Mosleh 2011)
Over the recent past, the accumulation of major mishaps, crises and accidents have made it clear that organisations must still improve their capabilities to address safety "not as a stand-alone activity that is separate from the main activities and processes of the organization" but as an integrated part of total performance management. The requirements for safety management in existing and upcoming standards and regulations, as for example the ISO 31000 and or the Seveso II directive, call for a proactive strategic approach, anticipating risks and demonstrating a capacity to keep safety at the centre of changes driven by commercial competition, and ensuring that safety evidence itself becomes an effective driver of change. However there is often a gap between the state principles and an actual roadmap to their implementation. Furthermore organisations, especially the one dealing with safety critical operations, find it difficult to integrate their different functional units in a common programme of operations management or change; there is no clear consensus about what it means to be 'proactive'; there is no integrated framework for analysing or managing all the human related functions in an operational system.
Innovation may rely on assembling the best practices, tools and methods already available for functional analysis, risk assessment, interactive emergency scenarios analysis, performance monitoring, design review, training and knowledge management, in an integrated framework able to address safety management in the main aspects of a product or process lifecycle the cornerstone of which is the building of a common operational picture to support the capacity to perform more participatory and dynamic risk identification and solutions loops in:
- Design (new plants, processes /procedures availing new visualization tools)
- Ad hoc critical activities (management of change or scheduled overhaul)
- Operations management (establishing of dynamic risk registers).

This is the scope of a new EU funded research project called TOSCA and the present paper will introduce the current framework being built.

1. Total Safety Management and SME in Europe

Small and medium size enterprises (SMEs) have a high economic potential for European countries since they provide many opportunities for employment and economic growth. Therefore, in the last decade, there has been an increasing interest in occupational health and safety in SMEs accompanied by many European projects supporting their viability (see European Agency for Safety and Health at Work report

2005). The majority of studies in the literature have found that SMEs have an increased risk of accidents compared to large enterprises. However, Sørensen et al. (2007) found that this relationship holds for SMEs that are independent; in contrast, for SMEs that are part of larger organizations, the work environment does not seem to present more hazards than the large enterprises. Another survey conducted in Italy (i.e., 84 small-sized and 25 medium-sized enterprises responded to a questionnaire) reported on the importance of SMEs' perception of safety and identified current safety management priorities and methods. Micheli and Cagno (2009) found that, although 80 % of SMEs claimed that safety was among their main priorities, they reported problems in planning safety interventions because of limited financial resources, lack of management tools and a burden of compliance with regulations and codes. SMEs focused their investments on issues associated with purely regulatory or legislative aspects, that is, (1) training and information of workers on safety, (2) upgrading installations to comply with safety standards, and (3) introducing safer production technologies and personal protective equipment. A tendency was observed among SMEs to outsource safety management to compensate for the lack of specific competences within the enterprise; this tendency was greater in small-sized enterprises. Therefore addressing their capacity to risk assess actual operation with an easy to apply resilient methodology and provide the capacity to monitor and record data on the operations in a solution to be embedded in their routine data collection can offer significant benefits in terms of their capacity to improve safety and performance.

2. The issues of SMEs safety management systems in Europe and the TOSCA project

The Total Operations Management for Safety Critical Activities (TOSCA) project is a European Project within the context of the 7th Framework Programme aimed at developing an innovative approach to integrate and enhance safety, quality and productivity especially for SMe in the process industry.
The scope of TOSCA is to work out a well established and economically suitable framework in which the most innovative tools and techniques (advanced 3D software, virtual reality, innovative theoretical models, updated information exchange protocols etc) are operated together in order to get advantage on the possible synergies in processing standards requirements, fulfil regulations, improve safety and enhance productivity. As part of it the project is developing a theoretical framework for Total Safety Management in the process industry particularly focused on SME applications .
To better define and highlight the needs of the industry regarding the development of an integrated methodology for assessing safety, quality and operations management. the partners of the project examined the most appropriate methods to elicit the required information in an effective way. The use of a survey and more in depth face to face interviews were the two approaches chosen to assess the present situation of the industrial installations handling toxic and flammable substances. Through both methods it has been possible to enquire current practices and needs in relation to the range of methods, standards and best practices used for safety, quality and operations management.
The two streams of work have been able to provide a multifaceted view of the current status quo: a) on the one hand the development of and interview guide and the execution of a significant number of interviews at the end-users' premises by the partners of the consortium and b) on the other hand the development of an on-line survey (questionnaire) to be remotely completed by interested end users together with the elaboration of the data collected (a still on-going procedure) along with the organisation of three workshops, one with representatives of the Greek industrial communities and two with the WP2 project partners.

Challenges in carrying out systematic risk assessments

Since TOSCA places an important emphasis on the development of risk assessment methodologies that would be also suitable for SMEs, the partners also investigated some challenges in implementing such methods in the industry. Hardy (2010) has provided a synthesis of the challenges encountered by SMEs and large industrial companies both in aviation and process industries. Table 4 presents some of the challenges in implementing a systematic risk assessment methodology particularly in SMEs. These challenges should provide a basis for face-to-face interviews of TOSCA partners with SME managers and safety personnel. The list of challenges can also guide the development of risk assessment methods in later activities of the project.Another study that is worth reporting regards the application of risk assessment methods in the gas and oil companies in Norway. Andersen and Mostue (2012) carried out a survey of 41 petroleum companies (mainly large companies), 15 engineering companies (mainly SMEs) and 43 risk consultants to examine the challenges in applying risk analysis in the petroleum industry.

Table 1: Challenges in implementing risk assessments in SMEs and large companies (Hardy, 2010)

SMS component	Challenges in safety management
Hazard identification	Failure to consider common cause conditions Failure to consider hazards related to maintenance Failure to consider the impact of human error Failure to consider hazards related to organizational and management issues Failure to update the analysis after design changes Failure to update the analysis as the procedures change
Risk assessment	Lack of standardization of risk matrices Making unrealistic assumptions about the system and operations Focusing on the worst credible event and ignoring more likely but less severe events Failure to recognize when risks are not independent Failure to update the risk analysis after changes in the design or procedures
Risk reduction	Redundancy and other controls can add complexity which can reduce safety Active controls can introduce complications when compared to passive controls Automated controls can reduce operator effectiveness in an emergency Common causes can defeat redundancy in controls Risk controls can increase operator workload

The results can be summarized below:

- Risk analysis methods were mostly used in the design and modification stages – and not during daily operations
- Daily generation of knowledge regarding plant risks did not build on formal risk analysis methods
- There were ambiguous opinions about the impact of new information technologies on the risk picture
- Limited focus on human and organizational factors in risk analysis

3. TOSCA Challenges to address TSM needs for SMEs

TOSCA shall have to address many of these challenges facing SMEs in managing safety. First, there is a need to motivate SMEs to invest in safety management and show that there is a business case for safety. For instance, Antonelli et al. (2006) proposed that the following factors can motivate SMEs to put capital investment into the health and safety:

- Interpreting SHE issues as an integral part of doing 'good business'
- Maintaining reputation
- Achieving higher productivity
- Keeping within the law, hence avoiding punitive action from government
- Avoiding cost of accidents
- Containing insurance costs
- Meeting client demands
- Being a 'good' employer

Second, TOSCA risk assessment methodologies should be practical and user-friendly to SMEs so that safety practitioners can master them easily and apply them during safety critical activities. An effort should also be made to tailor risk assessment methods so that they can be used on a daily basis – e.g., operational risk management – for safety briefings in operational and maintenance tasks.

Third, formal risk assessment methods are useful but there is a need to adopt a resilience –based approach in order to support front-line operators in improving their knowledge of risks and in providing feedback to upper levels of the organization (Andersen and Mostue, 2012).

Fourth, TOSCA tools should provide specific indicators for monitoring how successful the safety interventions are for the management of change. The tools should demonstrate that there is some intrinsic benefit to the business of the SMEs. This is important because developing Environmental Health and Safety (EHS) interventions for heterogeneous types of SMEs is difficult since they are hard to reach and not easily motivated if the intervention has few evident benefits. In their report, Legg et al, (2009) recommended that, for programs to be successful, managers and consultants in SMEs should:

- Focus on a particular industrial sector or risk
- Combine health and safety with other management goals
- Combine active interventions with practical documentation and tools
- Measure its adequacy by evaluations of their effects afterwards
- Have the active involvement of different actors (employers, employer associations, workers, trade unions) in its planning and implementation

Finally, the IT tools of risk assessment and the virtual reality simulations of the working environment should take into account several challenges identified by earlier studies (e.g., Table 1). Many European SMEs are using complex technologies and operate in a competitive environment that increases 'variability' in the way that operations are carried out daily. Hence, TOSCA tools should have to cope with the uncertainty of the systems of work and working environments of European SMEs.

4. THE TOSCA methodological approach to TSM

Following on the main critical operational areas identified in the analysis of the needs for total safety management in SMEs and process industry in general within TOSCA it become clear that the following interrelated aspects needed to be addressed:

1. The use of innovative technologies for Functional analysis and Risk assessment
2. The use of innovative tehnology for design review and management of change (forboth plant design and safety cirtical task review)
3. The use of innovative technology to enhance safety management of everyday operations

The different modules comprising the TOSCA TSM devised to address those aspects are illustrated in Figure 1, and they are briefly introduced below.

4.1 Common Operational Picture.

The Common Operational Picture is the information and knowledge about the operational system used to support risk assessment and safety management. It may be represented in different ways but should be accessible to all stakeholders involved in a project in order to analyse and communicate risk, and to support training and procedure design. In this deliverable the work has been concentrating on understanding the current state of the art in tools and methods used to represent the system being analysed, the tools used for risk assessment, and the form the risk registry whenever present may take. This was done so as to highlight what aspects of the above safety critical organizations may need to improve.

4.2 TSM for Design

This section is seeking to understand how risk is assessed at the design stage, specifically through formal risk assessment techniques, dynamic risk modelling techniques, and rapid prototyping. Dynamic risk modelling involves the development of a model of risk to calculate risk levels, compute performance indictors, and perform sensitivity analysis of risk mitigation measures. Rapid prototyping involves the creation of a representation (physical or virtual) of a system or component for evaluation purposes. The scope is to understand how organisations may need to improve risk assessment at the design stage.

4.3 TSM for Critical Activities

The critical tasks considered are the phase of a project when major changes may be introduced to an organisation, and this section seeks to understand how such changes are managed in order to reduce risk. Some organisations may have a formal protocol to follow for managing change, while others may simply use existing channels of communication and/or training. In the deliverable an attempt was made to understand how organisations manage safety in defining and designing critical tasks and what their future needs are for improvement in this area.

4.4 TSM for Operations

This section focuses on monitoring and management of risk during the operational phase. What is needed is a clearer understanding of how risks are currently monitored, for example through incident reporting or safety performance indicators (SPIs), how training is used to manage risk in the operational phase, and

how changes are communicated outside of major projects/commissioning. We also seek to understand how to address effectively future needs of organisations in these areas.

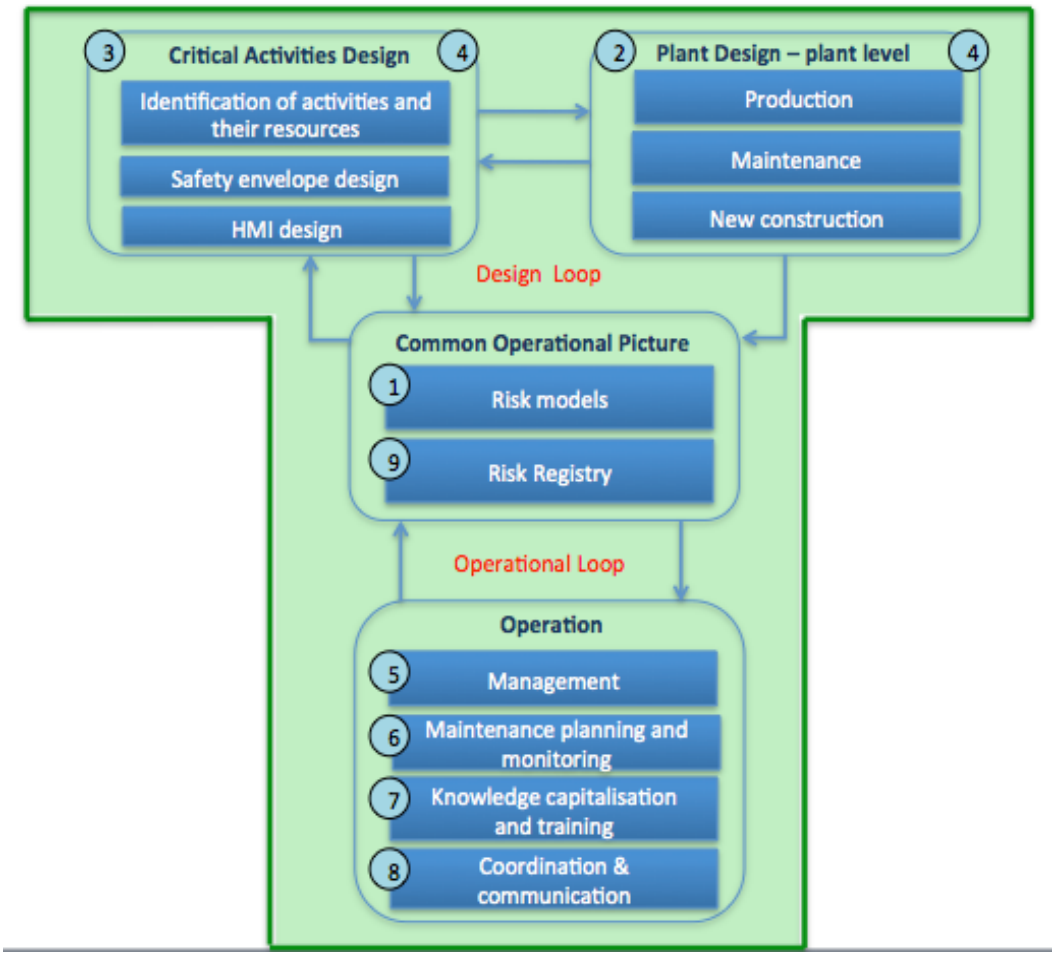


Figure 1: TOSCA Total Safety Management Framework (©copyright of TOSCA project consortium)

5. Conclusions: the current Test beds and the future development

To follow up the development and the testing of the TOSCA methodology in the three main sections and the deployment of the tools to support It within the project we have currently chosen to develop 5 test beds to test in the first phase the effectiveness of the proposed approaches in the areas identified.
The test beds chosen are the following:

1) The use of process mapping and task analysis to improve an SME risk assessment in the food processing industry and as a cornerstone for participatory risk assessment procedure review and training. This case is to test the deployment of Common operational picture and its implications in risk assessment.
2) The establishment of a risk register and a set of SPI to support hazard identification and risk monitoring in a company comprising several energy production plants. This is to test a better approach to risk monitoring in the operational loop.
3) The development of a better 3D risk map for a company producing fertilizers based on a 3D model of the plant to be sued as a better document management repository and a baseline for their safety management systems and management of information around changes.
4) The use of Rapid prototyping and VR simulations to test possible alternatives in the design of a procedure for water testing of LPG storage tanks and train contractors and operators on it.. To test the use of innovative technology for design review.
5) The use of VR to review and train operators and contractors for loading and unloading of cryogenic liquids. To test the use of innovative technology on review and training of safety critical tasks.

The test beds are currently under development their review should occur around October of this year. After this in the second stage of the project other test beds may be developed however the main efforts will be put in revising the methods and tools used for them and customize them for a wider usability in the community of practice. This will entail the development of cost benefits analysis for the developed test beds and the deployment of collaborative customization for the proposed solutions. Collaborative customization is where the business conducts a dialogue with the individual end users/customer to help them articulate their needs, to identify the precise offering that fulfils those needs, and to make customized products for them. This approach is appropriate for businesses whose users/customers cannot easily articulate what they want and grow frustrated when forced to select from a plethora of options, therefore it can be the most appropriate approach for supporting SMEs in facing ever new developments and technologies in the area of total safety management as an emerging field.

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