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Improvement of Safety Culture in Academic Laboratories of EPFL

Master Thesis Chemical Engineering and Biotechnology

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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THESIS SUPERVISED BY THIERRY MEYER

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Abstract

In order to provide appropriate theoretical background, the construct of safety culture was discussed. Mechanisms of this construct were presented through the analysis of several descriptive or assessment models, and one definition from literature was given.

Safety culture is a multi-faceted construct gathering values, beliefs, perceptions, etc., within an organization. It was decided to focus this project on safety climate, which corresponds to the perceptible manifestations of safety culture.

The distinction between safety climate and safety culture being regularly missed in literature, the differences between both of these constructs was emphasized.

Assessment of safety climate was performed through an online survey. Questions were based on Reason's model and Parker's framework, which described five typologies for 11 concrete and 7 abstract aspects. The survey was sent to every person linked to a laboratory and results focused on people who stated laboratory-work as their main occupation.

Results of the survey indicate respondents adopt generally a "generative" approach (the best typology defined by Reason) for the assessed dimensions. However, it was determined that each School presents different strengths and weaknesses.

It was determined that this framework could be applied at EPFL but needs to be redesigned to be more accurate regarding EPFL organization. Certain typologies' description appeared to not be necessarily relevant or adequately formulated. A review of the formulation with academic HSE experts appeared to be necessary.

Cronbach's alpha coefficient's value is 0.75 which indicates an acceptable internal consistency, which means this survey measures the same construct.

A global HSE score has been calculated within lab-workers of EPFL, according to the "Hearts and Minds – Understanding your culture" brochure, resulting to a score of 3.53 (max score: 5).

As respondents were all willing to participate to this survey, a strong positive bias is suspected and therefore in depth assessment are necessary to validate this statement. Group discussions within research units could be a solution to prevent this bias.

Finally, the survey highlights three major improvement opportunities, concerning the reporting of accidents, the safety training and the role of CoSecs. Reflection paths are proposed to extend the analysis of these dimensions and improve them.

1 Introduction

Accidents' impact can vary from slight damage to tremendous catastrophe, depending on the involved hazards and the context. High-risk industries (nuclear or chemical for instance) present large potential impacts due to their activities. Thus, these industries have been particularly focused on safety development to prevent such catastrophes.

Safety in industries has been developed in three phases, starting with the improvement of technical equipment to limit failure rate. Once the induced accident rate decrease stabilized, System of Management of Safety (SMS) have been developed in the purpose of safety improvement through prevention, means and individuals. The next step of safety development concerned the organizational aspect of safety, which is the subject of this report (figure 1).

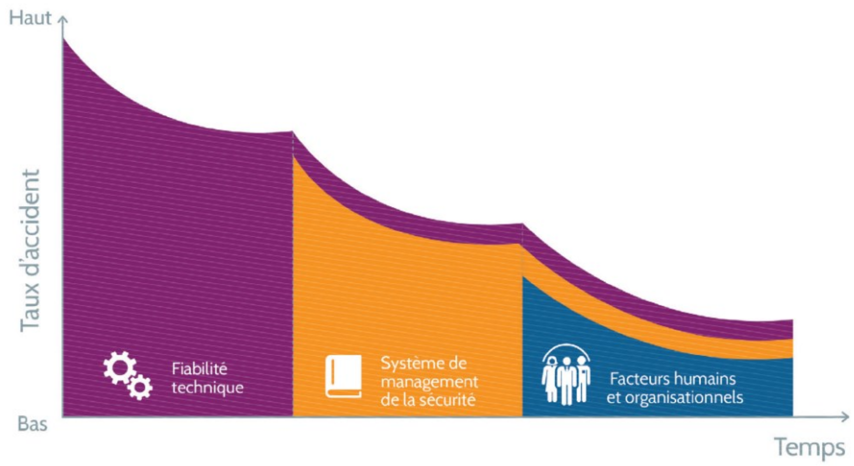


Figure 1 Evolution of frequency and gravity of incidents versus time and the factors of risks (ICSI, 2017)

Safety culture is generally more developed in industry than academia, and recently, awareness of the importance of organizational factors in safety performance starts raising in academia.

This report will first focus on the theoretical background underlying this construct. Then we will focus on the possible application and assessment at EPFL.

1.1 Emergence of safety culture in industries

In order to introduce this concept, a chronology presents the context of the appearance of safety culture and organizational factors. Two case studies are detailed to emphasize the differences between technical, human and organization factors.

1.1.1 Chronology

March 28th, 1979, Three Mile Island (US) Nuclear Power Plant (NPP) suffered a major dysfunction on the secondary non-nuclear section of the plant. A chain of events, detailed below, drove the core of the plant to partially melt down. Although radioactive releases had no detectable health effects, "it was [at the time] the most serious accident in US in commercial nuclear power plant industry" (US

NRC, 2014). The investigations concluded that misunderstanding and misinformation of this event led to several decisions that aggravated the situation.

Critical role of human operator was then identified as a major key in safety concept of an industrial plant.

April 26th, 1986, Ukraine. A test was performed on reactor N°4 of Chernobyl Nuclear Power Plant. After a serie of errors, including violations of the procedures guarantying reactor's integrity, the worst nuclear accident in history happened. (IAEA, 2017)

The International Atomic Energy Agency (IAEA) investigated the accident and the terms "safety culture" appeared for the first time.

After this moment, safety management in industries changed. Organizational factors are now seen as a major safety issue due to the potential impact that might occur in case of failure. A major accident can lead to important financial impact (reparations, victims' compensations, production losses, etc.) and to an important impact on public image (reputation, trust). The latter being also paramount for governmental organizations.

Poor safety culture also led to other serious accidents (Bhopal, Challenger, Piper Alpha, …). The Bhopal case is presented below as a case study to exhibit the characteristics of a poor safety culture.

Following these accidents, safety culture has then been deeply investigated to understand the mechanism that lead to good safety performance in term of organizational aspects and its implementation in industry. Some of the resulting models and tools are presented in latter part of this report.

1.1.2 Case study: Bhopal accident

This first case study is based on an accident which occurred in an industrial plant and is considered as the largest industrial disaster. (BBC News, 2010)

1.1.2.1 The accident

The Union carbide pesticide plant in Bhopal, India, used methyl isocyanate (MIC). This compound is highly volatile and toxic. Financial health of the company was not good and cuts were done on safety and small deviations were considered normal and acceptable (minor leaks, odours, etc.).

In the night of 2nd-3rd December 1986, a leak of MIC was notified to the control room due to odour detection.

The operator searched the installation and concluded to a small leak.

More calls notified the control room as odour expanded. The operator investigated more deeply the MIC installation, and noticed a tank was vibrating and releasing heat, sign of exothermic reaction.

Back in control room, the operator started the emergency procedure. Vent gas was directed to a gas scrubber with caustic soda. The scrubber malfunctioned and was not able to neutralize the gas. Further investigations determined afterwards that this scrubber was not designed for major leak and could never have neutralized such a leak.

The second safety barrier was a flare tower which was supposed to burn the vent gas. It was disconnected at this moment.

The third and last safety barrier was the water curtains which were deployed by firemen of the company. Unfortunately, those were under-dimensioned and the water streams could not reach the top of the chimney, where gas escaped.

At this moment, nothing could be done to avoid the gas to impact the population. The communication to the authorities were inefficient and the alarm went late to the hospitals and the police force.

On this single night, 4’000 persons died of direct effects of the MIC exposure, 8’000 in the following couple of weeks, and 8’000 others have died since from gas-related diseases.

1.1.2.2 Triggering events

An unclogging operation were performed in the unit when water flowed back in the MIC tank. Pipes were interconnected to improve efficiency and flexibility of production. A check valve was supposed to be present, but was not. Nitrogen inerting was out of function during several days and the situation has not been reported.

The water flow entrained rust of the pipe, which contained iron, a catalyst of the decomposition reaction of MIC.

1.1.2.3 Analysis of the accident

The chain of events leading to this accident revealed that there were not only technical failures, but some less perceptible dysfunctions concerning management of safety in this particular plant.

Amongst the different dysfunctions we can highlight the lack of anticipation (“what can go wrong?”), the acceptance of deviations (“Small disturbances are OK”, for example small leakes), safety cuts and complacency (“Nothing serious happened recently, we can reduce our efforts”) and a bad communication within the company and with external stakeholders (authorities and hospitals for example).

Those dysfunctions have major similarities; this concerns general operations of the company and are not due to one operator error. There come from the term “[safety] culture”. This extreme case has been selected to emphasize the importance of safety culture, but it is important to keep in mind that safety culture concerns every safety aspect of an organization’s life.

1.2 Safety Culture in academic institutions

The concept of safety culture is quite anchored in most of high-risk industries and has been well explored by researchers, academia exhibits a strong improvement potential. Main reason is the organizational difference between both of these environments.

Several serious, even lethal, accidents occurred in academic institutions in the last decade:

- University of California Los Angeles, USA, 2008: Ignition of tert-butyl lithium and chemical fire, one chemistry research assistant suffered major burns; she died few days later. UCLA was fined USD 31’000.- and the professor settled an agreement to escape prison. (Kemsley, 2009)
- TexasTech University, USA, 2010: Explosion of nickel hydrazine perchlorate derivative, a graduate student lost three fingers, suffered burns on hand and face and injuries on one eye.

The Chemical Safety Board (CSB) concluded to a lack of good practices in the university. (US CSB, 2010)

- University of Hawaii, USA, 2016: Explosion of a mixture O2/H2, a postdoctoral researcher lost her arm. University of California Center for Laboratory Safety (UCCLS) concluded the underlying cause "of the accident was failure to recognize and control the hazards of an explosive mixture of hydrogen and oxygen". (Kemsley, University of Hawaii lab explosion likely originated in electrostatic discharge, 2016)

These examples show that severe accidents can occur in academic institutions. However, consequences of accidents in university are relatively less dramatic than industrial accidents (example: Bhopal, India, 1984: a leak of methyl isocyanate killed 4'000 persons in one night, thousands of others died from diseases due to gas exposure).

UCLA accident is detailed below as a case study to expose the failures in organizational aspects of safety which led to the accident.

The difference of considerations regarding safety between industry and academic could ensue from the hazards perception and the scale of potential accidents and their gravity.

This point will not be discussed here. The differences of both these environments will be discussed to understand why the industrial safety culture researches cannot be directly transposed and applied.

1.2.1 Case study: UCLA accident – ignition of pyrophoric

This case study focuses on an accident in an academic institution. Even if the consequences are less dramatic that the consequences of an industrial disaster as presented above, this accident had an important media coverage. The analysis is based on an EPFL-DSPS course dispensed to safety coordinators (CoSecs) (DSPS-SCC, 2017).

1.2.1.1 The accident

December 29th, 2008 at University of California in Los Angeles (UCLA), a staff research assistant was working in a laboratory in molecular Sciences building. She had at this moment a bachelor degree in chemistry.

Throughout the accident she was manipulating, with a syringe, tert-butyl-lithium, a pyrophoric substance igniting spontaneously when in contact with air. The plunger came out of the syringe and the substance ignited.

An open bottle of hexane was present, even if it was not part of the experiment. The fumes ignited too, as did Sheri's clothes. She was not wearing a lab coat. The emergency shower has not been used.

She suffered of serious burns on half her body and died eighteen days later.

1.2.1.2 Triggering event

The direct cause of the accident lays in the mishandling of the syringe. However, a plunger coming out of the syringe is supposed to be an incident rather than an accident, moreover a lethal accident. This incident has been aggravated with hexane fumes.

1.2.1.3 Analysis of the accident

Similarly to the Bhopal accident, but to a smaller scale, analysis of this accident revealed organizational issues.

Accidents and near-misses were not reported, audits corrective measures were not systematically applied, no specific training were proposed for manipulating of dangerous chemical compounds, supervision presented deficiencies.

Even if the professor in charge of this laboratory faced charges of felony, it is impossible to consider one unique person responsible for the mentioned dysfunctions. They are the product of the organizational context from which ensue such standards and practices.

1.3 Differences between academia and industry

Academia and industry are two different environments with their own particularities. As safety culture has been essentially developed in high-risk industry, it is important to detail the differences between both these environments in order to understand why we cannot directly consider safety culture in academic institutions as it is considered in industry.

Hierarchical organization

Industries have a top-to-bottom approach and centralized power, where accountability between the different levels of responsibilities are clear. Power and leadership are also important factors to spread practices within a company.

In academia the power is very scattered and decentralized; Chemical Safety Board US (CSB), an American federal agency, brought to light the issue of "fiefdoms", considering the independency of professor regarding their laboratory's organization (US CSB, 2010).

Purpose

An industry's main concern lies in profitability. Thus, efforts are made to avoid useless expenditures and ensuring infrastructural integrity of the plant of the company. DuPont claim they demonstrated that a good safety performance is strongly correlated with profitability (DuPont, 2015).

Also public image is an important consideration within companies. For instance, a serious accident can weaken trust of people in the company, provoke authorities' sanctions, etc. Thus industry tend to accept safety as an important factor protecting the company's sustainability.

Academia focuses on research and new discoveries, thus the impact of profitability, in terms of money, is almost negligible, to a certain point. However, the potential relationship between research performance and safety is to be discussed.

Complexity

Several factors also influence the complexity of academia regarding industry. First, turn-over of researchers is high, with more than 80% of renewal amongst researchers within four years. Also these researchers, in particular PhD students, have a higher level of formation, and a smaller work experience.

Hazards emerge due to the dynamism of the activities, with introduction of new technologies, processes in the development phase, fast evolution or redirecting of projects and the wide range of researches. For instance, more than 80'000 different chemical compounds are used at EPFL (internal SCC documentation).

1.4 EPFL Organization

This project focuses on the safety culture within EPFL academic research units and it is important to briefly present the organization of EPFL regarding safety in order to harmonize the used terminology.

At EPFL, hundreds of research units are active on various topics and are on the responsibility of a professor. They are gathered within 23 institutes, gathered in turn into 5 schools (Life Sciences, Basic Sciences, Engineering, Architecture Civil and Environmental Engineering, Computer and Communication Sciences) and 2 colleges (Management of Technology and College of Humanities).

The presidency of EPFL and 6 Vice-presidencies manage the transverse services (General Counsel, Development Office, Human Resources and Operations (VP-HRO), etc.) and form the Direction of the EPFL. The Direction is responsible for Occupational Safety and Health and delegates tasks to different stakeholders.

Deans or college directors are responsible at the first level of the application of safety prevention measures. Research units' heads are responsible for setting up an organization able to fulfill safety specifications. They take support from the safety coordinators (CoSec), generally a member of the unit.

Safety, Prevention and Health Domain (DSPS) supervise organization of safety in schools and colleges and depends of the VP-HRO. It takes support from the CoSec (DSST, 2012).

2 Theoretical background: the construct of Safety Culture

Safety culture is a recent concept coined in 1987 from the investigations of Chernobyl disaster. Since then, many researchers focused on this subject through different aspects (psychological, anthropological, sociological, etc.). No universally accepted definition has been found, however some tendencies can be highlighted.

In 1991, Cox and Cox provided a definition: “safety culture reflects the attitudes, beliefs, perceptions, and values that employees share in relation to safety”. This definition is presented, assuming it provides sufficient information to approach the subject and remain clear.

However, many different definitions have been given (over twenty). (Guldenmund F. W., 2000).

2.1 Culture versus Climate

Previous case studies exhibit the fact that [safety] culture is deeply engraved within an organization. However, another term was defined in 1951 and used in research of organizational factors: the climate. Climate directly refers to the perceptions of a construct.

It is accepted that the confusion between culture and safety is common, even in specialized publications (Guldenmund F. W., 2000) so this part will attend to establish a preliminary basis to differentiate these constructs. Defining clearly the difference between these constructs is not the aim of this work and it is advised to read the review of Guldenmund, 2000 for further discussion and information.

Soe et al. associated “culture” with the words “deep”, “stable” and “qualitative” while climate is referred by “superficial”, “snapshot” and “quantitative”, exhibiting the difference of tangibility of these constructs (Seo & M. R. Torabi, 2004).

<u>Perceptibility</u>

Climate is defined as the direct perceptions employees have regarding safety and organizational factors. Culture incorporate the underlying factors that are not directly perceived. These factors are deeply anchored in people minds, sometimes unconsciously, and in the company history. Culture is also tacitly transmitted with time to new employees.

<u>Stability over years</u>

Culture is considered as a very stable trait of an organization while climate can be more fluctuating. De Cock and al. stated culture changes occur in at least five years (Guldenmund F. W., 2000). On the other hand, safety perceptions, i.e. climate, can change right after a punctual event (major accident, new procedure, etc.) without involving a change in culture. (Schoeffel & Thompson, 2017)

To emphasize these sustainability, authors associate the culture with the “personality” of an organization and reflects what “is” an organization, while climate refer to the “mood” and what “has” the organization.

<u>Causality</u>

In his review of literature, Guldenmund concluded that culture presently “refer[s] to a global, integrating concept underlying most organisational events and processes” (despite this definition was given to climate at the beginning), while climate concerns the “overt manifestation of culture within an organization”. The causal relationship between culture and climate is therefore spotlighted as climate ensues culture.

<u>Inclusion</u>

Now we will focus on the separation between these constructs.

According to Cox & Cox (1991), safety culture can be defined as the reflection of "the attitudes, beliefs perceptions, and values that employees share in relation to safety", while safety climate has been defined by "the objective measurements of attitudes and perceptions towards occupational health and safety issues." (Guldenmund F. W., 2000)

For this project I consider safety climate as a part of safety culture, representing the perceptible and measurable manifestations of it.

<u>Multi-faceted</u>

Culture incorporates different dimensions of organizational aspects such as values, beliefs, practices, history, etc. These different facets of culture make that several approaches are needed to assess culture (audit, inquiry, group discussions, etc.)

Climate is one of these aspects, gathering the perceptible manifestations of culture, and can be assessed through quantitative surveys.

<u>The iceberg metaphor</u>

To illustrate this construct, we can consider the safety culture as an iceberg. Safety climate would be the emerged part that can be directly observed and immerged part would be the essential part of the iceberg, which guarantee the stability of the ice. Both parts influence each other and are influenced by the surrounding water (i.e. their environment). These interactions are exhibited in the reciprocal model, presented further in this report.

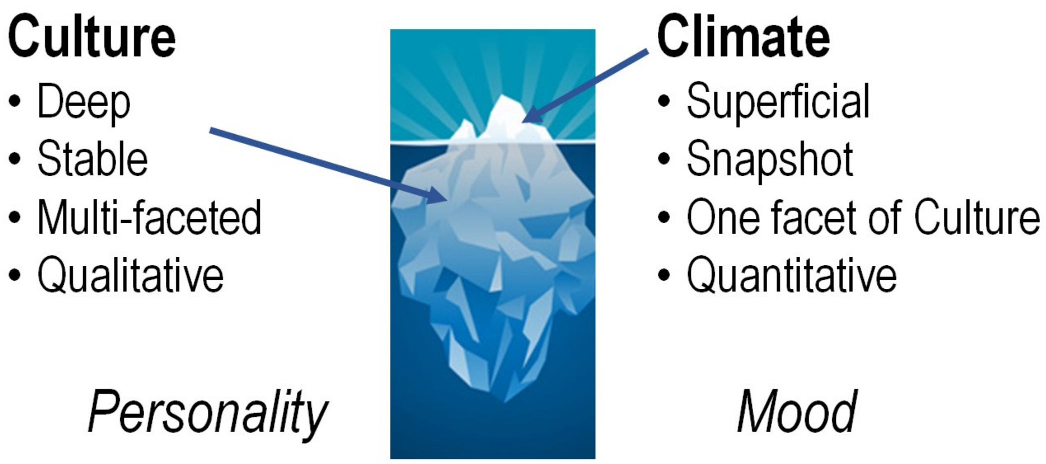


Figure 2 Culture vs climate: the iceberg metaphor

Followings these statements it appears that safety culture cannot be measured by one unique tool but need in depth assessment. Such assessment will need a tremendous workload so it has been decided to focus this project on the assessment of safety climate in academic research units.

2.2 The different models of safety culture

We will focus on some existing models that have been developed to describe and/or assess safety culture or safety climate. Five models will be presented and compared to assess their possible implementation and use in an academic context such as EPFL.

As discussed above, safety culture is a multi-faceted and intangible construct; therefore, models differ regarding the authors' background and should be seen as complementary rather than contradictory.

2.2.1 Layers models

The layer model is based on the differences of perceptibility to the different components of the safety culture structured as layers of an onion. This structure was proposed in 1982 by Deal & Kennedy (Guldenmund F. W., 2000) and several authors adapted this model to their observations, giving different meanings to outer layers. This model describes organizational culture and can be applied to safety culture.

During this work, Schein's model was considered as the terminology seems more easy to understand for non-sociologist. Schein defined three layers, the "Artefacts", the "Espoused values" and the "Basic underlying assumptions" (from the outer layer to the core).

- Artefacts: These are the directly perceptible manifestations of safety culture:" what is done". A new employee of an organization will quickly perceive these. Artefacts can be assessed through surveys.
- Espoused values: These are the messages transmitted by the management and are the values adopted and supported within an organization (International Atomic Energy Agency, 2002):" what we say". Espoused values can be assessed through individual interviews.
- Basic underlying assumptions: These are the deepest layer of culture. It includes the fundamental belief that an organization subscribe in an unconscious way. They reflect the history, the beliefs and assumptions of founders and key leaders of an organization. Groups discussions can allow to assess this layer.

It is important to notice that the terms « Artefacts » and « Espoused values » are the reflection of the caution given to the meaning of outer layers and the fact that "what is seen and heard is not always a true expression of culture" (Guldenmund F. W., 2000). In other words, differences can occur between what the management say (e.g. "safety is the more important") and what they really do and what the workers feel (e.g. "we have to be productive no matter what").

Schein's model has been used by IAEA to develop an assessment model for safety culture in high risk organizations, i.e. organizations which should have a low failure rate and high safety level. Several dimensions have been described and attributed to the corresponding layer (International Atomic Energy Agency, 2002).

The model consists in a three-stages scale regarding the main considerations in safety assessment within an organization.

- Stage 1: Safety is based on rules and regulations: This stage includes organizations that see "safety as an external requirement, and not as an aspect of conduct that will allow it to succeed". Compliance is then reached through numerous rules to limit deviation of processes.

- Stage 2: Safety is considered an organizational goal: At this stage safety performance is independent of external requirements and is reached through goal and targets.

- Stage 3: Safety can always be improved: The idea of continuous improvement is adopted and applied to safety and there is a lot of emphasis on management style, communication, training, etc.

The table 1 shows an example of a set of layers that might be expected within an organization rules-based. This illustrates how basic underlying assumptions can influence artefacts (i.e. the climate) and the difference of perceptibility between these layers.

Table 1 Example of layers for a rules-based organization

Schein's layers	Rules-based stage
Artefacts	Numerous rules for safety compliance
Espoused values	Zero tolerance for safety deficiencies
Basic assumptions	[Management thinks] People are undisciplined and self-interested; they cause accidents.

In the context of this project, this model is particularly interesting to illustrate the depth of safety culture and the perceptions problematic regarding the different facets of this constructs. However, this model incorporates numerous sociological notions and concepts that are difficult to assimilate for unexperienced people.

2.2.2 Reciprocal culture model

This model describes the interactions between factors that shape culture and is based on behaviour theory. Several scholars developed this model, Bandura used it to explain behaviour and Cooper applied it to provoke change of behaviour (Cole K. S., 2013).

Three factors can be distinguished, even if the terminology might change depending on the author:

- The person: it includes all psychological aspects and the individual perceptions (=climate).
- The behaviour: it refers to the attitudes of people within the organization.
- The environment: it is related to the context the organization is going through.

The figure 3 represents the different interactions between each of these factors. It is important to notice that although interactions are reciprocal, they are not meant to be equal but vary on time and circumstances.

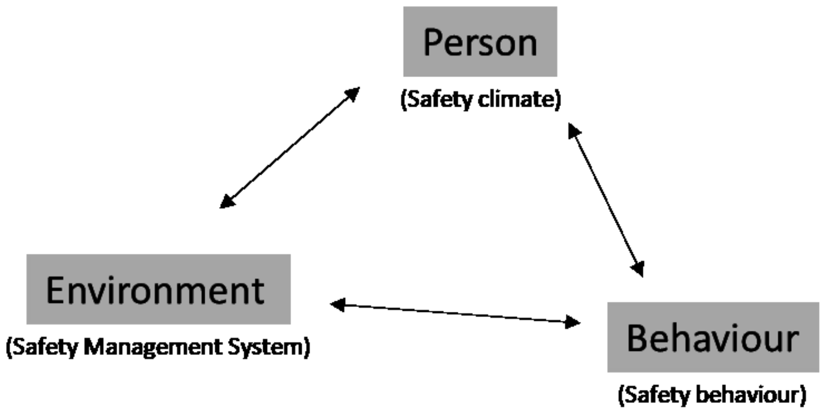


Figure 3 Schematic representation of reciprocal culture model

As an example, we can represent the system as a schoolchild misbehaving at school. His misbehaving (behaviour related) influences the teachers and schoolmates (the environment) which will apply constraints on this schoolboy (punishment, bad grades, etc.). These constraints will influence the schoolboy's perceptions of school (person/individual). These perceptions, probably negative, will influence the boy's behaviour.

This example illustrates the factors of the model but does not includes reciprocity of interactions.

It is important to note that, despite its psychological aspect, this model has been largely concretely applied, as 56% of publications are related to Applied Health Psychology (addiction, prevention, etc.), 20% to Education, 16% to Business and only 2% to pure psychology according to an unofficial November 2013 Google Scholar search. (Social Cognitive Theory, 2017)

Regarding safety aspects, we can assimilate the psychological factor (person) to the safety climate, which can be assessed through surveys. Environment refers to the safety management system, assessed with external audits. Behaviour is directly the safety behaviour (R. M. Choudry, 2007).

This model is presented to exhibit the different factors responsible for the evolution of safety culture and their interactions. Yet, this model also necessitates a strong background in human sciences, particularly psychology.

2.2.3 Reason model

2.2.3.1 Westrum's model

Reason's model is based on a model developed by Westrum in 1984 that assesses the range of interest of organizational culture (personal interest, department interest, global interest) regarding information flow and leadership (Fleming, 2006).

Westrum defined these three level, as "Pathological", "Bureaucratic" and "Generative". Table 2 shows the different considerations of information according to the level of organizational culture as an example. This can be generalized for several dimensions of culture (responsibility, reaction to failure, etc.)

Table 2 Example : Information considerations according to Parker, 2006

Westrum's level	Pathological	Bureaucratic	Generative
Information is...	Hidden	Ignored (if not interesting)	sought

2.2.3.2 Reason's model

In 1993 Reason adapted Westrum's model by including two typologies, reactive and proactive, in order to able users of the model to do an in depth assessment (Parker D., 2006). According to Parker, the five typologies can be condensed with the following statements:

Pathological: Who cares about safety as long we don't get caught?

Reactive: Safety is important; we do a lot every time we have an accident.

Calculative: We have systems in place to manage all hazards.

Proactive: We try to anticipate safety problems before they arise.

Generative: HSE is how we do business round here.

These typologies reflect the maturity of safety culture within an organization, pathological and generative being respectively the less and the more mature typology.

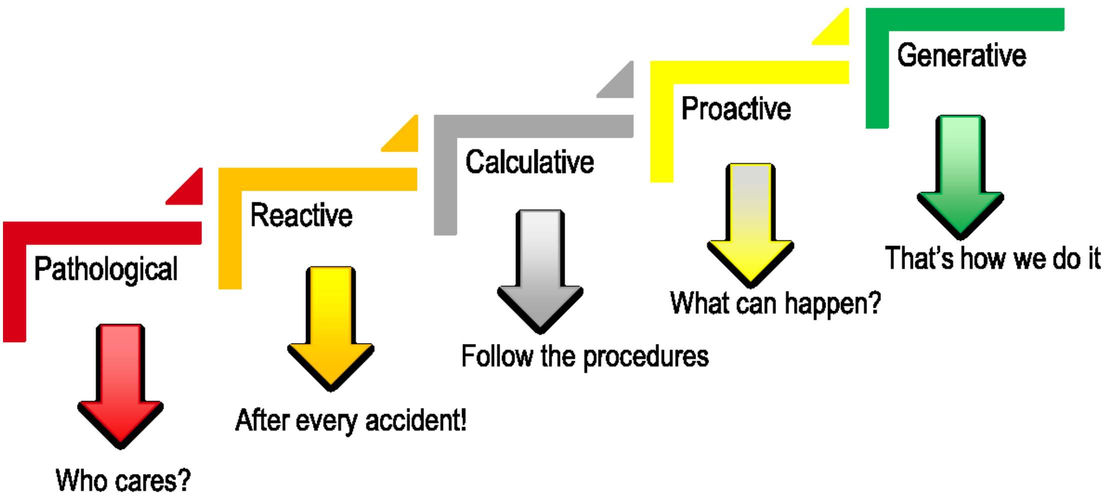


Figure 4 Safety Culture Maturity Model according to Reason

2.2.3.3 Parker's framework

Based on the safety culture maturity model of reason, Parker, Lawrie and Hudson developed a framework of several dimensions characterized for each level in oil and gas industries. They conducted interviews of executives of different companies to investigate eleven concrete and seven abstract dimensions of safety culture which are described for every level (Fleming, 2006). This framework is available in appendix A .

This framework is included in the "Hearts and Minds Program" (H&M) developed by Shell to provide solution to improve safety culture (Energy Institute, 2017). It is the basis of the "Understanding your culture" brochure, one of the tool provided in this kit.

This model is well documented and several tools have already been developed, facilitating its implementation and use. The proposed scale is also quite clear and terminology do not require particular theoretical background.

2.2.4 DuPont Bradley Curve

In the 90's, DuPont committee board wanted to investigate the differences of safety performance between their plants and performed on-site investigations all around the world. Firstly, they claim they demonstrated the correlation between safety, productivity and profitability (DuPont, 2015).

Secondly, they developed a model of safety culture known as the DuPont Bradley curve. This curve illustrates a decrease of accident rate when reaching a high level of safety culture (Figure 5). The thoughts behind the curve is the direct influence of leadership on workers' commitment to safety through values, attitudes and beliefs.

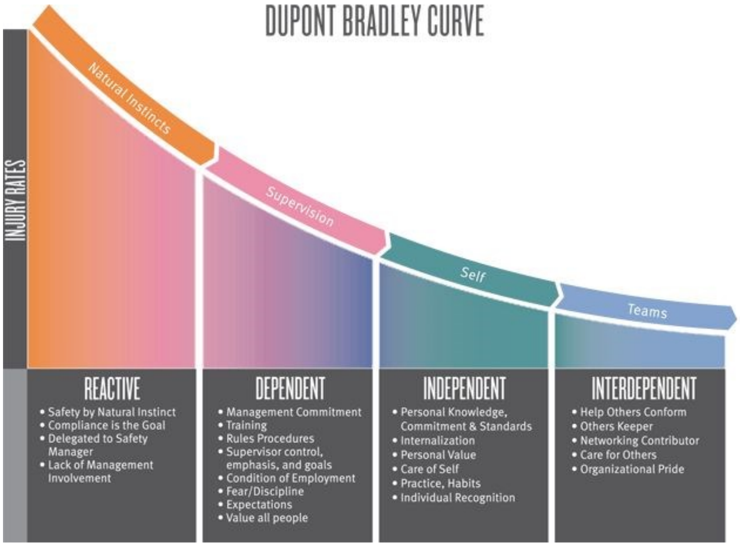


Figure 5 DuPont Bradley Curve (DuPont, 2015)

The curve presents four typologies:

<u>Reactive</u>: Compliance to laws and regulations is the goal.

<u>Dependent</u>: Safety is enforced through supervisor control.

<u>Independent</u>: Personal value and care-of-self ensure safety for the individual.

<u>Interdependent</u>: Safety concerns the whole team and is an organizational pride.

This model is presented due to its notoriety and reputation. The typologies are quite clear and understandable, but the documentation about theory and scientific approach is extremely poor ("black-box" model). This lack of documentation will be the main reason for the dismiss of this model.

2.2.5 Safety Culture by Daniellou, Simard and Boissières

The "Fondation pour une Culture de Sécurité Industrielle" (FONCSI) is a French foundation with the goal of helping industrial companies to improve safety. It has financed a project on the human and organizational factors of industrial safety. Safety culture takes an important part of this work and the point of view of the authors is briefly presented here. (FonCSI, 2010)

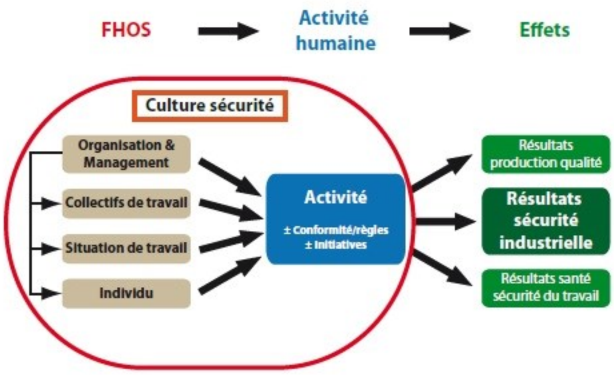


Figure 6 Safety culture and effects according to Daniellou, Simard and Boissières (FONCSI, 2010)

The authors described the safety culture as “the set of developed and rehearsed practices by major concerned stakeholders to manage risks of their profession”. The focus is on the identification of the conditions of positive contribution of operators and collectives to safety.

The authors consider two groups which are mainly concerned by safety: the management and the employees.

Considering these two main stakeholders and the fact that safety culture is built by collective, the authors assess safety culture within four typologies, reflecting the respective involvement of both the Management and the Employees.

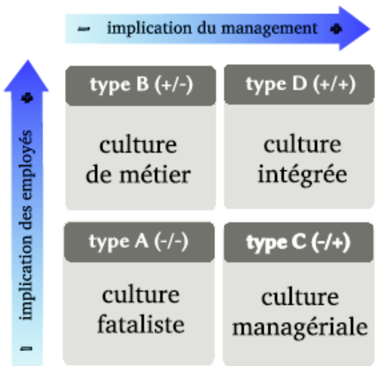


Figure 7 Safety Culture typologies according to Daniellou, Simard and Boissières (FONCSI, 2010)

<u>Fatalistic culture</u>: In this typology, both the employees and management are poorly concerned by safety issues and think “accidents happen”. People then tend to do nothing to avoid accidents as they will happen anyway.

<u>Job culture</u>: This typology concerns a strong involvement of employees but not of management. It reflects a culture in which employees developed techniques to work safely on their own. These practices are generally informal and orally transmitted to new workers.

Managerial culture: This culture appears when management are strongly involved in prevention of accidents through rules and norms. Employees' responsibility is then limited to the strict applications of recommendations and rules regarding safety.

Integrated culture: In this typology both employees and management are involved. Management's leadership is directive (top-to-bottom approach) and emphasize the importance of safety. However, employees have an important role as they bring their knowledge of terrain and are listened by management as valuable contributors to safety (participative leadership, bottom-to-top approach).

This model is particularly interesting for its "2D-approach" for the evaluation of safety culture. As discussed earlier, leadership is one of the most important factor to foster safety culture development, but academia organization regarding leadership is quite complicated. The concept of a job culture could provide reflection track to slightly diminish importance of leadership (without neglecting it!).

2.2.6 EPFL application – choice of a model

Several existing models have been presented and discussed. As they all differ regarding their considerations and approaches, it is important to select the one that might apply as efficiently and easily to EPFL organization as possible. The scoring board below presents the relative strengths and weaknesses of these models regarding different criteria.

Table 3 Scoring board comparing of the different safety culture model for application in academia

	IAEA	Reciprocal	Reason	DuPont Bradley	Daniellou
Easy to use	++	-	++	-	+
Documentation	++	-	+	-	+
Influence of leadership	--	+	--	-	++
Identification of problems	+	++	++	+	--
Total score	**3**	1	**3**	-2	2

Easy to use: This concerns the theoretical needed to understand and communicate this model through EPFL community. For instance, it might be inconvenient to make EPFL community adopt a too complex model.

Documentation: The available information of the models is assessed, ad it is important to have as many information as possible to apply correctly the provided tools and to understand them.

Influence of leadership: as discussed, leadership is a main aspect of safety culture. However, the "fiefdoms" organization in academia, as discussed above, is a strong barrier to effective leadership regarding safety by a centralized service of EPFL. We look here at the importance given to other factors as discussed in the Daniellou model's part.

Identification of problems: The aim of this work is to provide information of safety culture within the laboratories of EPFL, but also to provide the tools, or at least identification of improvement opportunities. Here is assessed the identification of problems provided by the models and the tools given (or not) to correct them.

According to the four criteria of the score board, it appears that both IAEA and Reason's models can be suitable to EPFL organization. However, IAEA model includes three stages and evolution between these stages can take an important time. Thus I chose Reason's model as it seemed important to have a model that display a relatively quick evolution to avoid discouraging the concerned workers.

3 Method

It has been decided to assess safety climate within EPFL academic laboratories as the initial step of safety culture improvement. Regarding the corresponding literature, it is accepted that safety climate can be assessed through surveys. This method allows to gather a lot of data with a reasonable workload and short time.

3.1 Objectives

The following objectives have been expressed:

- The survey should determine if the chosen model is suitable for an application at EFPL.
- The survey should provide an overview of safety climate of the academic research units of EPFL.
- The survey should identify strengths and improvement opportunities.

3.2 Model

According to the scoring board in the previous part the model of Reason is chosen as the evaluation scale, and Parker's framework will be used as a basis to develop the survey.

The "Hearts & Minds Toolkit – Understanding your culture" brochure, based on the same model, suggests to select relevant dimensions (approx. 9) regarding the activities of the target audience and the supervision/management aspects. In this case as the objectives are addressed to workforce level, the selection will be based on the perceptions of the lab-workers, it means they need to be involved in the corresponding processes. Detailed are provided in part 3.3.3.1. "Applicable dimensions' identification".

This toolkit also has been recognized as having a pragmatic approach of culture assessment (L. Eckelaert, 2011) and focuses on the evolution rather than descriptive anthropological or psychological aspects. Thus it is expected to provide a good support for safety culture improvement at EPFL regarding a long-term approach.

3.3 Method of data collection

Several methods have been discussed in order to find the better compromise between the number of respondents, the scientific validity and reliability. It is also important to be able to collect valuable information to provide information to the SCC.

- Number of respondents: Many surveys are distributed to EPFL community, especially near the end of the semester. Moreover, contrary to several companies, survey completion will not be accounted as work-time, so the survey need to be as short and fast to complete as possible.
- Scientific validity and reliability: It is universally recognized that surveys are very sensitive to personal interpretation and subjective bias (International Atomic Energy Agency, 2002, pp. 22-39). Therefore, it has been decided to adapt an existing and reviewed safety climate assessment tool rather than to create entirely a survey which might be quite questionable.
- Valuable information: Despite the information about the applicability of the model and safety climate, it is expected to get situational analysis through this survey (for instance, does people systematically report accident?). This should provide reflection path for the Safety Competence Center to fulfill their mission regarding the safety at EPFL.

3.3.1 Dismissed method

This part focus on the methods that have been considered to develop the survey but were rejected.

3.3.1.1 Likert scale

Likert scale is very common in surveys. Such surveys ask the respondents to indicate their agreement level to sentences, generally on a five or seven points scale as presented below.

Table 4 Example of Likert-scale with five points and non-forced choice

Strongly disagree	/	Disagree	/	Neither agree or disagree	/	Agree	/	Strongly agree

Regarding the IAEA recommendations (International Atomic Energy Agency, 2002, pp. 37-38), it was planned to develop at least four questions by dimensions to ensure good coverage of the dimension.

This method provides a simple and quick survey, but we noticed that assessment of safety climate regarding Reason's model would be complicated as it was nearly impossible to state questions for which each of the five Likert point will correspond to one of the five typology of the model.

For instance, the dimension "accident and incident reporting, investigation and analysis" could not be assessed through a Likert-type question as the three best typologies (calculative, proactive and generative) include a systematic reporting of accidents. Thus it is impossible to differentiate these three typologies if a respondent strongly agrees with "I report systematically accidents".

It has been proposed to develop several questions in order to match every typology with a certain pattern of answer, but this seemed very empirical and we preferred to apply a validated method. Thus, this method was dismissed.

About thirty questions have been developed regarding the selected dimensions of Parker's framework, they are presented in appendix B for informational purpose and potential future use.

3.3.1.2 Simple sentence selection

Following the conclusions of the Likert-scale questionnaire, a second method was developed to apply more faithfully "H&M" method.

It was proposed to have respondents choosing, for each dimension, the typology's description that suit the best his perceptions of safety within his laboratory.

In order to keep a quickly filled survey, the descriptions of the typologies have been summarized in short and simple sentences. This summary is available in appendix C.

However, it has been noticed that we might lose some of core information of the original framework and this method was dismissed for the benefit of the one presented below.

3.3.2 Chosen Method

Finally, it was decided to apply the "Hearts and Minds Toolkit – Understanding your culture" scoring sheet based on Parker's framework. As for the previous dismissed method, respondents will have to choose the most suitable typology for each dimension, but in this case the descriptions will not be simplified. Also in "H&M" program, respondents have to choose the description representing their perceptions knowing the related typology (pathological, reactive, etc.). In this case these would not be displayed to avoid positive or negative bias[1].

Unfortunately, this method seems quite time-consuming and it is expected to have less respondents willing to fulfill the survey, over it is assumed the answers will be more reliable.

Also, to improve understanding of lab-workers, the framework has to be adapted to fit the terminology and structure of EPFL. This adaptation is presented in part 3.3.3.2 "Adaptation of selected dimensions for EPFL application".

3.3.3 Parker's Framework and Hearts and Minds Program

Parker and al. developed a framework regarding organizational safety culture by interviewing senior oil and gas company executives. This framework includes the key features of safety identified in literature (Parker D., 2006) distributed between two categories : concrete and abstract organizational aspects.

These features, or dimensions, have been described by the interviewees at each of the five levels of Reason's model.

Shell's Hearts and Minds program, which is intended to help organizations to improve their HSE performance (Energy Institute, 2017), used this framework to develop part of a toolkit to understand safety culture within a company.

The first part of this toolkit is the understanding of its own safety culture (following parts will not be discussed as they treat about safety culture improvement). This program proposes to evaluate its safety culture regarding the developed framework during group discussion. Basically, a score sheet has to be filled during the group discussion to assess the level of the company for each applicable dimension. The average HSE Culture Score is the weighted mean, assuming the weights of the levels increasing from one (pathological) to five (generative).

The term applicable has its own importance as its exhibits the fact that all dimensions of the framework are not necessary relevant depending on the company and the organizational level of the respondents group. The first step to adapt the framework to EPFL organization will then be to identify the applicable dimension depending on the target audience.

The framework also has been developed with oil and gas company executive only. Thus it is admitted that the given descriptions are specific to industrial organizations, in particular to oil and gas industries. The second step will be to adapt the framework regarding the EPFL organization (hierarchy, terminology, accountability, etc.)

3.3.3.1 Applicable dimensions identification

The following part summarizes the criteria that resulted in the selection of eight dimensions and the creation of a supplementary dimension. The selected dimensions are displayed first with a short

[1] Tendency to provide "socially acceptable answers" which do not reflect the truth, (International Atomic Energy Agency, 2002)

description and the reasons it appears they are relevant. Omitted dimensions are listed below in the same manner.

Reminder: the target audience is the lab-workers mainly working in a laboratory at EPFL (which are mainly PhD students).

<u>**Selected dimensions**</u>

This part presents only the selection of appropriate dimensions.

- **Incident and accident reporting, investigation and analysis:**

This dimension relates to the obligation to report every incident to the Safety Competence Center (SCC) and the investigation's depth following the report.

Lab-workers are concerned with this dimension as workers are supposed to report themselves the incident (to their manager or SCC directly). Investigation and analysis aspects are assessed too to evaluate the perceptions that lab-workers have of the analysis performed by SCC.

- **Work planning including Permit-to-Work, Journey management:**

Permits-to-Work are a systematic hazard analysis performed before working, thus this dimension is about safety consideration as well in planning establishment and overall planning.

Lab-workers spend more of their time performing experiments so it is assumed they will feel concerned with this dimension and the involvement of their professor within the process, i.e., are the good questions asked regarding safety?

- **Competency/training – Are Workers interested?**

Continuous improvement goes through acquiring new skills, safety skills included. This dimension looks at the training process and the willingness of the workers to follow safety training.

Basic safety training is mandatory at EPFL to work in a laboratory so lab-workers are forced to be concerned with this aspect. Further training sessions are proposed to so the interest of respondents to non-mandatory training sessions will be assessed to.

- **Who checks safety on a day-to-day basis?**

This dimension assesses who checks safety and the consideration given to the safety within the unit.

This dimension will help assessing if lab-workers tend to be involved in safety surveillance process or if they tend to let the "person in charge" take care of safety alone.

Safety coordinators (CoSec) involvement has been considered in this dimension but it has been decided to avoid the maximum of modifications of the original framework. Thus a new dimension was created to evaluate CoSecs' position and influence.

- **Who causes the accident in the eyes of professors?**

The reaction of the management regarding the workforce is important. It is assumed that in a strong safety culture people knows accidents are a chain of events and rarely the consequences of one unique mistake. Root causes need to be identified at the organizational level to ensure improvement and adequate corrective measures.

Obviously, to fully assess this dimension involvement of professors is necessary. Thus, in this work one is interested by the perceptions of the workforce and the underlying question is “According to your personal opinion, where are root causes of accidents in the eyes of your professor?”.

- **How do safety meetings feel?**

This dimension concerns the present atmosphere during safety discussions and their purpose (blaming, reminder of rules, anticipation of problems, etc.). For instance, a pathological safety culture will be reflected by conflicts and unwillingness to participate to safety discussions, whereas in a generative safety culture, discussions will be more spontaneous (called by anyone) and tend to anticipate problem before they arise.

This dimension will be included in the survey to assess the feeling of lab-workers about safety discussions. Contrarily to most industries, there is no meetings fully dedicated to safety at EPFL and it is assumed that safety would be addressed in group meetings, if addressed.

- **Balance between HSE and profitability**

This dimension assesses the relative priority between safety and operations. According to the framework, a pathological organization will focus on profitability and consider safety as a loss of money only. A generative organization will consider that a good safety performance is a prerequisite to profitability. DuPont claim they demonstrated the correlation between safety and profitability and used it as a basis for the development of their own model (DuPont, 2015).

At EPFL, profitability is replaced by research performance but the idea remains. We want to know if lab-workers are willing to stop an experiment, risking the loss of an expensive product, for instance if safety appears to be compromised.

- **Commitment level of workforce and level of care for colleagues?**

The point of interest is the perimeter of safety considerations in people’s mind. Is safety just a way to avoid being reprimanded? Or is it driven by personal interest and survival instinct? Is it an issue that concerns the group as everyone is aware of its responsibility regarding the laboratory?

It seems appropriate to include this dimension in the survey as laboratories are shared workplace gathering several persons. This seems important to evaluate this as laboratories are often crowded places.

- **Position and influence of CoSecs?**

This dimension is not included in Parker framework but was created to evaluate the perceptions of safety coordinators nominated in every EPFL research unit. The expected behaviors corresponding to the level of maturity have been defined regarding the mission of safety coordinators and the tendencies of other dimensions.

The detailed description of this dimension is given in the below part regarding the adaptation of the framework for EPFL application.

Dismissed dimensions

This part presents the justification of the dismissing of remaining dimensions.

- **Benchmarking, Trend and Statistics**

It is assumed this dimension would professor responsibility and probably not perceptible by lab-workers.

- **Audits and reviews**

This process involves the professor, the CoSec and the SCC. Lab-workers' involvement is reduced.

- **Hazard and unsafe acts reports**

We supposed this dimension very close to incidents and accidents reporting and lab-workers may not clearly distinguish unsafe acts and incidents.

- **Contractor management**

The infrastructure department (DII) is a main stakeholder as it coordinates requests for works and they may have no interactions with lab-workers.

- **Work-site job safety techniques**

Due to the heterogeneous activities within academic institutions, it is assumed that hazard analysis would require tremendous workforce (J-L. Marendaz, 2013). Thus, this dimension might be assessed, taking in account the method of hazard identification developed at EPFL (Marendaz, Friedrich, & Meyer, 2011).

- **What is the size/status of HSE department**?

This dimension assessment should be performed through external audit of SCC.

- **What are the rewards of good safety performance?**

It seemed unclear if this dimension should apply at the laboratory level or individual level. The former would be assessed through external audit, the latter seemed to be barely widespread within EPFL.

- **What happens after an accident? If the feedback loop closed?**

This dimension assessment should be performed through external audit of SCC.

- **Is management interested in communicating HSE issues with the workforce?**

This dimension could be assessed through external of SCC and/or with personal interviews of professors to discuss the interest and motivations of HSE communication.

- **What is the purpose of procedures?**

This dimension assessment should be performed through external audit of SCC.

3.3.3.2 Adaptation of selected dimensions for EPFL application

Parker's framework has been developed in oil and gas industry and therefore the organizational considerations are very specific and may be inapplicable to an academic institution.

Moreover, most of laboratory members probably never worked in industry, especially PhD students that generally begin their thesis shortly after their graduation. Terminology has to be adapted to correspond to the usual terms to ensure a good understanding of statements.

As discussed above, major differences between academia and industry lie in the hierarchical organization and the goal. Terminology can also be a source of misunderstanding between these two environments.

The dimensions have been adapted according to these assumptions and are presented below.

In order to simplify the reading, the systematic changes have been listed.

<u>Systematic changes</u>

Table 5 summarizes the systematic changes that have been made to the framework to correspond to EPFL organization.

Table 5 Systematic terminology changes of Parker's framework

Parker's Framework	EPFL adaptation
Management/Supervision	Professor
Workforce/Worker/Employee	Lab-worker
HSE	Safety
Company[2]	Laboratory

<u>Management/Supervision</u>: The clear top-to-bottom path of leadership and responsibility in industrial companies ensure that the management of a unit is accountable of both safety and production. At EPFL this top-to-bottom leadership does not exist and the term professor was chosen to represent the person in charge of a unit to avoid a misunderstanding between the professor's and the Safety Competence Center's responsibility.

<u>Workforce/Worker/Employee</u>: The terms lab-worker was preferred to emphasize the audience targeting on people who mainly manipulate in a laboratory. As the term workforce referred to the operational level, it seemed important to clarify that the decisional and strategic levels (Professor and Head of Institutes) were not concerned.

<u>HSE</u>: As this acronym is never used at EPFL, we doubted that everyone would know what it referred to.

<u>Company</u>: As discussed earlier, culture (and therefore climate) is a construct common to a group of people, often discussed at the company level. At EPFL, each research unit can be seen as a distinct

[2] This change is exceptionally different in the dimension "How do safety meetings feel?", in the proactive typology.

company in the meaning that this unit has its own goals and objectives. In the same way that different companies may share an industrial plant with several common rules regarding common process (safety, energy, waste management, etc.), EPFL infrastructure is shared between laboratories and research units. Yet it is expected that culture would develop within a research unit.

<u>Specific changes</u>

This part summarizes the adaptation of each dimension to be as close as possible of EPFL organization. Systematic changes and unaltered dimensions are not mentioned.

- **Incident and accident reporting, investigation and analysis:**

The only punctual change occurs in the description of proactive behaviour. It stipulates reports are sent *companywide*, referring to department having different activities than the one declaring the incident. At EPFL as activities vary from a laboratory to another the term companywide has been replaced by *whole EPFL campus.*

- **Work planning including Permit-to-Work, Journey management:**

As this dimension refers to the safety considerations in operational business, it has been renamed *Experiment planning, safety, Lab-management* as laboratory manipulations and experiments are the operational business. The term permit-to-Work in the calculative description has been dismissed as this practice is not applied at EPFL.

- **Who checks safety on a day-to-day basis?**

In reactive description, external inspectors are replaced by Safety Competence Center as this is the service in charge of laboratory audits and the point of contact for safety matter.

In calculative description the sites have been replaced by laboratories as the perceptions of lab-workers are relevant within their laboratory.

In proactive description, the stakeholders of cross-audits have been listed with professors replacing the managers and supervisors. Cosecs and lab-workers are added, the former due to their position in term of safety coordination, the latter for their importance in laboratory activities.

- **How do safety meetings feel?**

It has been assumed that no unit has meeting specifically oriented to safety but would prefer to integrate safety within existing group meeting. Thus the dimension was modified as “Importance of safety in group meeting?”.

In the proactive typology of Parker’s framework, these meetings are described as “genuine forum for interaction across the company”. Exceptionally the term “company” has been changed to “laboratory” as group meeting are limited to unit research members and it seemed utopic to expect safety to be discussed across units on a regular basis.

- **Balance between HSE and profitability**

It is considered that profitability is not the main concern of a laboratory in terms of money, but the importance is rather placed in research performance (publications, patents, etc.). This dimension is changed regarding this consideration.

A time-related behavior is added to the pathological typology to diminishes the focus on money on the original framework. Also it seemed coherent to add this consideration as certain experiment might take a long time to be performed and the thought "If I stop now I lose my whole week of work" might appear.

- **Position and influence of CoSecs?**

This new dimension has been described in order to assess the perception that lab-workers have of the position and role of CoSecs within their unit. Efforts were made to be as consistent as possible for each level and to represent as faithfully as possible the tendency of the original framework.

Pathological: For this level it was assumed that the members of the laboratory would not see the purpose of having a safety coordinator except fulfilling EPFL policy.

Reactive: In a reactive laboratory, CoSec will have importance once a problem occurred and will be expected to help find corrective measure.

Calculative: Cosec will be in charge of ensuring the laboratory "follows the rules" as this typology is driven by the trust in the system as a protection.

Proactive: Laboratories with proactive behavior will tend to use Cosec's training and skills to anticipate problems and find preventive measures.

Generative: As every member of a generative laboratory will participate to safety tasks, the Cosec will be "only" the interface between the unit and the Safety Competence Center and might give a technical support if needed.

The complete adapted framework is available in appendix D.

3.4 Technical construction of survey

This part summarizes the special considerations factored in. These considerations aimed at compliance to IAEA recommendations, practical aspects and data treatment.

<u>Support</u>

For practical reasons for diffusing and collecting data, a web tool designed for surveys has been chosen. This platform ensured confidentiality regarding EPFL policy as it belongs to EPFL web domain. It also permitted to limit access to EPFL mail address owners and allowing them to answer only once.

<u>Dimensions sequencing</u>

In order to facilitate the concentration of the respondents and prevent them to interrupt the completion of the survey, the sequence of the dimensions was considered important. We imagined the path of a new arrival in a lab, with emphasize of the methods of work in the first place, following by the integration of the new-member in the lab, and then the reaction to accidents. This story-telling approach is expected to keep the attention of the respondent to his maximum and therefore increasing validity of the answers.

<u>Typologies ranking</u>

IAEA mentions the fact that employees "may be keen to give the "right" answer" and "will instinctively seek what they believe to be the "socially acceptable" response" (International Atomic Energy Agency, 2002). In order to limit this, we will randomly rank the question for each dimension. However, the order will remain identical for every respondent, allowing possible to analyze data for “speeding”, i.e. people who answers without actually reading the questions (checking every time the first box for instance).

The questionnaire is displayed in appendix H.

4 Results

Before publishing the survey, a pilot phase was conducted in order to get previous feedback on the survey and preliminary remarks. The volunteers were also asked to give their opinion about the survey in order to improve it before running it at school level.

The pilot phase was first performed within the Safety Competence Center and external HSE managers in industry. During the second part of pilot phase, the survey was diffused within willing research units. The units were asked to fulfill the survey, and, if relevant, a feedback of the results were proposed to the units to discuss their answers.

4.1 Pilot phase

4.1.1 Specialists feedback[3]

The main feedback concerned the length of the sentences to be selected. Most of the respondents emphasized that long sentences might be daunting and it may discourage people from answering.

Several uncertainties have been discussed concerning some dimensions, in particular the one concerning the incident and accident reporting. The relevance of a daily access to reported accidents was questioned, as well as the definition of an accident within academic organization which seemed to be quite unclear and not universal.

It was also noticed that the distinction between some descriptions was tenuous and it might be difficult for non-HSE specialists to understand these differences. However, it was decided to preserved these tenuous differences.

A particular attention will be given to the communication and the contextual explanations about the purposes of the survey and to insist and the importance for respondents to inquire their own perception rather than an estimation of overall perceptions of lab-members.

4.1.2 Research units' feedback

Six professors accepted to diffuse the pilot survey within their unit. It was expected to reach a higher participation rate with a direct support of the professor in charge of the unit to assess validity of the survey. This is summarized in table 6.

Table 6 Participation rates of research units of pilot phase

Sample	Participation rate
Labo-1	17 %
Labo-2	29 %
Labo-3	40 %
Labo-4	17 %
Labo-5	0 %
Labo-6	10 %

Feedback session and discussion were not proposed to research units 1,2,5 and 6 due to the low participation rate or non-significant number of answers (labo-2). Due to a lack of time and interest, the feedback of labo-4 was not planned.

[3] Based on email discussions. Available upon request.

A meeting with Labo-3 was planned to present the result of the unit and discuss it. A presentation of the theoretical background was displayed before the presentation of the results (see Appendix E). Lab-members had the opportunity to intervene and react to the results. A summary of the meeting was sent to the professor.

The results of the lab are presented below. The professor's answers were segregated from the answers of lab-workers. The maturity of safety climate was determined as the mode of the data values for each assessed dimension. These values are indicative and not statistically relevant due to the low sample's population.

Table 7 Results of Labo-3 for each dimensions in percent (N=7)

	Pathological	Reactive	Calculative	Proactive	Generative	Labo.	Prof.
Planning	14.3%	14.3%	28.6%	0.0%	42.9%	Generative	Calculative
Balance	0.0%	0.0%	42.9%	0.0%	57.1%	Generative	Proactive
Training	71.4%	14.3%	14.3%	0.0%	0.0%	Pathological	Generative
Safety discussions	14.3%	0.0%	0.0%	0.0%	85.7%	Generative	Proactive
Who checks safety	42.9%	0.0%	14.3%	14.3%	28.6%	Pathological	Calculative
Commitment for colleagues	0.0%	42.9%	0.0%	0.0%	57.1%	Generative	Generative
Who causes accidents	0.0%	0.0%	28.6%	14.3%	57.1%	Generative	Proactive
Accidents reporting	42.9%	28.6%	0.0%	14.3%	14.3%	Pathological	Calculative
CoSecs	28.6%	14.3%	14.3%	28.6%	14.3%	N/A	Calculative

The following issues were identified during the discussion:

- Lack of context, resulting in misleading questions (ex. About individual responsibility regarding safety),
- Some typologies, for certain dimensions, were not mutually exclusive and a ranking system might be needed rather than only checking one answer,[4]
- Some questions may not make full sense in an academic environment.

Due to the short schedule for this project, the survey was diffused to EPFL community before the discussion, therefore these issues were not corrected and will be subject to recommendations in corresponding part below for further investigations.

It was highlighted that generally the respondents were not able to hierarchize the answers, i.e. determining which is the "best" or the "worst" answer, avoiding therefore a bias.

We observed that this laboratory predominantly adopted a generative behavior (5/9 dimensions) regarding the assessed dimensions. As the responsible professor of this unit exhibited a strong interest

[4] For instance, in the dimension Competence/Training, the pathological typology is to considered safety training as a necessary evil. Due to interpretation issues, it appeared that people might want to answer this one as there is mandatory safety training at EPFL. Thus in their minds it not necessarily excludes other typologies.

and motivation to participate to this experiment, it is not surprising that this laboratory exhibits a strong safety climate. This corroborates the idea that leadership highly influences safety culture.

The three dimensions evaluated as pathological were safety accounting, accidents reporting and training. These scattered dimensions and their original formulation's relevance in academic context could be questioned. Adaptation of the typologies should then be further adapted.

Moreover, the dimension "Position and influence of CoSecs" displays no obvious tendency. As this is a new dimension specifically created for this survey, we can suppose that the described typologies are not as relevant and consistent as the original's framework.

4.2 Second phase

The survey was diffused to EPFL community via e-mail. An email was sent to institutes to reach a maximum of lab-workers such as PhD students, technician, professor, scientific collaborator, administrative assistant, etc. The first message was sent on November 29th and a reminder was sent on January 4th. Institutes in which laboratory-work was supposed negligible were not concerned (Architecture, mathematics, informatics, communication system, etc.)

A total of 4324 persons received the email. The survey was provided in both English and French.

As no significant changes in the survey occurred after the pilot phase within laboratories, the corresponding answers were integrated to the global results of the survey. Pilot answers from the SCC and external specialists were not integrated.

4.2.1 Summary

The tables below summarize the collected data of the survey.

Two answers have been deleted of the results due to invalidity (one duplicate entry and one respondent stipulated that he answered randomly for one question).

Table 8 Repartition of respondents regarding the source of data collection

Source	Pop. [-]
Pilot phase answers	18
English version answers	48
French version answers	19
Total answers	85
Participation rate	2.0%

The participation rate is computed regarding the number of persons who received the email, the PhD students, professors, technician, administrative assistant, etc. Repartition of the respondents regarding schools is given in table 9.

Table 9 Repartition of respondents regarding their School

School	Pop. [-]
SB	33
SV	12
STI	28
ENAC	11
IC	1
Others	0

Table 10 Repartition of respondents regarding their role

Roles	Pop. [-]
PhD Students	38
Postdoc	10
Professor	5
Technician	9
Other	23

The category "other" gathers master thesis students, interns, scientific collaborators, engineers and roles that was not proposed in the survey. Also three participants of the pilot phase have not informed about their roles due to a configuration issue of the survey at the time.

Table 11 Repartition of respondents regarding their occupation within a laboratory

"Is laboratory-work your main occupation?"	Pop. [-]
Yes	62
No	20

The same three participants of the pilot phase could not answer this question for the same reason.

The three tables (9 to 11) above will be used to display results according to different criteria.

Are you working in an academic laboratory at EPFL?	Pop. [-]
Yes	84
No	1

Table 12 Repartition of respondents concerning link to an academic laboratory of EPFL

This table is used as a systematic criterion; every person answering "No" will be excluded of the results.

Several sets of criteria will be used to aggregate information at different level and for different population. These sets are described in table 13 below.

Table 13 Sets of criteria

	Main Occupation	School	Roles
Set 1	Yes	All	All
Set 2	Y&N	All	PhD students
Set 3	Y&N	SB	All
Set 4	Y&N	SV	All
Set 5	Y&N	STI	All
Set 6	Y&N	ENAC	All
Set 7	Y&N	All	All

4.2.2 Assessment of dimensions

The results of the respondents who stated that they work in laboratories as their main occupation (set of criteria 1) are presented. This includes a major part of PhD students, but also the technicians, Postdoc, interns, etc.

The results are displayed below for each dimension. They are summarized in a scoring table as well as the indicative HSE Score as defined in the "Hearts and Minds toolkit – Understanding your culture" brochure.

It is important to remind that people who responded to the survey were all willing to. Therefore, we can assume they have an interest in safety so they might positively skew the results.

<u>Experiment Planning, Safety, lab-management</u>

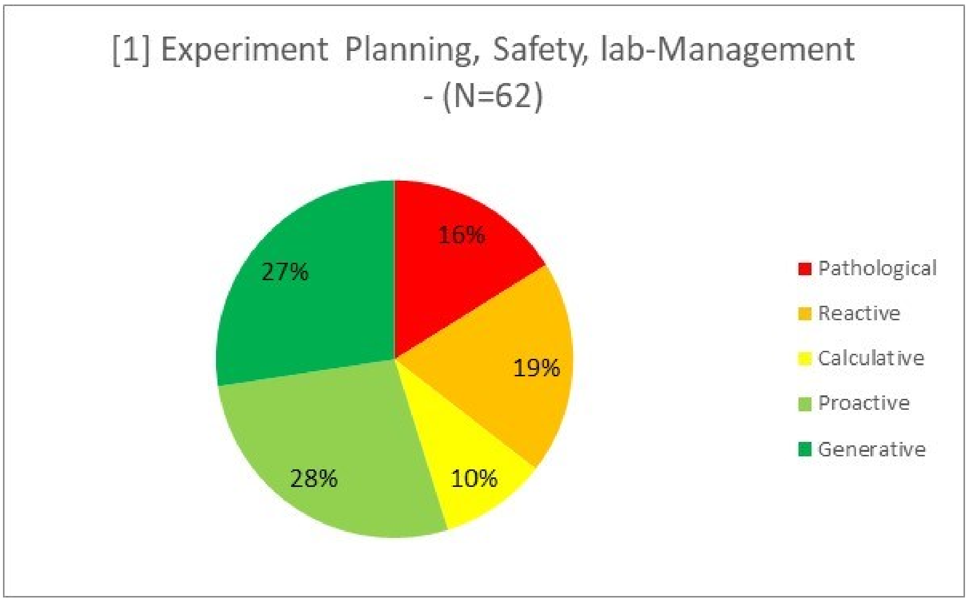


Figure 8 Repartition of typologies for dimension 1 within lab-workers

Regarding this result, we can assume that a majority of respondents (55%) grants importance to the planning of their experimentations and includes safety considerations into it (proactive and generative typologies).

35% of respondents (pathological and reactive) indicated they focus on the execution of their experimentations, probably to fulfil professor requirements regarding the volume of data, and only time is considered (if considered!).

Balance between safety and research performance

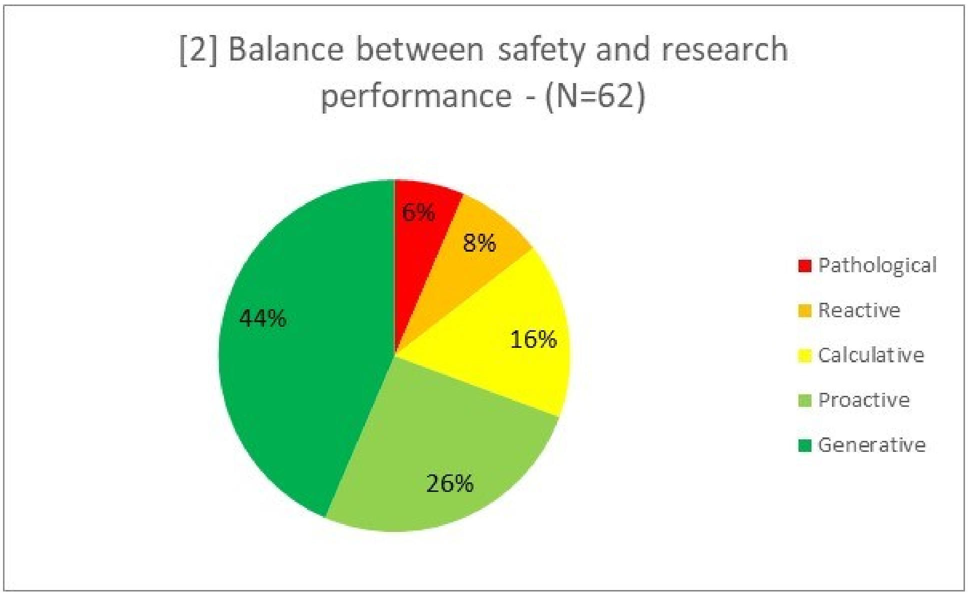


Figure 9 Repartition of typologies for dimension 2 within lab-workers

It appears that a large majority (70%) of respondents do not consider safety as a barrier to research performance but can adapt to prevent or to correct deviation. No conflict between safety and research seems to be present for them, on contrary of the 16% of respondents who indicated a calculative typology. These lab-workers might have some difficulties to manage both safety and research but still have important consideration for the safety within their unit.

Competence/training – are workers interested?

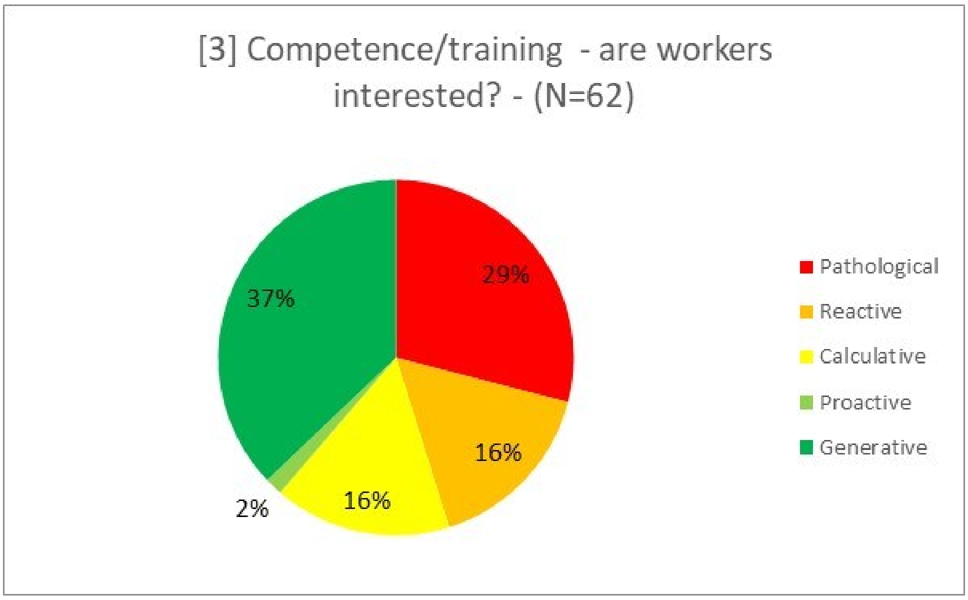


Figure 10 Repartition of typologies for dimension 3 within lab-workers

29% of respondents see safety training as a “necessary evil”, which indicates they only attend the session because it is compulsory. We can suppose these respondents are not satisfied with the content of the proposed safety training or do not consider safety training as relevant or important regarding their laboratory work.

On contrary, 37% of respondents consider needs are identified and they are part of the process. We can assume this occur at research units' level during group discussions for example.

It would be interesting to investigate a possible correlation within the perception of hazards within laboratories with the interest for safety training, as the lack of identified hazard might be a cause of lack of interest.

Importance of safety in group meetings?

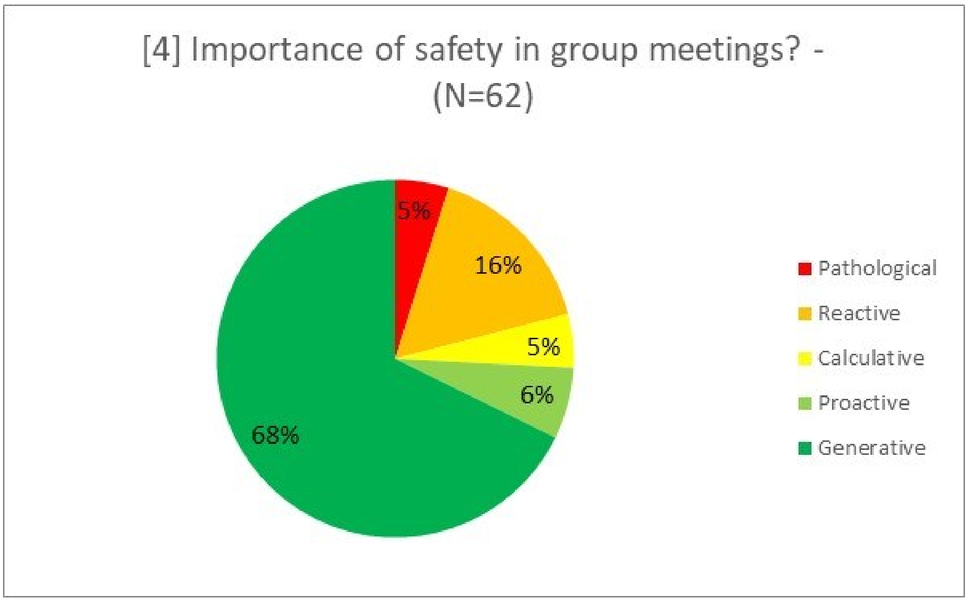


Figure 11 Repartition of typologies for dimension 4 within lab-workers

This result indicates that safety is not a taboo within research units and issues are discussed when noticed for 68% of respondents. This exhibits a relax atmosphere within the unit and we can assume blame is not an issue for them.

On contrary, for 16% of the respondents it seems that conflict and blame are present during safety discussions. This atmosphere could be the source of hidden mistakes, provoking a loss of information.

Who checks safety on a day-to-day basis?

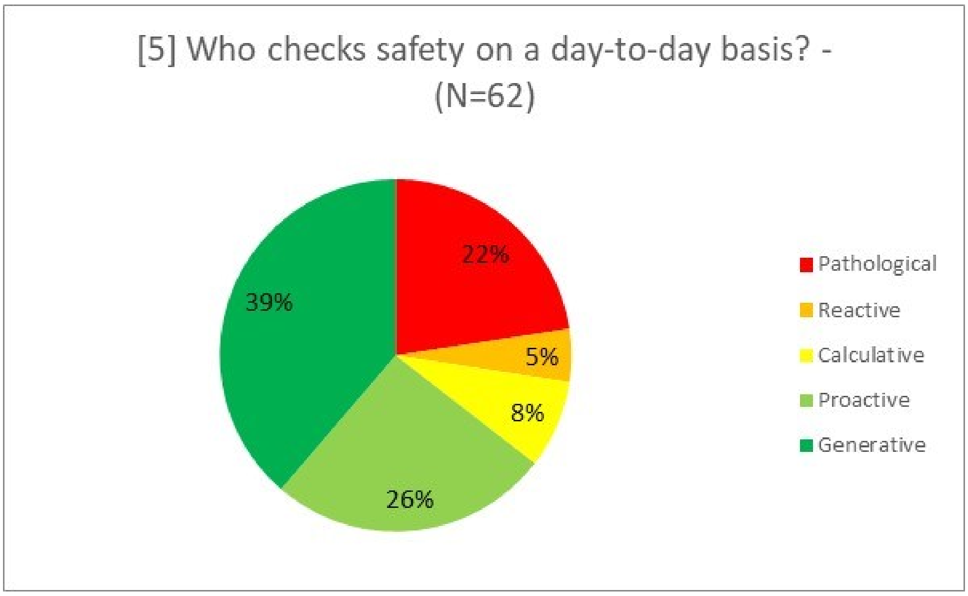


Figure 12 Repartition of typologies for dimension 5 within lab-workers

It appears that team spirit exists for at least 65% of the respondents as they seem to be conscious of the importance of their attention regarding safety for themselves as for others.

22% of respondents indicated a pathological typology, as they think individual see fit to take care of themselves. This might indicate they think mistakes come from individual mistakes and therefore, if everyone works safe, everyone will be safe.

Commitment level of workforce and level of care for colleagues?

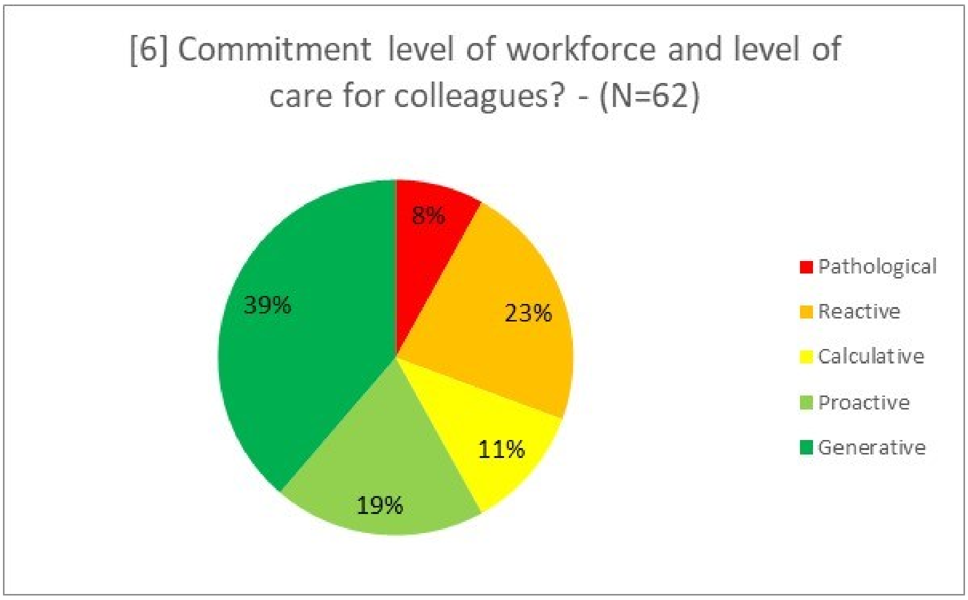


Figure 13 Repartition of typologies for dimension 6 within lab-workers

39% of respondents exhibit a high level of commitment and care for colleagues and 19% indicated the development of pride within their unit, which indicates a well-developed team spirit and consideration for other people.

On the other hand, 23% of respondents indicated that commitment is dependent of safety performance as it diminishes after a period without incident.

Another difference appears regarding the range of interest, as 31% of respondents (pathological + reactive) focus on the individual while 58% of respondents' commitment is about the team.

<u>In your opinion, who causes accidents in the eyes of professor?</u>

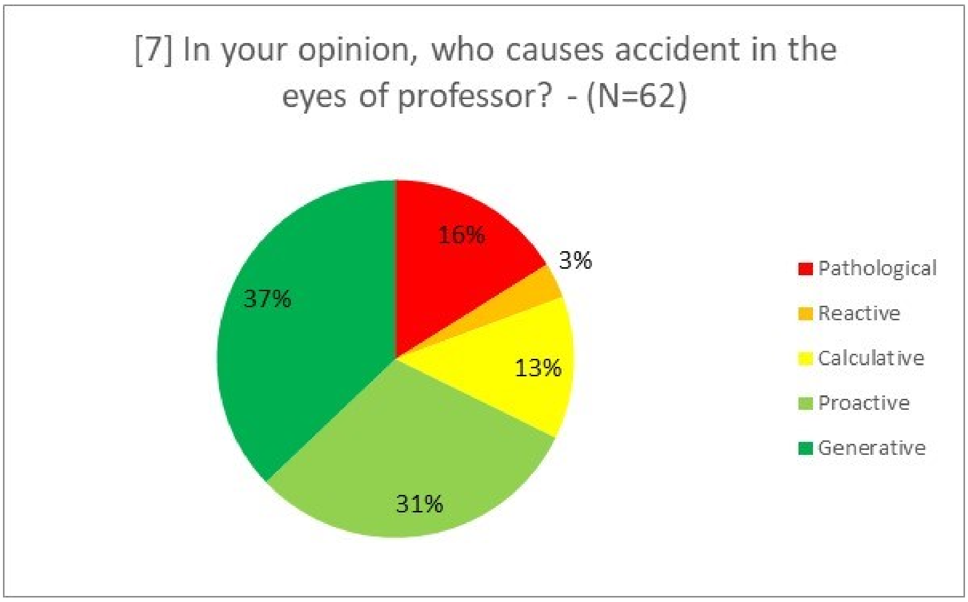


Figure 14 Repartition of typologies for dimension 7 within lab-workers

These results exhibit that 68% of lab-workers estimate professor feel responsible in case of accidents and blame is not an issue as problems as considered at a broad range.

However, for the rest of the respondents it appears that they estimate that, for the professor, causes lie in individual.

<u>Incident and Accident reporting, investigation and analysis</u>

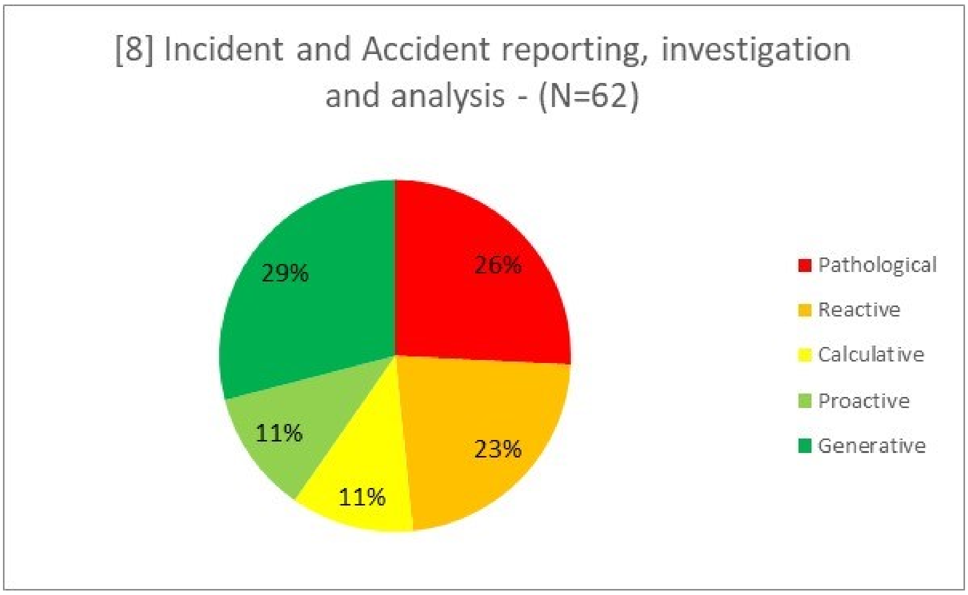


Figure 15 Repartition of typologies for dimension 8 within lab-workers

These results displays that a quarter (26%) of the respondents do not report systematically accidents and/or consider analysis are superficial and do not go beyond legal requirements.

On contrary, 29% of respondents indicated accidents are systematically reported and consider investigations are driven by deeply understanding of the situation.

These really divergent results indicate a strong difference of accident reporting within the different research units and the reason of such considerations could be further investigated.

Influence and position of CoSecs

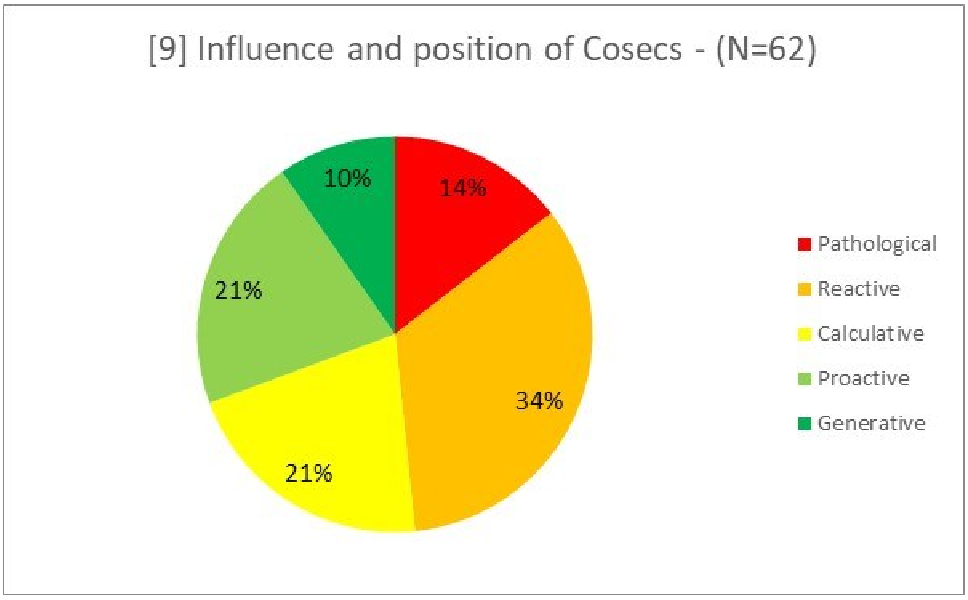


Figure 16 Repartition of typologies for dimension 9 within lab-workers

This result exhibit a scattering of the consideration of CoSec's role within research units as the answers are quite equilibrated. However, it appears that CoSecs are principally seen as exceptional help to correct problems (34%).

Scoring table

Table 14 recapitulates the numbers of answers for each typology, for each dimension. The score, calculated as the weighted mean, provides indications of the dimensions with a particular need of corrective measures and improvement.

Table 14 Detailed results for set of criteria 1

	Pathological	Reactive	Calculative	Proactive	Generative
[1] Planning	10	12	6	17	17
[2] Balance	4	5	10	16	27
[3] Training	18	10	10	1	23
[4] Safety discussions	3	10	3	4	42
[5] Who checks safety	14	3	5	16	24
[6] Commitment for colleagues	5	14	7	12	24
[7] Who causes accidents	10	2	8	19	23
[8] Accidents reporting	16	14	7	7	18
[9] CoSecs	9	21	13	13	6

In table 15, the score has been calculated as the weighted mean considering assigned values to the different typologies, going from 1 to 5 for pathological to generative.

The global HSE Score is the mean for dimensions 1 to 8, dimension 9 (CoSecs' position) being dismissed as not originally included in the Parker's framework.

Table 15 Mean score for the 9 dimensions and their standard deviations

	Mean	Standard deviation
[1] Planning	*3.33*	2.16
[2] Balance	*3.93*	1.51
[3] Training	*3.05*	2.88
[4] Safety discussions	*4.15*	1.78
[5] Who checks safety	*3.56*	2.51
[6] Commitment for colleagues	*3.60*	1.98
[7] Who causes accidents	*3.68*	1.99
[8] Accidents reporting	*2.95*	2.53
***[9] Cosecs' position and influence*[5]**	*2.77*	*1.49*
Global HSE Score	**3.53**	**0.42**

The dimension relating to the Cosecs' position has not been integrated into the mean as it was very scattered and one preferred to keep the HSE Score as defined in the "Hearts and Minds toolkit – Understanding your culture" brochure.

[5] This dimension is not included in the HSE score as it was not in the original framework.

4.2.2.1 Internal consistency

The Cronbach' alpha coefficient has been computed according to the formula:

$$\alpha = \frac{k}{k\text{-}1}\left(1\text{-}\frac{\sum_{i\text{-}1}^{k}\sigma_i^2}{\sigma_X^2}\right)$$

With k the number of items, σ_i^2 the variance of item i, σ_X^2 the variance of total score. (Bland & Altman, 1997).

Cronbach's alpha is a measure of the internal consistency, or reliability, of a measure. It provides information about covariances of items. In the case of such a survey, a high alpha coefficient would mean that the questions would be correlated and probably measure the same underlying construct.

Dimension about Cosecs still excluded, we obtained a Cronbach's alpha value of 0.75, which is considered as an acceptable value regarding the internal consistency of the survey.

The interpretation below is based on the presented data and aims to provide assumptions explaining these results and the differences between dimensions.

4.2.2.2 Working atmosphere [dimensions 1, 6 & 7]

Regarding dimension 1 "Experiment planning, Safety, lab-management", dimension 6 "commitment level of workforce and level of care for colleagues" and dimension 7 "Who causes accident in the eyes of professors?", we can assume a majority of laboratories having a relax atmosphere in which people have a team-spirit (dimensions 6&7) and that the communication within the lab should be good enough to ensure a global planning process well-established (dimension 1) (for each of these dimensions, respectively 55%, 58% and 68% of respondents indicated a proactive or generative typology).

We can say this comes from a strong leadership of professor toward a healthy atmosphere, limiting concurrency between PhD students for example, and proscribing rushing for the benefit of planning.

On the other hand, the pathological typology (between 8 and 16%) may result from a competitive atmosphere, limiting the interaction of care of colleagues, and high requirements from the professor, resulting in the focus on the collection of a maximum of data, working late and during the week-ends, etc.

4.2.2.3 Interest into safety [dimensions 2 ,4 & 8]

Dimension 2 "balance between safety and research performance" and dimension 4 "importance of safety in group meetings?" show that a large majority of respondents (respectively 70% and 74%) indicated a proactive or generative typology. It means that safety issues are actually not ignored when identified, and safety is not a taboo for most of units. According to these results, people feel free to talk about safety and they integrate safety as an important aspect regarding their researches and work.

However, dimension 8 "Incident and Accident reporting, investigation and analysis" shows that for almost half of respondents, accidents are not systematically reported (49% choose the pathological of reactive typology). Yet, incidents are a direct manifestations of safety issues and this lack of consideration of this aspect seems contradictory with the displayed behavior in dimensions 2 and 4.

Different hypothesis might explain this variance.

<u>The definition of accident is not universal:</u>

The definition of incident and accident might be not universal, as several reported they have never witnessed accidents within their laboratory. Yet, we can estimate that, in every lab, incidents occurred (broken glass, superficial scratches, contact with a hot surface, spill of a chemical, etc.). Thus these might be not perceived as accident. Also, reporting “minor” accidents, like superficial scratches, might be perceived as a loss of time.

<u>Unsatisfying feedback:</u>

We could assume that people do not report accident because of unsatisfying feedback and analysis. However, a non-negligible fraction of respondents affirmed investigations of accidents were deeply performed (29% indicated a generative typology) so this hypothesis is improbable.

<u>Sensitivity to organizational factors:</u>

We can suppose people are not sentient to the organizational factors and the importance of accidents analysis, even minor one, to prevent more severe accident and they only focus on past and present aspects of accidents but do not perceive the learning opportunities.

Thus we can suppose that people are not refractory to safety, as we could have imagined, but need to be educated and trained to distinguish subtler safety aspects, in particular the organizational factors.

4.2.2.4 Accountability [dimensions 1, 5 & 9]

Dimension 1 “Experiment Planning, Safety and lab-management” and dimension 5 “Who checks safety on a day-to-day basis?” exhibit a delegation of accountability from the professor to the lab-members as laboratories generally present a well-developed team-work (65% of respondents indicated a proactive or generative typology for dimension 5) regarding as well safety checking as planning process.

However, according to dimension 9 “Position and influence of CoSecs”, delegation and sharing of responsibility with CoSecs appear to be very scattered and the tendencies are very different from both previous dimensions. Causes of this scattering could come from two factors:

<u>Unconsistency of this dimension:</u>

First explanation could be the creation of this dimension was not consistent with original Parker’s framework. The new dimension has been described with short and simple sentences that might not include the subtleties of the position of CoSecs.

<u>Unclear definition of the role of CoSecs:</u>

Second explanation could the different expectations from the position of CoSecs in different research units. Some might consider CoSec as an administrative position, with the only responsibility to do the paperwork regarding safety regulations, or as an integral part of the process of prevention of accidents with the input of specific skills.

4.2.2.5 Adequacy between EPFL regulations and research units needs [dimensions 3, 8 & 9]

These three dimensions displayed the lowest scores out of all dimensions, respectively 3.05, 2.95 and 2.77. Another common factor is the involvement of EPFL, more specifically the SCC, as a stakeholder in these dimensions.

Therefore, one can suggest there is a gap between the edicted rules from the SCC and their application within the laboratory. This can result from a lack of communication (for instance, the role of the CoSecs, or the existence of an accident reporting web platform), or unidentified needs from the units (proposed training sessions not specific enough).

Further analysis could enlighten the underlying causes of this dichotomy and provide track of reflection in order to improve this situation.

4.2.3 Summary of sets' results

The followings tables summarize results for different sets of criteria.

Table 16 Summarized results for set of criteria 2

Results for set #2		
Role	**School**	**Main Occupation**
PhD students	All	Yes
Population (N)	34	
HSE score	3.38	
Standard Deviation	0.32	

Population of table 16 above is the PhD students of all schools who indicated laboratory work is their main occupation.

Tables 17 to 20 below summarize the results for different schools of EPFL. No filtering is done regarding role or laboratory work as main occupation.

<u>Basic Sciences School</u>

Table 17 Summarized results for set of criteria 3

Results for set #3		
Role	**School**	**Main Occupation**
All	SB	Y&N
Population (N)	33	
HSE score	3.43	
Standard Deviation	0.48	

Life Sciences School

Table 18 Summarized results for set of criteria 4

Results for set #4		
Role	**School**	**Main Occupation**
All	SV	Y&N
Population (N)	12	
HSE score	3.65	
Standard Deviation	0.52	

Engineering School

Table 19 Summarized results for set of criteria 5

Results for set #5		
Role	**School**	**Main Occupation**
All	STI	Y&N
Population (N)	28	
HSE score	3.50	
Standard Deviation	0.39	

Architecture, Civil and Environmental Engineering School

Table 20 Summarized results for set of criteria 6

Results for set #6		
Role	**School**	**Main Occupation**
All	ENAC	Y&N
Population (N)	11	
HSE score	3.56	
Standard Deviation	0.32	

Table 21 summarizes the results at EPF level, gathering all respondents.

Table 21 Summarized results for set of criteria 7

Results for set #7		
Role	**School**	**Main Occupation**
All	All	Y&N
Population (N)	84	
HSE score	3.51	
Standard Deviation	0.38	

For each set of criteria, dimensions have been ranked according to their own score. This would highlight strengths and weaknesses for each population, especially schools, in order to identify potential sources of learnings. For instance, we can notice that SV school (set 4) got a higher score for dimension 7 than STI school (set 5). Investigating the reasons of this difference might provide solutions for improving this dimension in STI school. Inversely, dimension 1 (“Planning”) could be improve at SV school thanks to the STI school methods.

Table 22 Dimensions ranking for each set of criteria

	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7
[1] Planning	**6** *(3.31)*	**6** *(3.24)*	**6** *(3.15)*	**7** *(3.17)*	**3** *(3.75)*	**7** *(3.18)*	**6** *(3.36)*
[2] Balance	**2** *(3.92)*	**2** *(3.68)*	**2** *(3.79)*	**3** *(3.92)*	**2** *(3.93)*	**3** *(3.64)*	**2** *(3.84)*
[3] Training	**7** *(3.02)*	**7** *(3.00)*	**7** *(3.12)*	**8** *(2.83)*	**7** *(3.07)*	**8** *(3.18)*	**7** *(3.06)*
[4] Safety discussions	**1** *(4.16)*	**1** *(3.97)*	**1** *(4.24)*	**2** (4.08)	**1** *(3.96)*	**1** *(4.18)*	**1** *(4.13)*
[5] Who checks safety	**5** *(3.53)*	**5** *(3.35)*	**4** *(3.42)*	**5** *(3.50)*	**6** *(3.25)*	**6** *(3.45)*	**5** *(3.39)*
[6] Commitment for colleagues	**4** *(3.58)*	**3** *(3.41)*	**5** *(3.39)*	**4** *(3.83)*	**4** *(3.68)*	**4** *(3.55)*	**4** *(3.59)*
[7] Who causes accidents	**3** *(3.69)*	**4** *(3.35)*	**3** *(3.64)*	**1** *(4.42)*	**5** *(3.46)*	**2** *(3.73)*	**3** *(3.71)*
[8] Accidents reporting	**8** *(2.95)*	**8** *(3.03)*	**8** *(2.67)*	**6** *(3.42)*	**8** *(2.93)*	**5** *(3.55)*	**8** *(3.00)*
[9] CoSecs	**9** *(2.77)*	**9** *(2.62)*	**9** *(2.52)*	**9** *(2.58)*	**9** (2.93)	**9** *(2.73)*	**9** *(2.71)*

Raw data are available in appendix F available upon request (attached file).

4.2.4 Indicator "Cosecs' Position and Influence"

During the adaptation of the framework, we created the dimension related to the CoSecs' position and influence within their labs. As this dimension was less dense as the others, it was suggested to use it at an indicator of safety climate within a unit to easily get information within the team through a unique question.

To evaluate this potential indicator, we considered a success if the level of maturity chosen by a respondent in dimension 9 (CoSecs' position) is equal to the weighted mean of dimension 1 to 8 for this respondent. For instance, if respondent A gets a score of 4.2 as the mean score of dimension 1 to 8, success will be reached if respondent A selects the proactive typology for dimension 9. Otherwise it's a failure.

Computing this, success rate has been of 22%. This correspond approximatively to the expected success for a random selection, thus it is not relevant to use this dimension as indicator for now; two factors may explicate this.

As discussed above, this dimension should be deepened to be more reliable regarding the rest of the framework; it is possible that after that it might be used as an indicator.

Also, CoSecs position and influence are quite a sensitive question and the high failure rate can come from the not universal consideration of the role of CoSecs within units.

5 Discussion

5.1 Objectives results

We discuss here the results and completion of the objectives presented in part 3.1 “Objectives”.

Determining if the chosen model is suitable for an application at EPFL

This model did not exhibit major inconsistency during the pilot phase and the survey therefore we can keep this tool for further investigations. However, it was determined that it is important to adapt more deeply Parker’s framework to be closer to academia and EPFL mechanisms. Cronbach’s alpha coefficient also presents an acceptable value of 0.75. This mean the survey is quite consistent but can be improved.

Providing an overview of safety climate amongst academic laboratories of EPFL

There were concerns regarding the number of answers, but it was sufficient to allow some interpretations. It permitted the extraction of some information, some confirming empirical thought (accident reporting for instance) or infirming them (level of care for colleagues for instance).

Thus we should not forget the positive bias that might exist as people who take time to answer probably had an important interest for safety.

Also, despite the participation rate higher than expected, it does not allow a representative interpretation of safety climate within academic research units. Recommendations are given below to propose a method to improve this participation rate as well to correct the positive bias and objectives of participation rate.

Moreover, regarding the table 22 “ranking of dimensions for the different sets”, we can observe a different morphology for each school. Therefore, an overview at EPFL level might induce a loss of information about safety climate within these school.

Identifying strengths and improvement opportunities

The answers, particularly the remarks from the survey, highlighted several improvement opportunities that need to be deepened to define a proper process of improvement.

Some dimensions exhibited strengths that are contradictory with common thought regarding safety at EPFL; for instance, the importance of safety during group meetings is representative of a relaxed atmosphere within research units. EPFL scholars appear to be not totally refractory to safety considerations.

A more detailed list of recommendations is presented in part below.

5.2 HSE scores

We can notice global HSE scores for each set of criteria are very similar (mean 3.51, max deviation +/-0.14). However, ranking the dimensions for every set regarding their score exhibits a difference of strengths and improvement opportunities. For example, we can notice that SV school (set 4) highest dimension is “who causes the accidents in the eyes of the professor?”, which is the 5th dimension for STI school (set 5). Contrarily, STI school seems to have better implemented planning process than SV school (dimension 1).

Regarding the results, it appears that the most recurring typology is generative. HSE score however indicated a mean typology balanced between calculative and proactive, with strengths and weaknesses varying between the schools.

Using HSE score as an indicator could therefore lead to a loss of information. For instance, two schools or institutes may have the same score but very different morphology regarding the strengths and weaknesses and improvement measures can therefore not be implemented in the same manner.

A detailed analysis of this dimensional ranking may provide information regarding the improvement of certain dimensions. For instance, we can investigate the reason of such a high rank of accident reporting within SV school to identify a way to develop this in other schools.

It is also important to keep in mind that due to the low participation rate, these values are strictly indicative. It would also be irrelevant to rank schools regarding their HSE score. Detailed information is given as recommendations.

As discussed in recommendations below, this method need to be improved in order to be more accurate and provide in depth assessment of safety climate. Such indicators could only give information about the level of maturity of safety climate within EPFL, which ensues from underlying causes that need to be assessed as well to provide improvement pathway.

5.3 Positive bias

It has been remembered several times that a positive bias is suspected in these results due to the length of the survey. A drawing lot was organized to motivate lab-members to answer the survey. It is interesting to notice only half of the respondents registered for this drawing lot. I assume that the lab-members who did not registered had a strong interest for safety in general and therefore strongly participate to this positive bias.

On the other hand, it is complicated to discuss the bias within the second half of respondents who did registered. Either they had an interest for safety and took the opportunity, either they were motivated by this drawing lot. No conclusion can be drawn as it was impossible to connect the answers to the drawing lot participants.

Regarding the reliability of the answers, it is assumed that people answered honestly and carefully. For each respondent, we checked simple pattern that might indicate a “speed-ticking” (for example if the respondent checked the first box for every answer). No answer was invalidated.

However, many remarks (31 over a total of 58 remarks) have been made regarding the design of the survey, more specifically to the relevance and/or the clarity of certain propositions. These remarks emphasize the fact that this the described typologies are very specific and quite complicated to understand without theoretical background and explanation. Remarks are available in appendix G.

6 Recommendations

Recommendations are developed according to two axes. First, we will discuss about the safety climate assessment and the improvement needed to be more significant and relevant in order to provide a more precise evaluation of safety climate within academic research units. Then some recommendations will concern the safety climate at EPFL, giving some improvement opportunities which ensue the output of the survey, the results regarding Parker's framework, and diverse remarks of respondents. These recommendations are given as a direct interpretation of results of the survey regarding safety climate.

6.1 Survey processing

This survey is a preliminary study for an in depth safety culture assessment and improvement. Processing the survey highlighted several issues and improvement opportunities that need to be corrected to perform further investigations:

- Parker's framework: The original framework developed by Parker was directly translated to EPFL/academia terminology. It appears that some dimensions (accident reporting, who causes the accidents in the eyes of professors in particular) were not perceived as relevant for several respondents. It seems necessary to strengthen the framework with safety experts working in academia.

- This consolidated framework can then be evaluated through group discussions. These discussions can provide more reliable answers as issues like the lack of context or misunderstanding can be solved. Groups discussions can also be an opportunity to validate a simpler survey as discussed in part 3.3.1. "Dismissed methods" (Likert-scale, simple sentences).

- The assessment of safety climate at EPFL could be completed with diffusing a simpler survey that might provide a higher participation rate; assuming the length of question was the main issue regarding the motivation of people to answer. This could provide statistically relevant data at School level and perhaps at institute level.

- Currently the Global HSE score is given at EPFL level. Relevance of this global score could be discussed as evaluation at School level exhibited different strengths and weaknesses depending on the school. HSE score at School level cannot actually be considered relevant due to the lack of respondent from a same School (~20 by school). A higher participation rate could allow monitoring at school level and maybe at institute level.

- The collected answers can be discussed as positively biases and probably skewed, considering respondents as volunteer and interest for safety. It could be interesting to evaluate the importance of this bias through objective indicators. For instance, I proposed to compare the actual ratio of reported accident to the respondents who affirm every accident is reported within their unit. This has not been done as I have been told I would not have enough time.

Statistical approach

Relevance of the results has been discussed due to the low participation rate. For a first improvement, I would suggest to aim a minimum participation rate equivalent to a hundred answers for each school. This value is proposed as it is the minimum generally admitted for statistical models like exploratory factor analysis (EFA), confirmatory factor analysis (CFA), principal component analysis (PCA), etc. (MacCallum, Widaman, Zhang, & Hong, 1999)

This minimum would permit to perform such statistical analysis and get solid information regarding the consistency of the results.

Regarding the results of the survey for the different schools (table 17 to 20) and the ranking table 22, it appears that assessment of safety climate is more relevant at school level as we can observe different tendencies. Thus a participation rate target at EPFL level is not suggested as it might be irrelevant.

During the literature phase of the project, statistical tools have been studied (exploratory factors analysis, Bayesian networks, principal components analysis, etc.) but have not been applied as the minimal number of answers ensuring statistic validity of the method was high (100+ of valid answers and 5 times the number of questions). Also the theoretical background, especially for Bayesian networks, is quite important. Developing a simpler survey might open the path to the application of strong statistical methods that might emphasize correlation and/or causality between items.

In depth analysis of underlying causes

Several assumptions have been proposed to explain certain observed tendencies and need to be tested. For some of them an opinion poll could be diffused, or added to the existing survey. This poll should be very specific as it needs to highlight specific information. For instance, regarding the accident reporting dimension, the following questions could be asked to exhibit the main refractory factor:

- Have you been informed of the obligation to report every accident to SCC?
- Have you been informed of the Event Manager for accident reporting?
- Do you think reporting every accident, even minor ones, is a loss of time?
- Etc.

This secondary questionnaire would answer the “why do we have such a safety climate?” question.

6.2 Safety climate at EPFL

Interpretation of results and the diverse discussions which occurred during this project brought out several improvement opportunities. Reflection tracks corresponding to these opportunities are presented here.

The following propositions are prioritized in two categories regarding their potential added value, importance and/or possibility of implementation.

6.2.1 Primary improvement opportunities

Accident reporting

It is acknowledged that accident reporting is an important safety process, allowing identification of problems before severe deviation. The survey exhibited, and that was not surprising, a dichotomy between the theory (every accident should be reported) and the reality at EPFL (major accidents only are reported).

Several possible explanations to this behavior have been outlined but further specific assessment is needed. To design a potential solution for this problem, the questions below should be answered first:

- Why do people not report every accident?

This issues may come from diverse problematics; time needed for reporting ("I don't want to take one hour to report a superficial scratch"), the fear to be ashamed ("I don't want people to know I did this mistake"), the lack of feedback ("Why should I report accident if the feedback is non-existing/insufficient/does not answer my interrogations?")

Concerning the latter example about feedback, a non-negligible fraction of respondents seems agree that analysis and investigation were satisfying (29% of proactive and generative typologies). If confirmed, this might tighten the field of research of the causes.

- What feedback do people expect from accident reporting?

In order to develop an efficient tool, it is important to define precisely the needs of every stakeholder; here the SCC (that is still in charge of safety) and the lab-workers. In this process, lab-workers are the main source of information; intervention teams can provide information when mobilized; and it is important to keep this source in the loop. If lab-workers tend to think reporting is pointless, they will stop reporting.

- How should information be managed?

Regarding the two main exposed problems (time needed for reporting and the shame) might be, at least partially, solved through information management level.

The fear to be ashamed, if confirmed, might be induced to the impersonal and global range of actual system as the reporting is very centralized, and available for every EPFL-member. We can imagine a reporting at lower level (school or even institute) to create a more private sphere of information-sharing. For example, people could see the accidents reported within their institute, while the SCC would have access to the global database.

Regarding the time needed to report accident, we can imagine a tick-a-box system to inquire basic information about hazards involved (animals, glassware, chemical compounds, etc.) and the application of an algorithm that will determine if further information are needed. For instance, a projection of a diluted acidic solution would not require precise information, while a projection of HF solution would necessitate further investigation.

However, this solution presents advantages and disadvantages:

<u>Advantages:</u>

This would provide a gain of time for SCC in the analyze of accidents as investigation's depth will depend on the accident itself.

Moreover, the needed workload might seem more reasonable in the eyes of involved lab-workers, who might be therefore more willing and receptive to accident reporting.

A statistical follow-up could also be implemented to highlight recurring "small" accidents to prevent aggravation.

Disadvantages:

This solution would necessitate to prioritize accidents and therefore a loss of sight of “small” accidents is possible.

It is globally recognized that major accidents are preceded by small accidents and, in industry, these small accidents are targeted to be suppress and it is assumed this would prevent major accidents.

The proposed method would go reversely, as focus would be on the largest accidents and granted importance will decrease with the gravity of the accident.

CoSecs

It appears that the position of CoSecs is very heterogeneous within research units. It would be interesting to perform further research and analysis in order to understand these differences and the reasons leading to them.

Once this will be understood, it might be possible to outline strengths of the role of CoSecs as perceived by professors and lab-members and to harmonize how CoSecs are seen. This might come through a communication campaign about added value of CoSecs, or by modifying the requirements specifications of this role.

Alternatively, it might as well to be a solution to accept these differences of perceptions and accept that the CoSec’s responsibility should vary per research unit and they should respond to particular needs while ensuring minimal safety requirements. CoSecs training sessions could then be adapted to different profile of person and units.

These profiles would differ by the relative position of the CoSecs regarding his two attachment units, the SCC and his unit. For instance, in a laboratory exhibiting a strong generative safety behavior where everyone is responsible for and participate to safety, the CoSec might be closer to the laboratory than the SCC, being only an interface and the contact between the two entities.

However, in a strong pathological laboratory, CoSecs might be closer to the SCC than the lab by being more of a supervisor and being more directive to ensure compliance. This would require a CoSec with more influence and power than the profile describe above.

Training

According to this survey, lab-workers do not feel concerned by training sessions and acquiring new skills. After a discussion with supervisors of this project, it appears that this is effectively a shortage in the continuous formation program.

However, as discussed in this beginning of this report, academia’s activities are particularly diverse and it will be complicated to identify and respond to the needs.

A first identification of primary needs could be performed through an inquiry with EPFL laboratories to highlight the main recursive dangers to which lab-workers are exposed. This could be performed through another survey or during the audits of laboratories by the SCC for example.

Nevertheless, according to Parker’s framework, employees should actively participate to the process. A participative platform could be a solution, based on the model of crowdfunding: For instance, if a lab-worker is interested for a specific training program external to EPFL, he might propose it on this platform and EPFL would participate to the fees if a certain number of people register; although it might be utopic to expect a large group of people to be such participating.

6.2.2 Secondary improvement opportunities

<u>PhD students Awareness</u>

It has been discussed that the lab-workers might be hardly receptive to the impact of organizational factors, and more generally to safety. As PhD students have an obligation to gain several ECTS credits, it might be interesting to propose a course of “safety management in laboratory” to stimulate interest of the main population of lab-workers for safety and to sensitize them.

This course might incorporate an introduction to organizational factors, case studies of accident (UCLA, TexasTech, etc.) to browse through this wide topic.

<u>Relationship between safety and research performance</u>

Literature generally states that organizations with a poor safety culture prioritize performance and productivity over safety. However, DuPont demonstrated a strong correlation between strong safety culture and profitability (DuPont, 2015).

It might be interesting to perform similar studies in academia to determine whether or not this behavior also exists in academia, and if it does it might be an important support to communicate and sensitize to the importance of safety.

Basically, the number of scientific publications of a unit and the number of accidents within this lab could be compared. No relevant literature has been found about this topic in academia.

This study could be extended to further factors as the working atmosphere, stress of the lab-workers, number of working hours, etc.

6.2.3 Parker’s framework enhancement

Climate assessment performed during this project was based on the framework developed by Parker and applied in the Hearts and Minds program. However, it is important to notice evaluated dimensions were selected regarding their perceptibility by lab-workers. Evaluation of the dismissed dimensions should also provide relevant information on EPFL safety climate but need to be assessed differently (audits, groups discussions, etc.).

6.2.4 Leadership

Proposed improvement opportunities focus on operational issues to improve existing practices who appeared to present deficiencies. Nevertheless, leadership is universally accepted as a main factor leading to a good safety culture but was not discussed during this project. Further investigations could provide reflection tracks to build up a strong leadership toward safety organizational factors.

For instance, a student-empowered approach was suggested as a viable method to improve safety culture in academia. This method contrasts with the traditional “top-to-bottom” approach in industry by increasing students’ responsibility and involvement towards safety (Mcgarry K. A., 2013).

Moreover, Parker's framework states that HSE responsibility should be "distributed throughout the company" and HSE department would be small but powerful (generative typology regarding the size of the HSE status) (Parker D., 2006). At EPFL, the SCC centralized the competencies regarding safety and part of these are delegated to safety coordinators (CoSecs) of each research units. A proposed solution might be the creation of a new hierarchical level at institute level. This would be in the same vein as Parker's framework, but this need to be assessed regarding the possibilities (external regulations, laws, etc.) and the relevance of delegated competencies.

7 Conclusion

This project was about safety culture improvement in academic laboratory at EPFL. As discussed in the first part of this report, safety culture is a complex construct. Thus an important part of this work was about safety culture literature to gather relevant information about the construct in order to provide the necessary knowledge to pursue this project.

Before improving safety culture, it was necessary to get indicators, scale or any tool allowing to numerically evaluate and monitor evolution through time. Reason's model was proven to be a suitable model for an application at EPFL. Parker's framework, developed according to this model, also provides interesting and relevant information. However, this framework was developed in oil and gas industries, and further and deeper changes of the described typologies are necessary to reflect academia organization.

Safety climate, the directly perceptible facet of safety culture, has been assessed through a survey diffused within EPFL community, especially PhD students. This survey provides interesting information, and we were able to extract reflection tracks for safety culture improvement.

However, further investigations are necessary to ensure a complete overview of safety climate within EPFL. Moreover, due to the length of the survey and the fact that respondents were all willing to answer the survey, a strong bias is suspected; methods need to be developed to facilitate global and more objective assessment.

Safety climate has been assessed with a "global HSE Score", as defined in the "Hearts and Minds" program of Shell, however it actually cannot be considered representative of EPFL safety climate due to the positive bias discussed above and the low participation rate. It was also suggested to consider this score at School level or even institute level rather than EPFL.

The survey permitted to identify several improvement opportunities of safety at EPFL. For instance, the reporting of accident can and should be improved. It is globally acknowledged that this is a key dimension of a strong safety culture as it may prevent severe accidents. Minor accidents are generally not reported at EPFL and changes could be induced through a different information management and a tool corresponding to the needs of research units' members, that needs to be defined.

The survey also exhibited an important gap between people regarding the role and the importance of CoSecs. As this part of the survey was not based on any proven method or frame, it is difficult to say where the problem stands. CoSecs being the first contact of laboratory to safety it might be important to develop and standardize their position through units.

8 Bibliography

BBC News. (2010, June 7). *Bhopal trial: Eight convicted over India gas disaster*. Consulté le January 7, 2018, sur BBC News website: http://news.bbc.co.uk/2/hi/south_asia/8725140.stm

Bland, J. M., & Altman, D. G. (1997). Statistics notes: Cronbach's alpha. *BMJ*, p. 572.

Cole K. S., S.-A. S. (2013). *A Literature Review of Safety Culture.* Albuquerque, New Mexico: Sandia National Laboratories.

DSPS-SCC. (2017). Cours CoSec - Case Study EN.

DuPont (Réalisateur). (2015). *The DuPont Bradley Curve* [Film].

DuPont. (2015, November 5). *The DuPont Bradley curve video.* Consulté le October 12, 2017, sur DuPont USA: http://www.dupont.com/products-and-services/consulting-services-process-technologies/brands/sustainable-solutions/sub-brands/operational-risk-management/videos/bradley-curve-video.html

Energy Institute. (2017). *Hearts and Minds ¦ Home*. Consulté le 12 4, 2017, sur Hearts and Minds: http://heartsandminds.energyinst.org/home

EPFL. (2012, 12 1). Directive en matière de santé et sécurité du travail (DSST). Lausanne. Consulté le 01 25, 2018

Fleming, M. (2006). *Developing safety culture measurement tools and techniques based on site audits rather than questionnaires.* Halifax: Saint Mary's University.

FonCSI. (2010). *Facteurs humains et organisationnels de la sécurité industrielle : un état de l'art.* Fondation pour une culture de sécurité industrielle.

Guldenmund F. W. (2000). The nature of safety culture: a review of theory and research. *Safety Science*(34), pp. 215-257.

IAEA. (2017). *Chernobyl Nuclear Accident*. Consulté le December 16, 2017, sur International Atomic Energy Agency website: https://www.iaea.org/newscenter/focus/chernobyl

ICSI, G. d. (2017). *La culture de sécurité : comprendre pour agir.* Institut pour une culture de sécurité industrielle.

International Atomic Energy Agency, .. (2002). *Safety culture in nuclear installations. Guidance for use in enhancement of safety culture.* Vienna: IAEA-TECDOC.

J-L. Marendaz, J.-C. S. (2013). A sstematic tool for Assessment and Classification of Hazards in laboratories (ACHiL). *Safety Science*(53), pp. 168-176.

Kemsley, J. (2009). Learning from UCLA. *Chemical & Engineering News*, 29-31, 33-34. Récupéré sur https://cen.acs.org/articles/87/i31/Learning-UCLA.html

Kemsley, J. (2016). University of Hawaii lab explosion likely originated in electrostatic discharge. *Chemical & Engineering news*, 5.

L. Eckelaert, A. S. (2011). *Occupational Safety and Health culture assessment - A review of main approaches and selected tools.* European Agency for Safety and Health at Work.

MacCallum, R., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor Analysis. *Psychological Methods, 4*(1), pp. 84-99.

Marendaz, J.-L., Friedrich, K., & Meyer, T. (2011). Safety Management and Risk Assessment in Chemical Laboratories. *Chimia, 65*(9), pp. 734-737.

Mcgarry K. A., H. K. (2013). Student Involvement in Improving the Culture of Safety in Academic Laboratories. *J. Chem. Educ.*(90), pp. 1414-1417.

Parker D., L. M. (2006). A framework for understanding the development of organisation safety culture. *Safety Science*(44), pp. 551-562.

R. M. Choudry, D. F. (2007, October). Developing a Model of Construction Safety Culture. *Journal of management in engineering, 4*(23), pp. 207-212.

Schoeffel, V., & Thompson, P. (2017). *Communication interculturelle I.* Bienne (CH): Cinfo.

Seo, D.-C., & M. R. Torabi, E. H. (2004). A cross-validation of safety climate scale using confirmatory factor analytic approach. *Journal of Safety Research*(35), pp. 427-445.

US CSB. (2010). *Texas tech University - Laboratory Explosion.* Washington DC: Chemical Safety Board.

US NRC. (2014, December 12). *NRC: Backgrounder on the Three Mile Island Accident*. Consulté le January 7, 2018, sur United States Nuclear Regulatory Commission website: https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html

Wikipédia. (2017). *Social Cognitive Theory*. Consulté le January 22, 2018, sur Wikipédia: https://en.wikipedia.org/wiki/Social_cognitive_theory

9 Appendix

Appendix A Parker's framework

PATHOLOGICAL	REACTIVE	CALCULATIVE	PROACTIVE	GENERATIVE
Who causes accidents in the eyes of management?				
Individuals are blamed, and it is believed that accidents are a part of the job. Responsibility for accidents is seen as belonging to those directly involved.	There are attempts to remove 'accident-prone' individuals. It is believed that accidents are often just bad luck. The responsibility of The System for accidents is considered but has no consequences.	Faulty machinery and poor maintenance are identified as causes as well as people. There are attempts to reduce exposure. Management has a Them, rather than Us, mentality and takes an individual rather than a systems perspective.	Management looks at the whole system, including processes and procedures when considering accident causes. They admit that management must take some of the blame.	Blame is not an issue. Management accepts it could be responsible when assessing what they personally could have done to remove root causes. They take a broad view looking at the interaction of systems and people.
What happens after an accident? Is the feedback loop being closed?				
After an accident the focus is on the employee, and they are often fired. The priority is to limit damage and get back to production.	Line management is annoyed by 'stupid' accidents. After an accident reports are not passed up the line if it can be avoided. Warning letters sent by management.	Workforce report their own accidents but maintain distance with contractor incidents. Management goes ballistic when they hear of an accident – "What does this do to our statistics?"	Management is disappointed, but asks about the well-being of those involved. Investigation focuses on underlying causes and the results are fed back to the supervisory level.	Top management is seen amongst the people involved directly after an accident. They show personal interest in individuals and the investigation process. Employees take accidents to others personally.
How do safety meetings feel?				
Meetings, if any, are seen as a waste of time. They are run by the boss or a supervisor, and are felt to be a case of going through the motions. Conversation often turns to sport.	Meetings are attended reluctantly. They provide opportunities to point the finger of blame for incidents, and form a standard response to an accident. Toolbox meetings may be dominated by non-work issues.	Meetings are like textbook discussions about company policy with limited interaction. The regular scheduled meetings feel like overkill. Toolbox meetings are run on a strict agenda.	Meetings feel like a genuine forum for interaction across the company. At lower levels all meetings are safety meetings and are used to identify problems before they occur.	Meetings can be called by any employee, taking place in a relaxed atmosphere, and may be run by employees with managers attending by invitation. Toolbox meetings are short and focused on ensuring everyone is aware of what problems might arise.
Balance between HSE and profitability				
Profitability is the only concern. Safety is seen as costing money, and the only priority is to avoid extra costs.	Cost is important, but there is some investment in preventative maintenance. Operational factors dominate.	Safety and profitability are juggled rather than balanced, with the line spending most of its time on operational issues. Line managers know how to say the right things, but do not always walk their own talk. Safety is seen as discretionary expenditure. If all contractors are unacceptable, the least bad is taken.	The company tries to make HSE the top priority, while understanding that HSE contributes to financial return. The company is quite good at juggling the two, and accepts delays to get contractors up to standard in terms of safety. Money still counts.	They are in balance, so that this becomes a non-issue. Management believe that HSE makes money. The company accepts delays to get contractors up to standard in terms of safety.
Is management interested in communicating HSE issues with the workforce?				
Management is not interested apart from telling workers not to cause problems.	The 'flavour of the month' safety message is passed down from management. Any interest diminishes over time as things get 'back to normal'.	Management shares a lot of information with workers and has frequent safety initiatives. Management does a lot of talking but there are few opportunities for bottom-up communication.	Managers realise that dialogue with the workforce is desirable and so a two-way process is in place. Asking as well as telling goes on. The emphasis is on looking out for each other in the workplace.	There is a definite two-way process in which management gets more information back than they provide. The process is transparent. It's seen as a family tragedy if someone gets hurt.
Commitment level of workforce and level of care for colleagues				
"Who cares as long as we don't get caught?" Individuals look after themselves.	'Look out for yourself' is still the rule. There is a voiced commitment to care for colleagues, after accidents, by both management and workforce, but this diminishes after a period of good safety performance.	There is a trickle down of management's increasing awareness of the costs of failure. People know how to pay lip service to safety, but practical factors may prevent complete follow through.	Pride is beginning to develop, increasing the workforce's commitment to HSE and their care for colleagues, but the feeling is not universal.	Levels of commitment and care are very high and are driven by employees who show passion about living up to their aspirations. Standards are defined by the workforce.
What is the purpose of procedures?				
The company makes HSE procedures out of necessity. They are seen as limiting peoples' activities to avoid litigation or harm to assets.	The purpose of HSE procedures is to prevent individual incidents recurring. They are often written in response to accidents and their overall effect may not be properly considered in detail.	There are many HSE procedures, serving as 'barriers' to prevent incidents. It is hard to separate procedures from training.	HSE procedures spread best practice but are seen as occasionally inconvenient by a competent workforce. A limited degree of non-compliance is acceptable.	There is trust in employees that they can recognise situations where compliance should be challenged. Non-compliance to HSE procedures goes through recognised channels. Procedures are refined for efficiency.

The seven abstract organizational factors defined by Parker

PATHOLOGICAL	REACTIVE	CALCULATIVE	PROACTIVE	GENERATIVE
Benchmarking, Trends and Statistics				
Compliance with statutory HSE reporting requirements, but little more. Benchmarking only on finance and production.	Try to respond as other companies do, and worry about the cost of accidents, and their placing in the 'safety league'. Statistics report the immediate causes of accidents.	Benchmark on incidents and accidents. Display lots of data publicly throughout the organisation. Focus on current problems that can be measured objectively and summarised numerically.	Benchmark against others in same industry, driven by management. Try to be the best in the industry. Look for trends, understand them and use them to adapt strategy. Explain findings to supervisors.	Benchmark outside the industry, using both 'hard' and 'soft' measures. Involve all levels of the organisation in identifying action points for improvement.
Audits and Reviews				
Unwilling compliance with statutory inspection requirements. Audits are mainly financial. HSE audits are unstructured, and only after major accidents.	Accept being audited as inescapable, especially after serious or fatal accidents. No schedule for audits and reviews, as they are seen as a punishment.	There is a regular, scheduled audit program. It concentrates on known high hazard areas. Happy to audit others, but being audited is less welcome. Audits are structured in terms of management systems.	Extensive audit program including cross-auditing within the organisation. Managementand supervisors realise that they are biased and welcome outside help. Audits are seen as positive, if painful.	Full audit system running smoothly with good follow up. Continuous informal search for non-obvious problems with outside help when needed. There are fewer audits of hardware and systems, and more at the level of behaviours.
Incident/accident reporting, investigation and analysis				
Many incidents are not reported. Investigation only takes place after a serious accident. Analyses don't consider human factors or go beyond legal requirements. Protect the company and its profits.	There is an informal reporting system and investigation is aimed only at immediate causes, with a paper trail to show an investigation has taken place. Investigation focuses on finding guilty parties.There is little systematic follow up and previous similar eventsare not considered.	There are procedures producing lots of data and action items, but opportunities to address the real issues are often missed. The search for causes is usually restricted to the level of the local workforce.	There are trained investigators, with systematic follow-up to check that change has occurred and been maintained. Reports are sent company wide to share information and lessons learned. There is little creativity in imagining how the real underlying issues could affect the business.	Investigation and analysis driven by a deep understanding of how accidents happen. Real issues identified by aggregating information from a wide range of incidents.Followup is systematic, to check that change occurs and is maintained.
Hazard and Unsafe Act reports				
There are no reports.	Reporting is simple and factual. Focus is on determining who or what caused the situation. The company does not track actions after reports.	Reports follow a fixed format for categorisation and documentation of observations. Number of reports is what counts. The company requires complete forms without blanks.	Reporting looks for 'why' rather than just 'what' or 'when'. Quick submission of reports is appreciated, and blanks in forms can be filled in later. Management sets reporting goals.	All levels actively access and use the information generated by reports in their daily work.
Work planningincluding PTW, Journey Management				
There is no HSE planning and little planning overall. What work planning there is concentrates on the quickest, fastest, and cheapest execution.	HSE planning is based on what went wrong in the past. There is an informal general planning process, based primarily on managing the time taken for a job.	There is a lot of emphasis on hazard analysis and Permit To Work. There is little use of feedback to improve planning, but people believe that the system is good and will prevent accidents.	Planning is standard practice, with work and HSE integrated in the plan. Plans are followed through and there is some evaluation of effectiveness by supervisors and line management.	There is a polished planning process with both anticipation of problems and review of the process. Employees are trusted to do most planning. There is less paper, more thinking, and the process is well known and disseminated.
Contractor management				
Get the job done with minimum effort and expense.	The company only pays attention to HSE issues in contracting companies after an accident. The primary selection criterion is price, but only poor safety performance has consequences for choice of contractors.	Contractors meet extensive pre-qualification requirements, based on questionnaires and statistics. HSE standards are lowered if no contractor meets requirements. Contractors have to get up to speed on their own.	HSE issues are seen as a partnership. Pre-qualification is on the basis of proof that there is a working HSE-management system. Joint company-contractor safety efforts are observed and the company helps with contractor training.	No compromises to work quality. Find solutions together with contractors to achieve expectations even if this means postponing the job until requirements are met.
Competency/training – are workers interested?				
Training is seen as a necessary evil. Attend training when it is compulsory by law. Workers don't mind exchanging a harsh working environment for a couple of hours training off the job.	Training is aimed at the person –"If we can change their attitude everything will be all right". After an accident money is made available for specific training programmes. The training effort diminishes over time.	Competence matrices are present and lots of standard training courses are given. Acquired course knowledge is tested. There is some on-the-job transfer of training.	Leadership fully acknowledges the importance of tested skills on the job. The workforce is proud to demonstrate their skills in on-the-job assessment. Training needs start to be identified by the workforce.	Issues like attitudes become as important as knowledge and skills. Development is seen as a process rather than an event. Needs are identified and methods of acquiring skills are proposed by the workforce, who are an integral part of the process rather than just passive receivers.
Work-site job safety techniques				
There are no techniques applied. Look out for yourself.	After accidents a standard work-site hazard management technique is bought in, but there is little systematic use after initial introduction.	A commercially available technique is introduced to meet the requirements of the management system, but leads to little action. Quotas are used to demonstrate that the system is working. Nothing else is used.	Job safety analysis/job safety observation techniques are accepted by the workforce as being in their own interest and they regard such methods as standard practice.	Job safety analysis, as a work-site hazard management technique, is revised regularly in a defined process. People (both workers and supervisors) are not afraid to tell each other about hazards.
Who checks safety on a day-to-day basis?				
There is no formal system, so individuals take care of themselves as they see fit.	External inspectors check sites after major incidents. Cursory site checks are performed by line supervision/ management when they are visiting, mostly after incidents or inefficiencies. There is no formal system for follow up.	Site activities are regularly checked by the line management, but not on a daily basis. Inspections aim at compliance with procedures.	Supervisors encourage work teams to check safety for themselves. Managers doing walk-rounds are seen as sincere. They engage employees in dialogue. Internal cross-audits take place, involving managers and supervisors.	Everyone checks for hazards, looking out for themselves and their work-mates. Supervisor inspections are largely unnecessary. There is no problem with demanding shutdowns of operations.
What is the size/status of the HSE department?				
If there is a department, it consists of one person or a small staff in the HR department.	The department is small and has little power. It is seen as a career backwater, and once in it is hard to get out. The staff is on call constantly, but usually very much in the background. The department is seen as a police force.	HSE positions are given to middle managers with good backgrounds who can't be placed elsewhere. It is a large department with some status and power, mainly performing number crunching and sending people on training courses. The HSE manager reports to someone in a position of operational authority.	HSE seen as an important job, given to high fliers. HSE professionals are recruited directly and advisors are appreciated by the line. All senior people in operations must have HSE experience. The HSE manager reports directly to the top management of the company.	There may not be an HSE department because it is not needed, as the safety culture is right. HSE responsibilities are distributed throughout the company. If there is a department it is small but powerful, having equal status with other departments.
What are the rewards of good safety performance?				
None is given or expected - staying alive is reward enough. There are only punishments for failure.	There are disincentives for poor HSE performance. The understanding that positive behaviour can be rewarded has not yet arrived. Managers' bonuses tied to LTI performance.	Some lip service is paid to good safety performance. Safety awards such as T-shirts or baseball hats are made. There are safety competitions and quizzes. TRCF is used when calculating bonuses.	There are some rewards and good performance is considered in promotion reviews. Evaluation is process-based rather than on outcomes.	Recognition itself seen as high value. Good HSE performance is intrinsically motivating.

The eleven concrete organizational factors defined by Parker.

Appendix B Likert questions developed regarding Parker's framework

The suggested scale was a five-point Likert scale with non-forced choice starting from Strongly disagree to strongly agree

1. **Incident reporting, investigations and analysis**
    1.1. *I think causal analysis of accidents should focus on workforce level.*
    1.2. *When a safety-related incident occurs elsewhere on campus, it is communicated to me with causal analysis.*
    1.3. *I have been told to report every incident, accident and near-miss to Safety Competence Center through the safety events manager.*
    1.4. *In my opinion, reporting every small incident may be superfluous.*

2. **Hazard and unsafe acts reports**
    2.1. *If I accidentally do something unsafe, I share it with the group to prevent future incidents.*
    2.2. *Discussions about unsafe acts are done in an informal way.*
    2.3. *We talk about unsafe acts when it happens.*
    2.4. *The PI encourages the lab to report as much hazard situations as possible.*
    2.5. *If my colleague does something unsafe, I am not comfortable to point this out to discuss it.*

3. **Work planning, PTW, journey management**
    3.1. *I have to inform my PI before I use dangerous substance (pyrophoric, extremely flammable, explosive).*
    3.2. *When a change occurs in my experiment (chemical, process, etc.) I assess safety issues that may arise.*
    3.3. *I am fully confident when I perform an experiment that have already been done several times in the lab.*
    3.4. *Discussions with my PI about new experiments systemically include safety aspects.*

4. **Competency/Training – are workers interested?**
    4.1. *I willingly participate to safety training sessions to acquire new skills.*
    4.2. *A good safety training is sufficient for new workers to ensure good safety behaviors in the lab.*
    4.3. *My PI encourages lab workers to participate in training session.*
    4.4. *I would like to propose specific training session in matters I'm concerned with.*

5. **Who checks safety on a day-to-day basis?**
    5.1. *I consider that working unsafely can be dangerous for my lab colleagues.*
    5.2. *In my lab, safety concerns are a legitimate reason to stop any experiment in progress, even if it might have impact on planning.*
    5.3. *In my lab, safety concerns are a legitimate reason to stop any experiment in progress, even if it might have impact on financial matters.*
    5.4. *Past accidents are the main reason that justify safety concerns.*
    5.5. *In our lab, we consider the CoSec as the responsible person in charge of safety daily business.*
    5.6. *In our lab the CoSec delegates tasks to lab workers.*

6. **Who causes the accidents in the eyes of management?**
    6.1. *I am afraid to be seen as responsible of an accident in the lab.*
    6.2. *In my opinion, most accident occur if people are disrespecting safety rules.*
    6.3. *Please indicate on the scale below the relative responsibility in case of an accident*

    Individual involved   o   o   o   o   o   Professor

    6.4. *In my lab, PI get involved for any incident in the lab, even small ones.*
    6.5. *My PI ensures maintenance of equipment is done as a preventive safety measure.*

7. **How do safety meetings feel?**
    7.1. *In my lab, group meetings are not appropriate moments to discuss about safety concerns.*
    7.2. *My PI established mandatory safety discussions.*
    7.3. *When an accident occurs, the whole team is concerned.*
    7.4. *Safety issues can be discussed anytime with all the lab.*
    7.5. *I feel recognition when I discuss a safety problem that concern the whole lab.*

8. **Balance between HSE and profitability?**
    8.1. *I feel free to delay my work to solve safety issues.*
    8.2. *Money is the major consideration when discussing safety improvements.*
    8.3. *In my opinion, safety considerations may slow down researches.*
    8.4. *I think I can reach better performances if I work in a safe environment.*

9. **Commitment level of workforce and level of care for colleagues?**
    9.1. *If I see a person in my lab doing something unsafe, I feel uncomfortable addressing the issue directly with him/her.*
    9.2. *My lab colleagues exert a strong peer pressure on me to work safely.*
    9.3. *Lab workers pay particular attention on new teammate in the lab.*
    9.4. *I consider equally both mine and other workers' safety when working in the lab.*

Appendix C Simplified framework for EPFL application

Pathological	Reactive	Calculative	Proactive	Generative
Incident/Accident reporting, [investigation and analysis]				
Incidents are not reported. [Investigations are seen as a loss of time when it concerns a minor incident.]	Informal reporting and only immediate causes are spotted. [Little follow-up, no events shared.]	Lot of reports, but no deep analysis. [Search for causes at workforce level.]	Trained investigators, systematic follow-up to ensure change occurred and is maintained. Reports an learnings are shared.	Deep investigations and analysis for a better understanding of how accidents happen by aggregating a wide range of incidents. Systematic follow-up.
Hazard and unsafe acts reports				
Non-compliance/near-misses are common and totally ignored.	Informal reporting of major near-misses. Focus on direct causes.	Formal reports. PI emphasize the need to focus attention on personal environment and situations.	PI’s set reporting goals. Reports focus on the “why”.	Information is accessed by PIs and lab-workers and learnings are used in daily work.
HSE consideration in experiment change management				
No HSE consideration when deviating a process. Focus on the quickest, cheapest, fastest execution and lot of data.	Quick reflexion if a minor incident occurred in the past in a similar context. Time taken to do the job is the priority.	Hazard analysis are mandatory for major change in the process and/or use of specific dangerous compounds (ex : pyrophoric, explosive, etc…).	HSE aspects are regularly discussed with PI. Workers are not caught by routine when changing a process.	HSE is a primordial aspect of change in a reaction. Deep analysis of deviation and what can happen, new elements involved, etc.
Competency/Training – are workers interested?				
Training is a necessary evil. Attending only when it is compulsory.	Training aimed at the person’s attitudes. Training specific to past accidents. Training involves new workers only.	Competence matrices are present. Knowledge is tested. Training may be seen as relevant for a particular job.	Training needs are identified. Leadership encourages training and workforce is proud to demonstrates skills.	Attitudes is as important as knowledge and skills. Workers can propose/ask for specific training/method and get actively involved in the process.
Who checks safety on a day-to-day basis?				

No formal system. People take care of themselves. CoSEc are fictive position	SCC involved in case of major incidents. No formal follow-up. CoSec are listen after incidents, for a short period of time.	PI checks activities but not on a daily basis. Inspections aim at compliance with procedures. CoSec have an important influence to ensure compliance.	Work team is encouraged. PI are present and dialogue with workers about safety. CoSec are seen as a reliable information source about safety.	Everyone checks for safety for themselves and others. Experimentations are stopped when situation seems abnormal.
Who causes the accidents in the eyes of management?				
Workers directly involved are blamed and seen as responsible.	It is assumed accident are caused by “accident-prone” individuals, and corrective measures have to be taken.	Technical issues are the main reasons of incidents (poor maintenance). Attempts to reduce exposure.	PIs admit to be part of the blame and include process in accidents causes.	Blame-free environment. PIs accept being responsible when root causes have not been solved. Each incidents is a lesson opportunity.
How do safety meetings feel?				
Safety is not discussed.	Safety is discussed reluctantly after incidents. Blaming is common.	Discussions are regulated, there is small interactions.	Safety is regularly discussed and meetings are used to identify problems before they occur.	Safety is discussed every time it feels necessary. Discussions ensure awareness through all workers.
Balance between HSE and profitability?				
Performance is the only concern. Safety is seen as costing money.	Preventive maintenance is done, but costs are still important.	Safety and performance are juggled rather than balanced. Safety is a discretionary expenditure.	HSE is one of the priority, it is accepted that safety contributes to financial health (avoid costs). Delays may occur for safety reasons.	HSE is not an issue. PI believe that safety increases performance. Delays are present until safety is not acceptable.
Commitment level of workforce and level of care for colleagues?				
“who cares are long we don’t get caught”. Self-interest only.	Self-interest still the rule. Care for others occurs only after incidents.	Awareness of failure costs is growing, but practical factors may prevent complete follow through.	Pride is beginning to develop, increasing HSE involvement of workforce, but not universally.	Standards are defined by the workforce. Level of commitment for care of colleagues is important.

These sentences have been developed in order to simplify the chosen dimensions of Parker’s framework.

Appendix D Adapted framework to EPFL organization

Pathological	Reactive	Calculative	Proactive	Generative
Incident/Accident reporting, [investigation and analysis]				
Many incidents are not reported. Investigations only takes places after a serious accident. Analyses don't consider human factors or go beyond legal requirements. Priority on protection of the laboratory (public image, grant, etc.).	There is an informal reporting system and investigation is aimed only at immediate causes, with a paper trail to show an investigation has taken place. Investigation focuses on finding guilty parties. There is little systematic follow up and previous similar event-share not considered.	There are procedures producing lots of data and action items but opportunities to address the real issues are often missed. The search for causes is usually restricted to the level of the lab-workers.	There are trained investigators, with systematic follow-up to check that change has occurred and been maintained. Reports are sent to whole EPFL campus to share information and lessons learned. There is little creativity in imagining how the real underlying issues could affect the research.	Investigation and analysis driven by a deep understanding of how accidents happen. Real issues identified by aggregating information from a wide range of incidents. Follow-up is systematic, to check that change occurs and is maintained.
Hazard and unsafe acts reports				
Hazard and unsafe acts are not reported.	Reporting is simple and factual. Focus is on determining who or what caused the situation. The Laboratory does not track actions after reports, neither do the Safety Competence Center	Reports follow a fixed format for categorisation and documentation of observations. Number of reports is what counts. The Safety Competence Center requires complete forms without blanks.	Reporting looks for "why" rather than just "what" or "when". Quick submission of reports is appreciated, and blanks in forms can be filled in later. The Professor sets reporting goals.	All levels actively access and use the information generated by reports in their daily work.
Experiment planning, Safety, Lab-management				
There is no safety planning and little planning overall. What work planning there is concentrates on the quickest, fastest and cheapest execution.	Safety planning is based on what went wrong in the past. There is an informal general planning process, based primarily on managing the time taken for a job.	There is a lot of emphasis on hazard analysis. There is little use of feedback to improve planning, but people believe that the system is good and will prevent accidents.	Planning is standard practice, with work and safety integrated in the plan. Plans are followed through and there is some evaluation of effectiveness by the Professor.	There is a polished planning process with both anticipations of problems and reviews of the process. Lab-workers are trusted to do most planning. There is less paper, more thinking and the process is well known and disseminated.
Competency/Training – are workers interested?				
Safety training is seen as a necessary evil. Attend training when it is compulsory by law. Lab-workers don't mind	Training is aimed at the person – "if we can change their attitude everything will be all right". After an accident money	Competence matrices are present and lots of standard training courses are given. Acquired course knowledge is	Professor fully acknowledges the importance of tested skills on the job. The lab-workers are proud to demonstrate their	Issues like attitudes become as important as knowledge and skills. Development is seen as a process rather than an event.

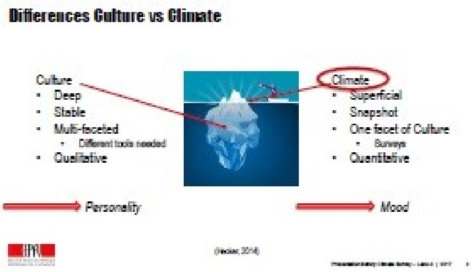
exchanging a harsh working environment for a couple of hours training off the job.	is made available for specific training programmes. The training effort diminishes over time.	tested. There is some on-the-job transfer of techniques.	skills in on-the-job assessment. Training needs start to be identified by lab-workers.	Needs are identified and methods of acquiring skills are proposed by the lab-workers, who are an integral part of the process rather than just passive receivers.
Who checks safety on a day-to-day basis?				
There is no formal system, so individuals take care of themselves as they see fit.	Safety Competence Center checks laboratories after major incidents. Cursory site checks are performed by the Professor when he is visiting, mostly after incidents or inefficiencies. There is no formal system for follow-up.	Laboratories activities are regularly checked by the Professor, but not on a daily basis. Inspections aim at compliance with procedures.	The Professor encourage work teams to check for safety for themselves. Professors doing walk-rounds are seen as sincere. They engage lab-workers in dialogue. Internal cross-audits take place, involving Professors, CoSec and lab-workers.	Everyone checks for hazards, looking out for themselves and their workmates. Professor's inspections are largely unnecessary. There is no problem with demanding shutdowns of operations.
Who causes the accidents in the eyes of management?				
Individuals are blamed, and it is believed that accidents are a part of the job. Responsibility for accidents is seen as belonging to those directly involved.	There are attempts to remove 'accident-prone' individuals. It is believed that accidents are often just bad luck. The responsibility of the system for accidents is considered but has no consequences.	Faulty machinery and poor maintenance are identified as causes as well as people. There are attempts to reduce exposure. Professor has a Them, rather than Us, mentality and takes an individual rather than a system perspective.	The Professor looks at the whole system, including processes and procedures when considering accident causes. He admit that they must take some of the blame.	Blame is not an issue. The Professor accepts he could be responsible when assessing what he personally could have done to remove root causes. he takes a broad view looking at the interaction of systems and people.
Importance of safety in group meetings?				
Safety discussions in group meetings, if any, are seen as a waste of time. They are run by the Professor. Conversation are often conflictual.	Safety discussions are addressed reluctantly. They provide opportunities to point the finger of blame for incidents, and form a standard response to an accident. Toolbox meetings may be dominated by non-work issues.	Meetings are like textbook discussions about EPFL policy with limited interaction. The regular scheduled safety discussions feel like overkill. Toolbox meetings are run on a strict agenda.	Safety discussions feel like a genuine forum for interaction across the laboratory. At all levels, all meetings are safety meetings and are used to identify problems before they occur.	Safety discussions can be called by any lab-workers, taking place in a relaxed atmosphere, and may be run by lab-workers themselves with Professor's support. Safety discussions are short and focused on ensuring everyone is aware of what problems may arise.

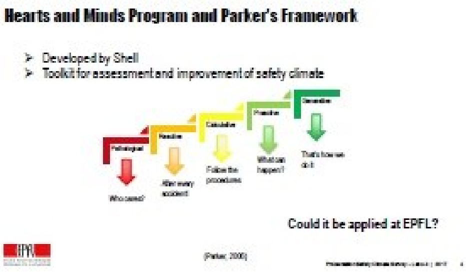
Balance between safety and research performance?				
Research performance is the only concern. Safety is seen as costing money and time, and the only priority is to avoid extra costs and delays.	Cost is important, but there is some investment in preventative maintenance. Operational factors dominate.	Safety and research performance are juggled rather than balanced, with the Professor spending most of his time on operational issues. The Professor knows how to say the right things, but does not always walk his own talk. Safety is seen as a mandatory expenditure. If all contractors are unacceptable, the least bad is taken.	The laboratory tries to make safety the top priority while understanding that it contributes to research performance and cost saving. The laboratory is quite good at juggling the two, and accepts delays to reach safety compliance. Money still counts.	Safety and research performance are in balance, so that this become a non-issue. The Professor believes that safety saves money and allows a better research performance. The Laboratory accepts delays to reach safety compliance.
Commitment level of workforce and level of care for colleagues?				
“Who cares as long we don’t get caught?” Individuals look after themselves.	‘Look out for yourself’ is still a rule. There is a voided commitment to care for colleagues, after accidents, by both Professor and lab-workers, but this diminishes after a period of good safety performance.	There is a trickle down of Professor’s increasing awareness of the costs of failure. People know how to pay lip service to safety, but practical factors may prevent complete follow through.	Pride is beginning to develop, increasing lab-workers’ commitment to safety and their care for colleagues, but the feeling is not universal.	Levels of commitment and care are very high and are driven by lab-workers who show passion about living up their aspirations. Standards are defined by the lab-workers.

This table presents the adapted dimensions to EPFL organization. Respondent will have to choose for each dimension the typology that, according to them, corresponds to the climate within their laboratory.

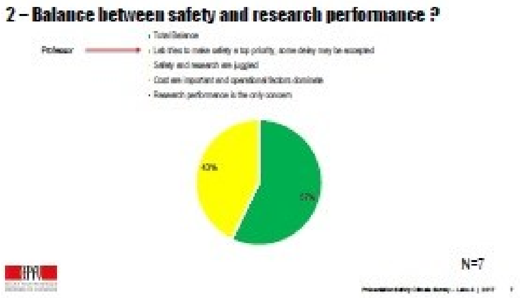
Appendix E Feedback presentation for pilot phase Labo-3

11/01/2018

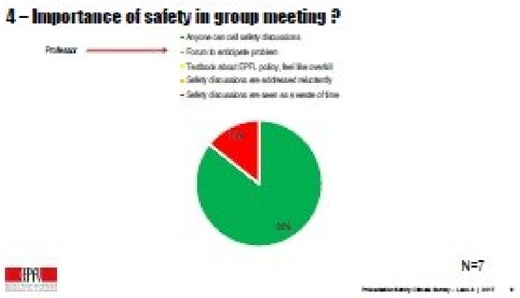


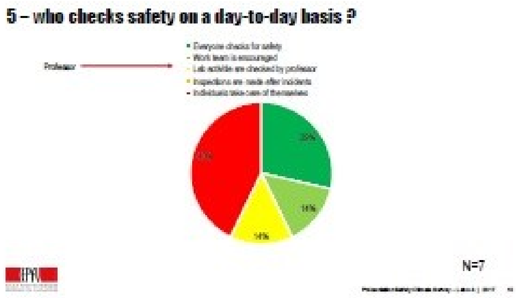


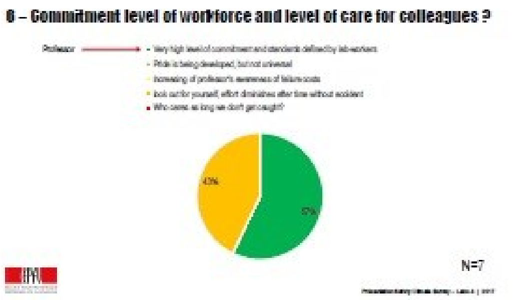
11/01/2018

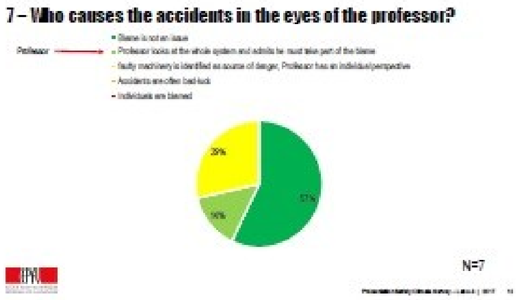

2 – Balance between safety and research performance ?
Professor
43%
57%
N=7


3 – Competency/Training – are workers interested ?
Professor
14%
14%
N=7


4 – Importance of safety in group meeting ?
Professor
N=7


5 – who checks safety on a day-to-day basis ?
Professor
14%
14%
N=7

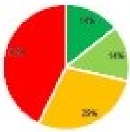

6 – Commitment level of workforce and level of care for colleagues ?
Professor
43%
57%
N=7


7 – Who causes the accidents in the eyes of the professor?
Professor
29%
57%
N=7

8 – Incidents and accidents reporting, investigation and analysis

Professor

- Deep understanding and systematic follow-up
- Reports are shared and little creativity to investigate underlying causes
- Procedures produce a lot of data, causes are searched at lab-workers level
- Informal system of reporting and little systematic for follow-up
- Many incidents are not reported

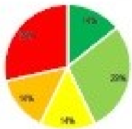


N=7

9 – Position and influence of CoSecs ?

Professor

- Cosec's workload is reduced
- Cosecs are a reliable source of information
- Cosecs ensure safety compliance
- Cosecs help is seek in case of problem
- Cosecs are nominated because it is compulsory



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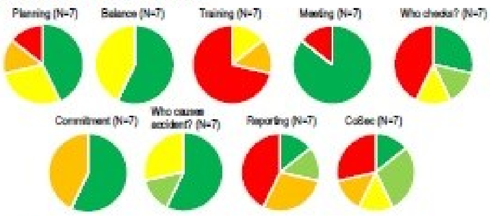
Summary and opportunities



Summary and opportunities

	Pathological	Reactive	Calculative	Proactive	Generative	Labo.	Prof.
Planning	1	1	2		3	Generative	Calculative
Balance			3		4	Generative	Proactive
Training	5	1	1			Pathological	Generative
Safety discussions	1				6	Generative	Proactive
Who checks safety	3		1	1	2	Pathological	Calculative
Commitment for colleagues		3			4	Generative	Generative
Who causes accidents			2	1	4	Generative	Proactive
Accidents reporting	3	2		1	1	Pathological	Calculative
CoSecs	2	1	1	2	1	N/A	Calculative

Questions?

Thank you for your cooperation !

Appendix F Raw data from the survey

Digital file available upon request.

Appendix G Summary of respondents' remarks

Remarks dimension 1	Everything that's enforced by DSPS is done, otherwise we try to do the least required to fulfil the DSPS recommendations	not convinced by the answers	
Remarks dimension 2	As long as EPFL pays for the installation of the safety equipment (as ventilated cabinets, etc..) we aren't really bothered	Proposed answers are very unclear to me	
Remarks dimension 3	I m so confused to find the difference between the answers	Rather unclear sentences	
Remarks dimension 4	we mainly discuss DSPS regulations and how we'll manage the logistics of new regulations (e.g., who and how often will do the trash, etc.)		
Remarks dimension 5	But instead of the professor the main lab technician.	In our lab, it is rather the CoSec and the technicians who look after the safety than the professor.	
Remarks dimension 6	There are always persons with different working styles with respect to safety, and when they come to the stage, you start asking yourself, why should you even bother if they are screwing everything up. I'm not a PI and I don't have a formal right to enforce any change in this situation.	again unclear propositions	
Remarks dimension 7	Sayings from PI like "I don't care, but that's your job that it gets fixed" are often heard		
Remarks dimension 8	there haven't been any incidents that I would be aware of	DSPS only is active yearly during the checkup, I think that it is one of the major factors preventing us from following the guidelines constantly. I have to admit though that from every visit our general behaviour gets better and better, so when it's time to prepare for the yearly checkup we have to do less and less every year.	I would say that I really don't know how it works since I haven't seen any formal investigation of accidents

Remarks dimension 9
I have not yet met our CoSec, who is in office solely due to political reasons. Thus, no one has / takes responsibility for safety issues.
There're a number of people in the lab who're more vigilant than the others and those will work with CoSec to ensure the lab safety is in place
No idea what CoSecs are
Why not several answers here ?
CoSecs take on an enormous responsibility in addition to their normal workload. In my opnnion, the systems in palce at EPFL do not do enough to support these individuals and offer little compensation and even less incentive for people to want to become a CoSec. (I am not a CoSec, just an observer).
What is CoSecs?

Have you any remark on this survey, the project, etc.?
The answers are to pin-pointed and do not fit all the scenarios
Sometimes, the choices seem to be unneccesarily long.
As of now, most of my responses to the survey are hypothetical, as a major accident has not occurred during my time in this lab.
Having a true responsible (CoSec) who is knowledgable (qualified) and who introduces new members to potential hazards, would be great. in our interdisciplinary lab, backgrounds vary greatly and thus knowledge of and about hazards and potential sources for hazards vary greatly too. not trusting others to actually know what they are doing, makes me weary & play by "everyone for themselves" rules, yet still considering not to inflict danger onto others.
The answers are too long and sometimes my answer would be a mixed of two or three or I just know part of the story.
The questionnaire is a bit vague, it takes a lot of time to actually understand the difference between the options in this survey, and then it's a trouble to find the better fit. Try improving! Or maybe it's only English version like this?
I think the questionnaire does not really take into account the activities in the field, which have rather specific issues compared to laboratory work
Safey in the lab is also about having locked doors that can be open with camipro card. In CH, we don't have that. So anyone can enter labs, access our computers/machines, steal chemicals, ruin years and years of research. I was hoping that this survey would have a question about that.
When no incident happened, it is quite hard to answer
The 5 answer suggestions were always very specific, and often none of them did really fit the situation in the lab. So I chose the one I thought was closest to our "reality".
The SCC team should rather act as a reliable partner to help the research groups to improve their procedures than just acting by repression, proposing solutions which are hardly applicable in an academic environment.
The questionnaire is too complex the formulation of the answers is way too complex and hinders the understanding and the true meaning behind the question. Moreover the answers from which we chose should be much shorter and directed towards the point. For many questions I didn't see which answer was fitting my case as they were extremely non precise and complete to understand. Overall I think this survey will produced results highly biased by the answer choices you gave and the way you formulated in a hard to understand manner.
The proposed answer generally don't match what I did like to answer. It is hard to see the differences between them
Some choices are obscure, sometimes don't cover all situations
I think that the answers are too detailed. I think that a better survey could have been done asking for numeric values about each of the details mentioned
Propositions throughout the survey are often unclear/reduntant
The responses are quite dense. Could be particularly challenging for those for whom English is not their first language.
At lot of the questions are written in a way that kind of assumes that accidents happens regularly. I don't think this is the case. Regarding the safety at EPFL, there is little or almost no focus on consequences of long time exposure to chemicals. For instance, working with solvents outside fume hoods seems to be normal in many labs at EPFL. Finally, inspections of labs at EPFL are

announced, hence we are always asked to clean the labs before the inspections. Those performing the inspections do not see how the labs normally looks like. This is a problem!
Sometimes difficult to relate to the suggested answers, which are more oriented from the point of view of a safety analsysis thant that of a person working in a lab everyday, maybe more examples would help, like situation to illustrate each option...
Don't see what the goal is... If it's to show that safety is not the main concern of every lab, we already know it thank you
Some questions are written in a way that can be difficult to understand for non-native english speaker

Remarques dimension 2	"Ije ne peux pas répondre ce que pense mon professeur !	La sécurité est un terme générique. Certaines normes toutefois sont concretement contre productive et voir même plus dangereuse une fois mise en place.
Remarques dimension 3	Chaque Laboratoire à des besoin en sécurité different. Il serait interessant de faire un bilan regulier (2-5ans) des besoin en securité spécifique de chaque laboratoire (à définir en fonction d'un audit/entretien) et de faire des modules pour les personnes concernées de tous les labos.	
Remarques dimension 4	Disscutions abordées à contrecoeur, oui, mais tout le monde saisit leurs importances	
Remarques dimension 5	le point 1 correspond le mieux a notre situation, mais le role décrit par le professeur ici est plutôt délégué au cosec.	
Remarques dimension 6	la dernière parti de ce point est très important : dans le laboratoire, chacun joue un role très different en terme de sécurité. certains sont attentifs aux autres, d'autres meme pas attentifs á eux meme.	
Remarques dimension 7	Difficile à dire pour ma part...	
Remarques dimension 8	Pas connu d'accident, les incidents sont reportés oralement et au plus vite au professeur pour trouver une solution	la declaration d'incidents ne concerne souvent que les accidents sérieux. dans ce cas le suivie fait par le dsps est constructif. pour les "incidents", des mesures correctement peuvent être prise au niveau du laboratoire si les causes sont déterminées facilement.
Remarques dimension 9	le cosec sert de delegué du professeur dans le labo, et doit signaler les problèmes. sa capacité d'action ou de persuasion peut être assez restreinte.	

Avez-vous des remarques sur le sondage, le projet, etc...?
souvent dur de se retrouver dans une des réponses
Il faudrait rendre les différentes options plus claires (moins de texte !)
Des réponses peut-être trop précises qui rendent les réponses appropriées dures
Les réponses possibles sont trop spécifiques et longues. Plus de réponses plus courtes avec la possibilité de réponses multiples aurait été préférable.
J'ai majoritairement répondu en dépi plutôt que par conviction à ce questionnaire. Je trouve que les question n'aborde pas les vrais questions de fond qui sont: "Comment faire respecter des normes

généralistes à des Laboratoires si différents? Comment faire un suivi et une adaptation de ces normes pour les besoins spécifiques de chaque laboratoire? Quels sont les moyens mis en place et mise à disposition par le service de sécurité pour faire un suivi et verifier les modifications faite? répondre aux questions? ouvrir un dialogue constructif pour le bien de tous?
Le questionnaire dans sa globalité n'est pas formulé de manière adéquate par rapport à la gestion existante de la sécurité à l'EPFL!

Appendix H Safety climate survey

Safety climate survey at EPFL

This survey aims to characterize the safety climate within EPFL Campus based on the perceptions of lab-workers within academic laboratory.

Your honesty is the key component of this survey so please be ensured that your answer will be treated anonymously.

This survey is based on a tested system developed in high-reliability industry and has been adapted to the academic system of EPFL.

For this survey, we will ask you how, in your opinion, certain themes are addressed within your laboratory and the EPFL. Five options will be suggested for each theme, please read them carefully and chose the most suitable one to your situation.

If you wish to, you can add potential details in the "remarks" field for each theme.

We thank you for your participation.

*Obligatoire

1 - Experiment planning, Safety, Lab-management

1. **Select the most appropriate :** *

Une seule réponse possible.

- ◯ Planning is standard practice, with work and safety integrated in the plan. Plans are followed through and there is some evaluation of effectiveness by the Professor.
- ◯ There is a lot of emphasis on hazard analysis. There is little use of feedback to improve planning, but people believe that the system is good and will prevent accidents.
- ◯ Safety planning is based on what went wrong in the past. There is an informal general planning process, based primarily on managing the time taken for a job.
- ◯ There is a polished planning process with both anticipations of problems and reviews of the process. Lab-workers are trusted to do most planning. There is less paper, more thinking and the process is well known and disseminated.
- ◯ There is no safety planning and little planning overall. What work planning there is concentrates on the quickest, fastest and cheapest execution.

2. **Remarks**

2 - Balance between safety and research performance?

3. **Select the most appropriate :** *

Une seule réponse possible.

- Research performance is the only concern. Safety is seen as costing money and time, and the only priority is to avoid extra costs and delays.
- Safety and research performance are in balance, so that this become a non-issue. The Professor believes that safety saves money and allows a better research performance. The Laboratory accepts delays to reach safety compliance.
- Cost related to safety is important, but there is some investment in preventative maintenance. Operational factors dominate.
- The laboratory tries to make safety the top priority while understanding that it contributes to research performance and cost saving. The laboratory is quite good at juggling the two, and accepts delays to reach safety compliance. Money still counts.
- Safety and research performance are juggled rather than balanced, with the Professor spending most of his time on operational issues. The Professor knows how to say the right things, but does not always walk his own talk. Safety is seen as a mandatory expenditure. If all contractors are unacceptable, the least bad is taken.

4. **Remarks**

3 - Competency/Training – are workers interested?

5. **Select the most appropriate :** *

Une seule réponse possible.

- Training is aimed at the person – "if we can change their attitude everything will be all right". After an accident money is made available for specific training programmes. The training effort diminishes over time.
- Competence matrices are present and lots of standard training courses are given. Acquired course knowledge is tested. There is some on-the-job transfer of techniques.
- Issues like attitudes become as important as knowledge and skills. Development is seen as a process rather than an event. Needs are identified and methods of acquiring skills are proposed by the lab-workers, who are an integral part of the process rather than just passive receivers.
- Safety training is seen as a necessary evil. Attend training when it is compulsory by law. Lab-workers don't mind exchanging a harsh working environment for a couple of hours training off the job.
- Professor fully acknowledges the importance of tested skills on the job. The lab-workers are proud to demonstrate their skills in on-the-job assessment. Training needs start to be identified by lab-workers.

6. **Remarks**

4 - Importance of safety in group meetings?

7. **Select the most appropriate :** *
Une seule réponse possible.

- Safety discussions are addressed reluctantly. They provide opportunities to point the finger of blame for incidents, and form a standard response to an accident. Toolbox meetings may be dominated by non-work issues.
- Safety discussions can be called by any lab-workers, taking place in a relaxed atmosphere, and may be run by lab-workers themselves with Professor's support. Safety discussions are short and focused on ensuring everyone is aware of what problems may arise.
- Meetings are like textbook discussions about EPFL policy with limited interaction. The regular scheduled safety discussions feel like overkill. Toolbox meetings are run on a strict agenda.
- Safety discussions in group meetings, if any, are seen as a waste of time. They are run by the Professor. Conversation are often conflictual.
- Safety discussions feel like a genuine forum for interaction across the laboratory. At all levels, all meetings are safety meetings and are used to identify problems before they occur.

8. **Remarks**

5 - Who checks safety on a day-to-day basis?

9. **Select the most appropriate :** *
Une seule réponse possible.

- The Professor encourage work teams to check for safety for themselves. Professor doing walk-rounds is seen as sincere. He engages lab-workers in dialogue. Internal cross-audits take place, involving Professor, CoSec and lab-workers.
- Laboratories activities are regularly checked by the Professor, but not on a daily basis. Inspections aim at compliance with procedures.
- Safety Competence Center checks laboratories after major incidents. Cursory site checks are performed by the Professor when he is visiting, mostly after incidents or inefficiencies. There is no formal system for follow-up.
- Everyone checks for hazards, looking out for themselves and their workmates. Professor's inspections are largely unnecessary. There is no problem with demanding shutdowns of operations.
- There is no formal system, so individuals take care of themselves as they see fit.

10. **Remarks**

6 - Commitment level of workforce and level of care for colleagues?

11. **Select the most appropriate :** *
Une seule réponse possible.

- There is a trickle down of Professor's increasing awareness of the costs of failure. People know how to pay lip service to safety, but practical factors may prevent complete follow through.
- Levels of commitment and care are very high and are driven by lab-workers who show passion about living up their aspirations. Standards are defined by the lab-workers.
- 'Look out for yourself' is still a rule. There is a voided commitment to care for colleagues, after accidents, by both Professor and lab-workers, but this diminishes after a period of good safety performance.
- "Who cares as long we don't get caught?" Individuals look after themselves.
- Pride is beginning to develop, increasing lab-workers' commitment to safety and their care for colleagues, but the feeling is not universal.

12. **Remarks**

7 - In your opinion, who causes the accidents in the eyes of professors?

13. **Select the most appropriate :** *
Une seule réponse possible.

- The Professor looks at the whole system, including processes and procedures when considering accident causes. He admit that he must take some of the blame.
- Individuals are blamed, and it is believed that accidents are a part of the job. Responsibility for accidents is seen as belonging to those directly involved.
- Faulty machinery and poor maintenance are identified as causes as well as people. There are attempts to reduce exposure. Professor has a Them, rather than Us, mentality and takes an individual rather than a system perspective.
- There are attempts to remove 'accident-prone' individuals. It is believed that accidents are often just bad luck. The responsibility of the system for accidents is considered but has no consequences.
- Blame is not an issue. The Professor accepts he could be responsible when assessing what he personally could have done to remove root causes. he takes a broad view looking at the interaction of systems and people.

14. **Remarks**

8 - Incident and Accident reporting, investigation and analysis

15. **Select the most appropriate :** *

Une seule réponse possible.

- Investigation and analysis driven by a deep understanding of how accidents happen. Real issues identified by aggregating information from a wide range of incidents. Follow-up is systematic, to check that change occurs and is maintained.
- There is an informal reporting system and investigation is aimed only at immediate causes, with a paper trail to show an investigation has taken place. Investigation focuses on finding guilty parties. There is little systematic follow up and previous similar event-share not considered.
- There are trained investigators, with systematic follow-up to check that change has occurred and been maintained. Reports are sent to whole EPFL campus to share information and lessons learned. There is little creativity in imagining how the real underlying issues could affect the research.
- Many incidents are not reported. Investigations only takes places after a serious accident. Analyses don't consider human factors or go beyond legal requirements. Priority on protection of the laboratory (public image, grant, etc.).
- There are procedures producing lots of data and action items but opportunities to address the real issues are often missed. The search for causes is usually restricted to the level of the lab-workers.

16. **Remarks**

9 - Position and influence of CoSecs?

17. **Select the most appropriate :** *

Une seule réponse possible.

- CoSecs have influence to ensure safety compliance.
- Lab-workers seeks for CoSec's help when a problem is detected.
- CoSecs are seen as a reliable information source about safety by lab-workers.
- CoSecs are nominated because it is compulsory
- CoSecs workload is reduced as everyone participates to safety tasks.

18. **Remarks**

Who are you?

This survey aims to determine tendencies according to different groups of people. This part will only help us to aggregate the results in relevant groups.
Survey remains anonymous.

19. **You are :**
Une seule réponse possible.

- a PhD
- A Technician
- A PostDoc
- Master thesis student
- Professor
- Intern
- Autre : ____________

20. **Is laboratory-work your main occupation?** *
Une seule réponse possible.

- Yes
- No

21. **Are you working in an academic laboratory at EPFL? (or more)** *
Une seule réponse possible.

- Yes
- No

22. **Which School are you in?** *
Une seule réponse possible.

- SB
- STI
- ENAC
- SV
- IC
- CDM
- CDH

23. **For non-student respondents, which Institute are you in? (ISIC, IPHYS, GHI, etc.)**

____

24. **For student respondents, which section are you in?**
Une seule réponse possible.

- SCGC
- SPH
- SMA
- SMX
- SGM
- SEL
- SMT
- SGC
- SSIE
- SAR
- SIN
- SSC
- SSV

25. **Have you any remark on this survey, the project, etc.?**

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