

Measuring the Safety Climate of Academic Laboratories to Improve Safety Behaviours

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In 2005, two major accidents occurred at the Ecole Polytechnique Fédérale de Lausanne (EPFL). Although there were no injuries, the material damages resulted in high financial losses. The management of safety was restructured as a consequence. One of the major changes consisted in the introduction of laboratory safety coordinators (CoSec) and since then, each research unit has to nominate one of its members to take on this function. The CoSec system has significantly helped increase the efficiency and the quality of the flow of safety observations and information between the safety coordinators, safety officers, and the laboratory members.

This system has the benefit of providing insights into the safety in each laboratory. The Safety Competence Center, a specialized Occupational Health and Safety team, has conducted a survey among the CoSecs to gain insight into the Safety Climate at EPFL. Information on whether laboratory members feel that their colleagues comply to the safety rules of the School and whether their professor supports the laboratory members in taking time for safety related tasks provides the SCC with directions for safety behaviour improvements. Subsets of the CoSec population defined by position at the School and background indicates a difference of safety perception. This tool therefore enables the SCC to create projects, focalize its efforts and resources, and set priorities to address the issues brought up by the CoSecs.

1. Safety climate

The term safety culture was coined following the investigations of the International Atomic Energy Agency (IAEA) of the Chernobyl Accident of 1986 (International Nuclear Safety Advisory Group, 1986). When the term was first used it was not defined, but it was nonetheless taken up and used by others to explain some of the causes of many other catastrophes such as the Kings Cross underground fire in 1987 and the Piper Alpha platform explosion in 1988. Many different models have been developed since then such as the IAEA model (International Atomic Energy Agency, 2002) and Parker's framework (Parker, Lawrie, & Hudson, 2006). One of the recent definitions by the U.S. Nuclear regulatory Commission is "The core values and behaviours resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment." (Nuclear Regulatory Commission, 2011)

Safety culture is highly complex, and many tools must be used to obtain a correct understanding of it. These tools include behaviour audits, surveys, interviews, safety audits, analysis of safety documents etc. Safety climate on the other hand, is much simpler to study. It measures the climate at one point in time and allows to observe its evolution year after year. Human behaviour has an important influence on exposure to risk in the workplace and can result in serious issues regarding occupational health and safety (OHS). It is therefore important to promote safe behaviour. Even with a good behaviour change program, change in behaviour is not expected to occur before 18 to 24 months. In this case a survey is useful to monitor of the progress of the different safety projects.

1.1 An example of safety structure

EPFL has five experimental faculties and two colleges (Management of Technology and College of Humanities): Architecture, Civil and Environmental Engineering (ENAC), Basic Sciences (SB), Engineering (STI), Computer and Communication Sciences (IC) and Life Sciences (SV). The safety coordinators (CoSec) function was introduced at the SB faculty between 2005 and 2006, followed in 2008 by the other faculties. At that time, the laboratory safety was largely managed independently in each faculty.

In 2005 two major accidents occurred at EPFL fortunately only resulting in high material damages. These events were the trigger for the restructuring of the safety management, at first in each of the faculties independently, followed by a centralized Occupational Health and Safety (OHS) management in 2011. The safety coordinator (CoSec) concept has since then expanded homogeneously over the whole university; each research unit has to select one of its members to take on this function. The aim of this approach is to have a safety representative in each research unit who helps the safety officers carry out certain safety tasks.

The complexity of scientific research has increased, which requires researchers to perform experiments outside of their scientific expertise. Biologists in the SV faculty are increasingly using hazardous chemicals, although they are not specifically trained for chemical safety. Safety issues may then arise, for example as notions on chemical incompatibilities when storing chemicals are not as obvious for biologists as for chemists. The Safety Competence Center (SCC) was created in 2016 in an effort to expand and harmonize the structure and management of laboratory safety first applied at the SB faculty, to the whole of EPFL. The CoSec system significantly helped increase the efficiency of the flow of information between the CoSecs and the laboratory members at the school level. As a result of this safety structure and management, there have been no major accidents since 2005. The CoSecs hold a crucial role in many of the projects of the SCC, and it is important that they perform their tasks as expected.

1.2 Importance of the CoSec role

In 2017 EPFL counted more than 350 research units (including platforms, institutes, workshops or other entities that present hazards), distributed among about 2,000 laboratories and 266 active CoSecs.

The primary mission of OHS is to ensure that workplaces are safe environments. To fulfil this mission activities are performed, such as laboratory safety audits; distribution of safety information and specialized courses for the researchers; hygiene and health; incident and accident; general training of all personnel as well as specific and interactive support. The SCC is available for the laboratory members when they need help or advice, and to listen to their feedback to understand both their needs and where improvements can be made. For the OHS to have a safety impact on these laboratories through the actions described above, it is essential that communication with the researchers flows easily in both directions; the CoSec act as a transmission gear. Fostering such a relationship is challenging due to the size of the SCC team relative to that of the research community. In an effort to help the SCC, the CoSecs have been entrusted with carrying out certain safety tasks such as:

1. be the contact person for occupational health and safety (OHS) in his unit
2. participate in SCC safety visits;
3. organize an introductory welcome concerning OHS for new employees and guests of the laboratory;
4. pass on safety information, safety-related problem and incidents concerning the laboratory to the SCC.
5. impose emergency measures to eliminate any imminent danger;
6. be acquainted with alarm systems, building evacuation procedures and emergency equipment and inform the laboratory staff;
7. Update door safety data-sheets once a year or each time that a hazard change occurs in the laboratory;
8. periodically check the presence and state of personal protective equipment and maintain this equipment up to date;
9. check that modifications requested concerning safety for the laboratory are implemented;
10. organize the announcement of events, participate in meetings and specific training sessions;
11. manage, even by delegation, the cleaning of the workplace, the storage of chemicals, waste collection and its transfer to the faculty stores;

There are three main parameters that impact whether a CoSec (or any employee) will carry out a task:

- knowledge, knowing what are their tasks are and how to do them;
- ability, being able to do their tasks (e.g. time and equipment);
- attitude, having the motivation to perform their tasks and being proactive. The CoSecs may know what to do and have the means available to do them, but if demotivated they will nonetheless not perform their tasks.

The most important task is the transmission of information to the people who specifically require the information (cf. Figure 1a). For example, in 2017 a new course on nanomaterials safety was created, and the

SCC consequently had to send out information regarding the course to the researchers concerned, i.e. those working specifically with nanomaterials. Although an inventory of laboratories and researchers working with nanomaterials had been performed in 2017, due to the high turnover of personnel as well as of research projects, the list was already outdated. Consequently, the SCC elected to send the information to the CoSecs, and to entrust them with transmitting it exclusively to the concerned people within their research unit. This method prevented the submersion of scientists with information that may not concern them and as a result, over time, have the SCC's emails automatically placed in the "spam" folder of the researcher's mailbox. Additionally, this enabled the SCC to target the right people, as the CoSecs know better which of their colleagues may be interested by such information. Whilst they are extremely important and helpful to the SCC for tasks such as these, any CoSec who ignores the email will result in a potentially large number of researchers who does not receive the information (cf. Figure 1b).

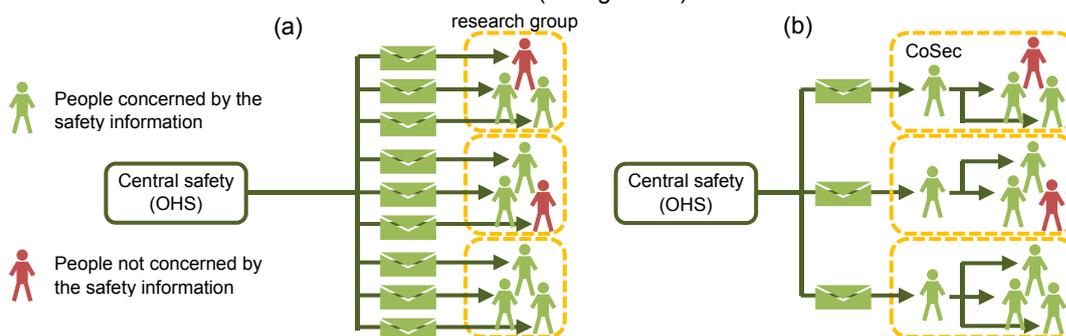


Figure 1 Example of spreading of information with and without the CoSec system. (a) All laboratory members obtain information from the OHS, regardless of whether they may be directly concerned or not by the information.

(b) The CoSec transmit the information to concerned people.

2. Safety Survey

The purpose of the survey was to improve the conditions in which the CoSecs perform their tasks at EPFL and have insight into the safety climate inside the research groups (Choudhry, Fang, & Mohamed, 2007) (Van Noorden, 2013). The impact of many SCC projects is strongly dependent on the willingness of the CoSecs to perform the tasks provided above. This study shows that a survey is the right tool to fine-tune existing activities and identifying new safety projects by understanding the CoSecs' needs, the interaction they have in their research unit and the recognition they look for. Three themes will be presented in the following sections: audits, difference among CoSecs, time devoted to their tasks and recognition.

2.1 Methodology

The survey was written both in French and English. An intranet version was first published in January 2017 and a web link sent by email to the CoSecs after the safety audit of their unit though the year. The survey is divided into four parts: an introduction that explains its purpose; a feedback concerning their experience of the aforementioned safety audit, questions regarding daily activities and a request for additional information (position at EPFL, faculty etc.). The number of questions is limited to 30 in an effort to maintain the time required to fill it in below ten minutes. The CoSecs are presented with questions that they can either answer through Likert-scales (Strongly Agree, Agree, Disagree, Strongly Disagree), multiple choice questions, yes/no-type questions and free text fields (de Singly, 2016). Respondents can skip questions if they desire, although it is asked that they answer all questions. The login information from the institution account was not made accessible to the analysis team to guarantee the anonymity of the people who answered.

The data from the English and French surveys was merged together using a unified numeric coding key using a statistical analysis software. The first analysis consisted of descriptive statistics, mainly by plotting the number of occurrences of each ordinal answer (Likert scale and yes/no). To some extent, nominal answers were also represented in frequency graphs when the free-text answer was limited by the number of available choices (e.g. "In what building are your laboratories located?"). A crosstab analysis was then performed to understand differences in responses among different CoSec subsets.

2.2 Results

By the end of 2017, a total of 151 survey were expected of which only 80 had been handed in. This preliminary result of 53% is not considered satisfactory. It is not yet clear if the survey can be made mandatory

and if this may bias results (Singh, Taneja, & Mangalaraj, 2009). During the year a total of four reminders were sent out, which increased the response rate by about 20%. The faculties with a more established safety climate (SB and SV) owe the highest number of responses, 59% and 56% respectively. The other faculties have a lower response rate, for instance STI has 36% and ENAC 39%. This already indicates that the harmonization of the school safety climate is different among the faculties and efforts have to be undertaken specifically.

Safety Audits

In order to continuously improve the health and safety of all collaborators as well as the safety infrastructures, the SCC periodically visits all laboratories of the EPFL. In 2017, over 250 research units were audited, which represents the majority of the experimental units. After the audit, a report is sent to the CoSec and the unit director. The deadline to return the report and implement the corrective measures is in general one month. The returned report must have the signature of the person who carried out the action on each remark and the signature of the unit director taking the responsibility for the entire set of measures.

Thirteen questions of the survey are devoted to the audit process. The manner in which the audit is organized and in which it occurs is generally appreciated by the CoSecs: They are happy with the deadlines (97% agree or strongly agree), they prepare themselves for the audit (95%), they believe they know where to get the information they need (93%) and they appreciate their contact with the auditors during the audit (95%). However, the feedback concerning relevance of the remark in the audit report is more contrasted: 52% slightly agree and 8% slightly disagree. This indicates that efforts have to be made to explain the audit remarks in the audit report. As a result, partly from the lack of understanding of the comments, the respondents were not convinced that the SCC met all of their requirement to contribute to safety (see Figure 3).

Although the CoSecs communicate the audit remarks to their team members, professors or other people concerned by the remarks, most CoSecs must take in charge the implementation of corrective measures themselves and do not delegate a lot. A campaign towards the professors may be necessary to sensitize them to the role of CoSec as well as to their own responsibility in the process.

As a consequence of these results, the SCC has reviewed the audit procedure. The safety audit is a crucial action that occurs once a year for each CoSec. It should not be perceived as an intrusion attempt nor as an administrative check but rather as a chance to expose successes and failures of the year and stimulate discussion. In order to do so, the number of audits has been diminished to promote a longer interaction with CoSecs, allowing safety officers to meet and discuss with the CoSec before the audit, get a deeper interest in their activities and promote proactivity of the CoSec through the year. In addition, part of the audits is now unannounced in order to see the unit's daily work as it is during the year. This suggestion was proposed by some CoSec in the free text of the survey in order to help them keep their laboratories in order through the year.

Difference among CoSecs

CoSecs are mostly represented by technician staff (39%), followed by permanent scientists (27%), PhD students (17%), postdocs (8%), team leaders (7%) and administrative staff (2%); 75% of the them are permanent personnel (administrative and technician staff, permanent scientist and group-leaders) and 59% are scientists. As shown in Figure 2, more than half have a CoSec experience of at least 3.5 years. Given that the units can choose their CoSec freely, this indicates that experienced researchers or technicians are usually chosen for this task.

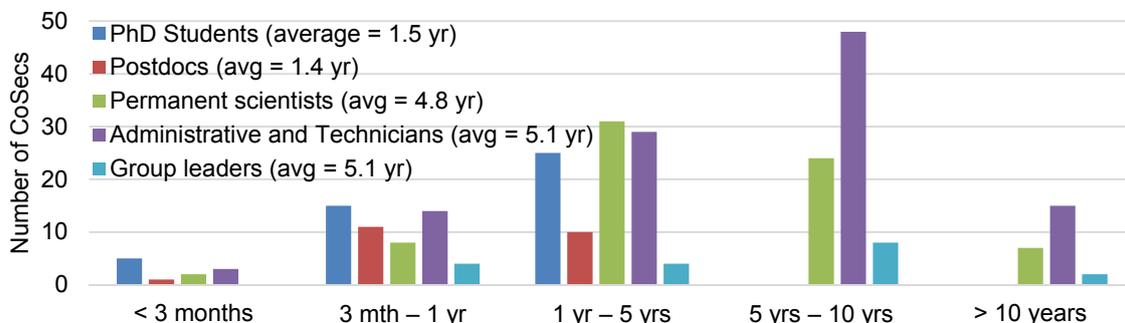


Figure 2 Time spent as a CoSec. The CoSec position is shown using different colours EPFL. The average time is shown for each of the categories in the legend.

A recent study by van Noorden (Van Noorden, 2013) points to differences in safety perception between those in junior roles and those in more senior positions such as professors. While the CoSec knowledge, capacity and attitude is different among them, it might be tempting to choose an employee for this function based on their age and position. The different actors within a laboratory do not share the same goals (e.g. technicians vs. doctoral students) nor the same daily activities. Selecting a population of employees for the CoSec role would therefore mean limiting and narrowing the safety vision that each is bringing to the OHS. Leaving the team leader to freely select the CoSec may not be ideal at first glance, but after understanding the differences it is possible to achieve a good compromise. This study will focus on the different positions held by the CoSecs. The time spent as a CoSec is somewhat linked to its position (e.g. administrative and technical staff are mainly senior employees).

A series of questions is based on activities, meetings and interactions that CoSec have or would like to have. Most of them (77%) are interested to have meetings with the SCC. These meetings are annual, but 35% of doctoral and postdoctoral researchers are interested in having more frequent meetings. Only 11% of the administrative and technical staff are interested in this option and there is also a higher percentage that is not interested in being followed and having regular meetings with contact person at the SCC (22%). 53% of the permanent scientist prefer to have a contact when desired. On this question doctoral students and postdocs indicate that they are slightly more interested. Concerning activities between the CoSec themselves, the survey shows the same trend. A large proportion of administrative and technical staff (43%) and permanent scientists (37%) are not interested in meeting other CoSecs. As pointed out by van Noorden (Van Noorden, 2013), the difference between new and more senior employees is also seen in this survey. Naturally, CoSec PhD students need more contact and follow-up from the SCC and also seek greater integration within the university.

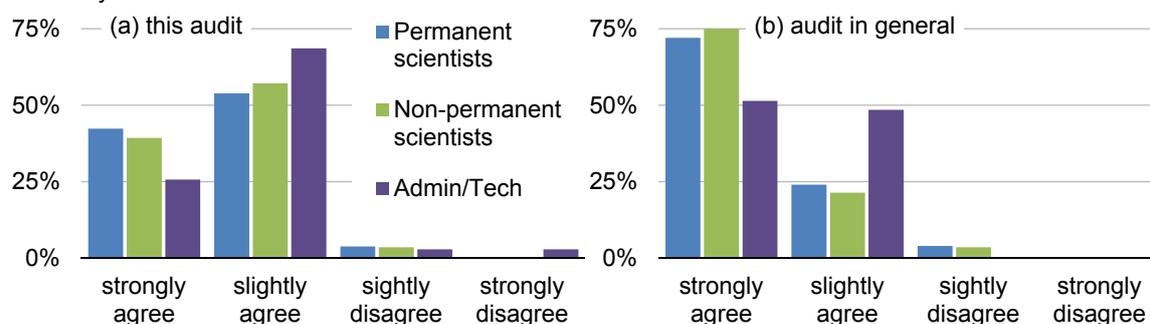


Figure 3 Opinion on the contribution of audits to the safety in laboratories. (a) safety audits at EPFL. (b) safety audit as expected by CoSecs.

The series of questions on the safety audit also indicates differences among CoSec subsets. Regarding the implementation of corrective measures in audit reports, 75% of permanent scientists announce delegating corrective tasks to their group, while only 42% of administrative and technical staff do so. To the question « In my opinion this safety audit contributed to the safety in my laboratory », only 26% of the administrative and technical staff strongly agree. This statement is more supported by permanent and non-permanent scientists who fully agree to 42% and 39% respectively (see Figure 3a). The same difference is seen concerning the perception of a generic safety audit (see Figure 3b). This set of question shows also a difference between scientists and permanent staff. By their daily work the technical staff is in charge of the maintenance of the experiments so that a higher percentage of the safety remark of the report is directly linked to their work. This analysis shows that audit have an impact on the safety perception and thus the safety climate.

As a consequence of these results, the annual CoSec meeting now includes the presentation of specific safety projects held by the CoSec themselves. The first project was achieved by a technician who presented a self-made apparatus to regularly check and clean the safety shower of his laboratory. This project has proven a great interest from other CoSec and especially the technical staff, indicating the success of the improved meeting.

Time devoted to the CoSec tasks and recognition

The safety management is an important part of the CoSec daily work and vary considerably between units. It depends on many parameters such as the number of group-members, laboratories and hazards. Several questions refer to this problem, during the safety audit process and the daily tasks. In general, the time devoted to interactions with the SCC is accepted by most CoSecs. For instance, 97% of the CoSecs are

satisfied with the deadlines given between the announcement and the safety audit. However, 17% of them think that they do not have enough time allowed by their group-leader to complete their tasks.

On the questions of support and recognition, 87% of them feel supported by SCC in their daily tasks. The non-scientific staff feels a lower daily support from the SCC. The Cosecs are involved in their role, they are convinced that their role strengthens the safety in the laboratory (46% strongly agree, 53% slightly agree) and being supported by their group-leader (55% strongly agree, 29%, agree). When asked if the people in their laboratory comply with the safety rules, 15% of respondents feel that people do not, 85% that they do, out of which 65% of the respondents slightly agree. The interaction with their group is thus more confrontational. CoSecs who are not supported by their group-leader also answer that the people of the group do not respect the rules of security and vice versa. The support of the group leader is therefore of high importance. PhD students and postdocs are under pressure to obtain results from their research and to publish to ensure a successful career. Additionally, their CoSec role may sometimes be perceived as that of a police officer amongst the colleagues, which is a difficult position to be in and not a motivating one. Because of this PhD students are more reluctant to intervene when one of their colleagues does not respect safety rules. This problem is emphasized by the fact that 40% of all CoSecs indicate that their role is not written in their contract. Therefore, 46% feel that their role is not acknowledged at EPFL. This pressure may result in demotivation and little incentive to perform safety tasks.

The SCC support should not be limited to providing tools and direct help, but also focus on the link they have with their respective groups. To date, there isn't a motivation system to reward CoSecs for their work. Discussions are ongoing with Human Resources to either provide them with a financial bonus or with compensation time (i.e. time off). New workshops and courses are being developed by the SCC and OHS to help increase the motivation of the CoSec by, for instance, sensitizing them to the importance of the different safety systems in place at EPFL, provide a space for to discuss amongst themselves of the difficulties they encounter, and to help each other out.

3. Conclusion of analysis to individual graphs

The use of surveys is crucial for monitoring the safety perception and safety climate over time. It allowed the quantitative measurement of problems that were already suspected from daily interaction with CoSecs. Different projects have been put in place and already proven to be helpful such as improved annual meetings and a new procedure for safety audits.

This study highlights differences among CoSecs with different positions and seniority. Although it is difficult to change the approach according to each of the them, part of the activity can be adapted to consider specific problems that some groups of CoSec have. This survey shows that time and recognition are intertwined and that the role of the head of the unit is crucial in the motivation of their daily work. On the other hand, if some of the CoSecs require more interaction than others, others require more independence. These conflicting visions illustrate the complexity of the research environment. One should not forget that empowering the CoSec function improves the safety both directly and indirectly, bringing safety ambassadors at the source of hazards.

Acknowledgement

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