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Does the management of regulatory compliance and occupational risk have an impact on safety culture?

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Abstract: Companies try to improve risk management in the field of Occupational Health and Safety (OHS). In recent years this has translated into the introduction of safety management systems (SMS). These management tools bring together personnel, policies and resources aimed at improving the performance of a company in the area of OHS. SMS provide a structured, global framework for risk management based on compliance with existing repositories. An SMS consists of various stages or processes, notably concerned with the management of regulatory compliance and risk analysis. Various tools are deployed in order to meet these SMS requirements.

At the same time, the concept of safety culture has progressively taken hold in organizations. The idea has numerous benefits and can contribute to a reduction in occupational accidents and illness. However, these benefits are presented as self-evident facts which have not really been tested and proven. It is therefore appropriate to study the nature and strength of relationships between safety culture and two explanatory variables; namely compliance management and risk assessment. In other words, it is necessary to assess the respective contributions of these two variables to the creation, deployment and running of safety culture within a company.

This paper is organized into three parts. The first part describes the definition of safety culture and looks at its various components as described in the literature. The second part presents ways to model the processes of regulatory compliance, risk assessment and safety climate and provides a further, descriptive model that uses common variables to identify the relationships between these three components in terms of nature and degree. Finally, the third section details the results of an experiment carried out in a company. The experiment demonstrates the deployment of models to evaluate the interactions between components, and its results are discussed and analysed.

Keywords: Safety culture, regulatory compliance, occupational risk, management.

1. INTRODUCTION

In the domain of Occupational Health and Safety (OHS), companies are constantly striving to improve their performance. This has translated into the introduction of Safety Management Systems (SMS). These management tools combine people, policies and resources to improve OHS performance. The SMS integrates various processes including notably, risk assessment and regulatory compliance. The safety culture of the organization also plays an active role in this desire for progress and is oriented towards the perception and management of risk by the workforce. It is based on, amongst other things, safety climate analysis tools. The results of these assessments provide new, proactive indicators that draw upon human and organizational factors. These indicators provide additional data, and raise interesting questions about the nature and degree of the relationships between them.

This article looks at the nature of the relationships (should they exist) between the safety climate and two of the foundations of risk prevention, namely the management of regulatory compliance and risk management. To address the issue, the article is divided into three parts. The first part describes the principle elements of a definition of safety culture and looks at its various components. The next section describes the various models that have been developed to study these components of safety culture. It also discusses the use of common variables to examine the relationships between them. Finally, the third part describes the execution

of an experiment at a pilot site to investigate in detail the nature and degree of the relationships between the different models.

2. SAFETY CULTURE, CONCEPTS AND THEORIES

This section describes the principle elements of a definition of safety culture and looks at its various components. Each component is described individually in the following sub-sections.

2.1 Definitions of safety culture

The term 'safety culture' emerged following the analysis of two major industrial disasters in the nuclear domain, namely Three Mile Island (1979) and Chernobyl (1986). While the Three Mile Island accident focused attention on the importance of organizational and human dimensions, it was only following the Chernobyl disaster that the term 'safety culture' was used for the first time, when it appeared in the accident investigation report published in 1987 by the International Atomic Energy Agency (IAEA). The authors of the report, the International Nuclear Safety Advisory Group (INSAG), described the concept of 'safety culture' and put forward the idea that a deficient safety culture was the main reason for the accident. It was not until 1991 that INSAG provided a more complete definition of the concept: "*Safety Culture is that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.*", (INSAG, 1991).

Since the late 1980s, numerous other definitions of safety culture have been proposed. One of those most often cited was provided by the Advisory Committee on the Safety of Nuclear Installations (ACSNI) in 1993, "*The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management.*", (ACSNI, 1993). The definition was later adopted by the United Kingdom's Health and Safety Commission. For authors such as Cooper (Cooper, 2000) this definition highlights the implicit relationships between psychological, behavioural and organizational points of view, based on the following:

- "*individual and group values, attitudes...*" make it possible to describe the perceptions and attitudes of participants towards safety goals (psychological component),
- "*patterns of behavior*" refers to the behaviour of individuals on a daily basis (behavioural component),
- "*...and the style and proficiency of, an organization's health and safety management*" indirectly captures the quality of the Safety Management System (organizational component).

More recently, using the same line of reasoning, Marcel Simard defines safety culture as, "*The set of practices developed and implemented by key stakeholders to manage the socio-technical risks of their profession.*" (Simard, 2009). The use of the word 'socio-technical' encompasses both the technical dimension (organizational component) and the human dimension (behavioural and psychological components). The term 'practice' on the other hand defines both:

- how to act (habitual and accepted behaviour) such as the wearing of personal protective equipment (PPE), compliance with the rules, the use of risk analysis; and
- ways of thinking (values, the importance attached to safety, beliefs, etc.).

These definitions are rooted in earlier work. For example, Cooper's work (Cooper, 2000) is based on amongst others, that of the Canadian psychologist Albert Bandura (Bandura, 1977), which describes the relationship between the psychological factors of the individual, their environment and their behaviour.

2.2 The components of safety culture

Independent of the definition used (INSAG, ACSNI or Simard) safety culture is based on three main components (Figure 1), which are behavioural, organizational and psychological.



Figure 1. The components of safety culture

The psychological component aims to analyse the attitudes and perceptions of the individual and the group. The behavioural component evaluates external factors (wearing PPE, following operating procedures, etc.) applicable to individuals in the field and observable behaviour. Finally, the organizational component corresponds to an analysis of business operations through its policies, procedures and structure. Each of these components is described below.

2.2.1. The organisational component

The organizational component refers to the SMS. The SMS is either the product of the companies' own efforts, or is derived from a standardized management system such as those provided by the International Labour Organization (ILO) or the Occupational Health and Safety Assessment Series (OHSAS). The various frameworks are usually based on a common thread, and their contents are similar despite different names (Cambon et al., 2006). Moreover, an analysis of the various requirements of these standards suggests that a majority already exist in the French regulatory framework. To illustrate this point, a comparison was made between sections of OHSAS 18001 and extracts from French regulations (Table 1).

Table 1. Comparison of the OHSAS 18001 standard with current French regulations

Section of OHSAS 18001 standard	Equivalent French regulation (examples)	Source
4.3.1 Identifying hazards, risk assessment and control	The employer shall maintain a single document containing the results of the health and safety risk assessment of workers in accordance with Article L. 4121-3. This assessment includes an inventory of the risks identified in each work unit of the company or institution.	Article R.4121-1 of the French Labour Code
4.4.1 Resources, roles, responsibility and power	The employer shall designate one or more competent employees to take charge of the company's protection and occupational risk prevention activities.	Article L.4644-1 the French Labour Code
4.4.2 Training, awareness and competence	When hired and whenever necessary thereafter, the employer shall inform the employee of the risks to their health and safety. <i>There are more than 420 regulatory requirements related to training or mandatory skills in the French regulatory framework.</i>	Article R.4141-2 the French Labour Code
4.4.3 Communication, consultation and participation	The employer shall inform each worker of the existence of the workplace exposure record. <i>More than 100 regulatory requirements related to information and training in the French regulatory framework.</i>	Article R.4452-26 the French Labour Code
4.4.4 Documentation	The employer shall record in a single document the results of the occupational risk assessment <i>More than 520 regulatory requirements related to documentation in the French regulatory framework.</i>	Article R.4121-1 the French Labour Code

As Table 1 shows, the main sections of the OHSAS 18001 standard correspond to French regulatory requirements. This reflects the fact that (like the OHSAS standard) French regulations simply aim to impose best practice and effective prevention measures in order to reduce the occurrence of accidents and occupational illness. The important role that the management of regulatory compliance plays in

organizational components (policy, procedures, communication, etc.), leads to an analysis of this component based primarily on the regulations in force.

2.2.2. The behavioural component

The behavioural component includes factors external to individuals in the field and observable behaviour. It therefore involves implementing an analytical model based on the reality on the ground found in the various workstations. This model was inspired by the methodologies required by the French regulatory framework for assessing occupational risk in the workplace. The objective of the risk assessment is that it should be, “*a prerequisite for the definition of prevention actions based on an upstream knowledge of the risks that the workforce may be exposed to. It aims to improve health and safety protection for employees and to improve working conditions within the company. As a result, the need for prevention also contributes to improving the overall performance of the company, from both a social and an economic point of view.*” (French Circular¹). The importance of risk assessment in the behavioural analysis of individuals leads to the design of a model for the analysis of the behavioural component based on the results of an occupational risk assessment.

2.2.3. The psychological component

The psychological component refers to what the individual thinks. It concerns their opinions, beliefs, perceptions, attitudes and values. This component can be measured by interviews and/or tailored questionnaires. Various questionnaires exist on the topic of ‘safety climate’; they investigate notably, perceptions of commitment to health and safety, job satisfaction, communication, personal perceptions of involvement in health and safety, etc. Studies conducted by Guldenmund (Guldenmund, 2000) and the United Kingdom’s Health and Safety Executive (HSE, 1999) have demonstrated that safety culture is often only considered under the heading of the psychological component in questionnaires and/or interviews. However, the representation of safety culture shown in Figure 1 shows rather that all three components are connected to each other and that together they form a platform for safety culture. It is therefore necessary to analyse all three components in order to properly characterize the safety culture of an organization.

This second section has briefly outlined the components of safety culture. The next step is to consider the following questions: how to approach the analysis of these various components of safety culture? What are the relationships between the different components? What contribution do basic components such as regulatory compliance and risk assessment make to the creation of a safety culture? What contribution do these elements make to the analysis and improvement of safety culture? Section 3 will address these questions.

3. MODELLING SAFETY CULTURE

In order to examine the relations between the components of safety culture, the components must be modelled using a set of descriptive and explanatory variables that can be linked. These variables were modelled independently for each of the three components. Models were developed for: the management of regulatory compliance, risk management and safety climate. A class diagram was created to describe the processes occurring in each model. Using this Unified Modelling Language (UML) diagram, the data structure for each class and the relationships between them (dependencies, composition, aggregations) can be explained. Each individual model, part of a system of models, is described below.

3.1. Modelling the organizational component

The organizational component of safety culture is examined here through the management of regulatory compliance. The model (Figure 2) shows the interactions between different actors with the regulatory compliance assessment model in place. It is based on the modelling work of Juglaret (Juglaret et al., 2011a).

¹ French circular DRT n° 2002-06 (18 april 2002)

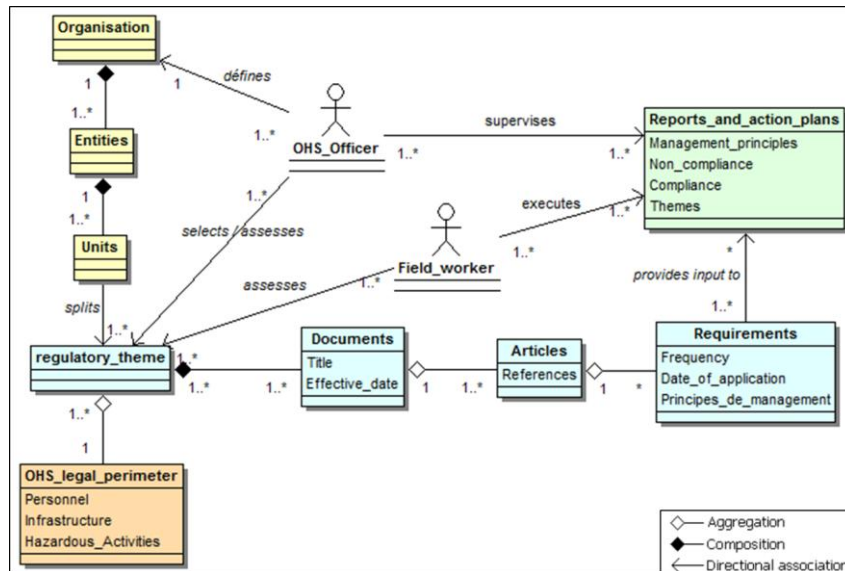


Figure 2. Model of regulatory compliance management

The model divides the organization into entities and units. Next, the selected units are associated with the various regulatory themes. Themes are selected from French regulatory framework (in particular the Labour Code). They include risk-bearing activities (for example resulting from chemical or biological hazards, or materials handling), infrastructure (fire, evacuation, etc.) and regulations related to personnel (employment contracts etc.). An analysis of the relevant texts makes it possible to summarise the regulatory requirements underlying each theme. The requirements' summary includes points such as the date they entered into force, how often they should be applied, management principles, etc. The results of this assessment provide input to an action plan and specialized analytic reports. The fact that some of the variables are also found in the other two models (e.g. management principles or risk family) enables a crossover study to be made with them (this is described in detail in section 3.4).

3.2. Modelling the behavioural component

This model (Figure 3) shows both the interactions between actors and the contents of the risk management model. It is based on the work of Juglaret (Juglaret et al., 2011b).

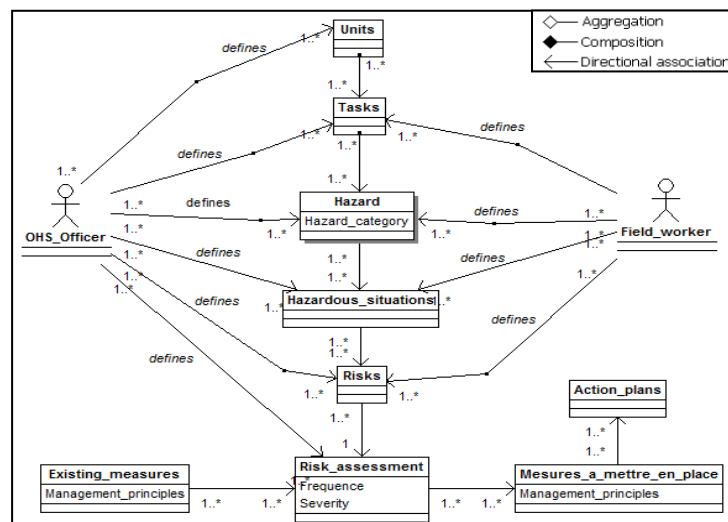


Figure 3. Model of risk assessment management

This risk assessment model divides the company into work units (or workstations). For each work unit the employee defines the principle tasks and hazardous situations. Risks arising from these hazardous situations are evaluated by the employee using a tailored analysis grid that takes into account the likelihood of occurrence and severity of the risk. Once the preventive measures used currently used by the employee have

been listed, the model makes it possible, if necessary, to add new measures to be implemented. These measures provide input to an action plan. This global analysis of the workstation provides detailed reporting.

3.3. Modelling the psychological component

This model (Figure 4) shows the contents of the safety climate model. The safety climate is a snapshot of the psychological component of the workforce at a given time (Flin et al., 2000).

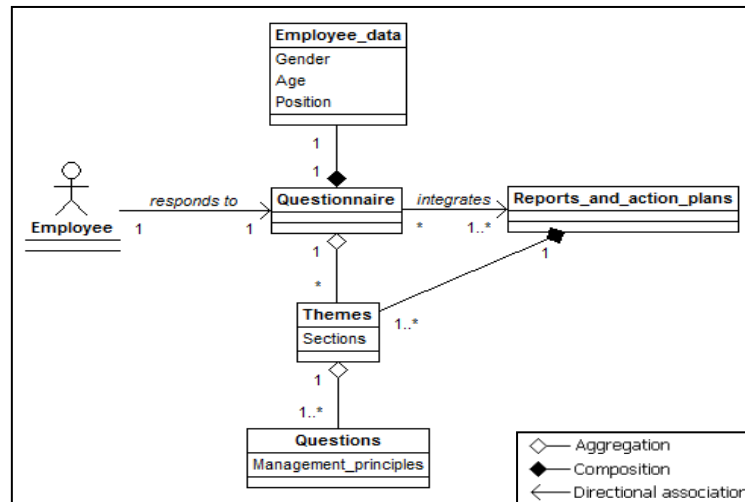


Figure 4. Model of safety climate management

The safety climate assessment model is based on the major themes common to safety climate questionnaires (Guldenmund, 2007). These questionnaires typically cover various management principles but also ask for the views of employees on the different risk families. All employees that participate in the survey respond individually to the questionnaire. Questionnaires use a Likert scale to capture opinions on topics such as the perception of commitment to health and safety, job satisfaction, communication, perceptions of personal involvement in health and safety, etc. The construction of the model evaluation of safety climate is described in an internal document (MinesParistech, 2012) The results of the survey provide input to reports and specialized action plans.

3.4. Interrelations between the three models

Sections 3.1 to 3.3 have outlined the models used to describe the three components of safety culture. In order to investigate the relations between them, the management principles of each model were integrated. As can be seen in Figures 2, 3 and 4, the following management principles have been added:

- for the regulatory compliance model: each of the regulatory requirements,
- for the risk assessment model: existing prevention measures and measures to be implemented, and
- for the safety climate model: the questionnaire.

Table 2 highlights the management principles found in the three safety culture models.

Table 2. Management principles and safety culture models

Management principle	Regulatory compliance	Risk assessment	Safety climate
Analysis	X	X	X
Training and information	X	X	X
Design and layout of the workplace	X	X	X
Operational management	X	X	X
Document management	X	X	X
Personal protection equipment	X	X	X
Management	X		X
Periodic checks and controls	X		
Emergency procedures and intervention methods	X		
Design and layout of workstations	X		

The fact some management principles are found in all three models is a good demonstration that relationships exist between them. Some principles are only present in one or two models; the particular characteristics of the other models make it impossible to examine the principle. Therefore, these principles are only used in the detailed analysis of the results of the model they appear in, and are not taken account in the examination of interrelations.

Using the same methodology, the principal risk families were integrated into the models:

- for the regulatory compliance model: on each of the regulatory requirements,
- risk families were already present in the occupational risk assessment model, and
- as part of the safety climate questionnaire: in the assessment of the views of employees of each risk family.

Table 3 highlights the risk families found in each model.

Table 3. Risk family analysis and safety culture models

Risk family	Regulatory compliance	Risk assessment	Safety climate
Mechanical	X	X	X
Chemical	X	X	X
Business trip	X	X	X
Explosion	X	X	X
Temporary work at height	X	X	X
Materials handling	X	X	X
Radiation	X	X	X
Electrical	X	X	X
Fire	X	X	X
Working environment	X	X	X
Physical activity/posture and movement	X	X	
Stress and psychosocial risks	X		X
Management	X		
Employment contract	X		
Workplace design	X		
Safety authorities	X		
Employer's responsibilities	X		
Category of employee	X		
Addictive practices	X		
Workplace environment		X	
Visual constraints		X	

As several risk families feature in several models it once again demonstrates that relationships exist between them. Some risk families are only present in one or two models; as above, the characteristics of the other models make it impossible to analyse them. As with management principles, these risk families are used in the detailed analysis of the results of the model they appear in, but are not taken into account in the examination of interrelations.

This crossover study of variables at the level of management principles and risk families provides a good demonstration of the relationships between the components of safety culture. Despite the fact that each model has a different purpose, it is possible to link them together through the use of specific variables. It remains to characterize the nature and degree of the relationships between models; this is achieved through a field experiment.

4. A CASE STUDY

This section describes the implementation of an experiment carried out in partnership with a major French company. It discusses the pilot site, the on-site deployment and the initial results.

4.1 The pilot site

The pilot site carries out research and innovation in the cosmetics field. It has been operating since 1953 and employs around 1,000 staff. There are two main divisions: the International Directorate General of Cosmetics and International General Directorate of Hair. Each division is organized into different branches.

4.2 Methodology

The experiment was conducted in three main phases: preparation, on-site execution and analysis and evaluation. These three phases are composed of eight interrelated tasks shown in Figure 5:

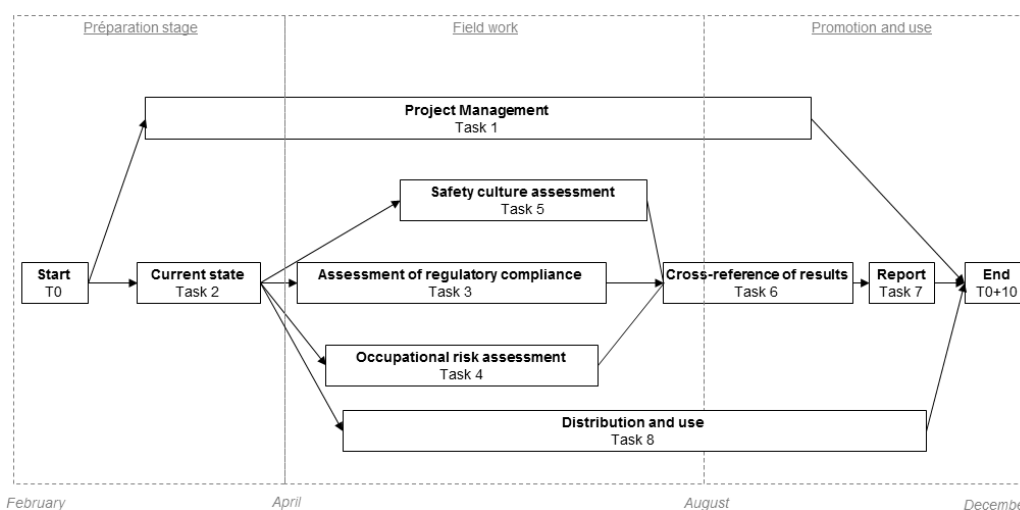


Figure 5. Structure of the experiment showing the eight tasks organized into three phases

4.3 Results and discussion

Using the defined methodologies and the experimental methodology, an investigation into the nature and degree of the interrelationships between the three individual models was carried out. The models deployed at the pilot site were used to assess the level of understanding of each management principle (on a scale of 0 to 100). Figure 6 shows the consolidated results.

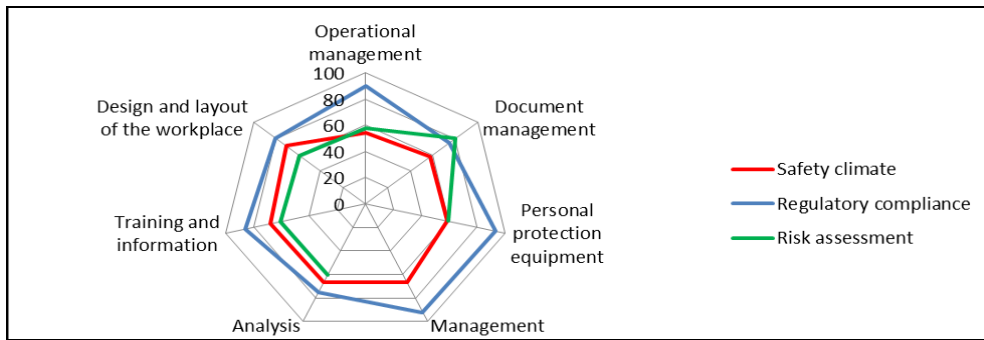


Figure 6. Level of understanding of management principles common to the three models

The radar chart shows that an analysis of the same management principle, at the same site using different models does not produce quite the same results. For example, the ‘personal protection’ principle has a level of understanding of over 90% using the regulatory compliance model, while the risk assessment and safety climate models evaluate the level of understanding to be 60%. An analysis of this field experiment suggests that this result is explained by the fact that regulatory compliance is evaluated more broadly than risk assessment and safety climate. While in general the site meets the majority of regulatory requirements, the specifics of the situation in the field tell a different story. The risk assessment and safety climate models examine the behaviour and the views of employees more closely, and provide a more detailed picture of factors related to personal protection. In this case, it was shown that although the company had all the necessary measures in place to comply with regulatory requirements, in practice employees were not applying all the rules.

Another radar chart was produced from data measuring the level of understanding of the various risk families according to the model used (Figure 7).

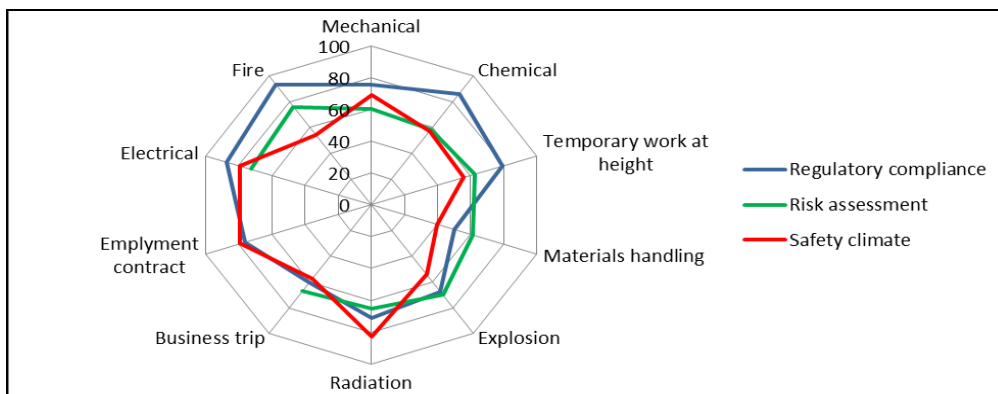


Figure 7. Level of understanding of each risk family common to the three models

As in Figure 6, the compliance model has an overall higher level of understanding than the risk assessment and safety climate models. It should be noted here that this article will not discuss the results of individual risk families.

Figures 6 and 7 show that, by means of common variables, the three models can be compared. These charts provide new indicators and Scorecards that can be used to improve OHS performance measurement (Juglaret et al., 2011c). The use of a radar chart is not intended to highlight the effectiveness of one model compared to another. Rather, it shows that each of the models can be used to examine the same variable from a different angle and can highlight points that are not apparent in the other models. To obtain a relevant indicator for a variable, an interesting approach is to deploy each of the three models; this provides a complete overview of the variable. Going beyond the current analysis, which looks at the different results obtained depending on the model used, it would also be interesting to carry out a detailed mathematical study to determine whether the variables used are independent (or not). This work is in progress.

5. CONCLUSION

The discussion of the safety culture concept in Section 2 assumes that it is based on three components, namely psychology, behaviour and organization. In practice, it turns out that an assessment of safety culture is based primarily on the psychological component. The question that arises from this observation is why the other components are either hardly, or not at all taken into account. Are there any links between these different components? If these components are integrated into the safety culture assessment, what contribution do they make to the construction of a safety culture? These questions led to the implementation of an experiment designed to address the hypotheses (described in Section 4). Section 3 explained the methodological approach for the characterization of the models deployed. Variables common to all three models, such as management principles and risk families were used to link them together. The results of the experiment described in Section 4 would be enriched by a detailed mathematical investigation of the correlations between models (e.g. factor analysis) to establish whether the common variables are independent (or not). An analysis of these results will better characterize the nature and degree of the interrelationships between the components of safety culture. After reviewing the results of this model it will be interesting to expand this research by other approaches to assessment of safety culture such as the organisational management of uncertainty for example. (Grote, 2007).

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