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NoTeS: Non-Technical Skills for Safety. Safety Interventions Implemented in Chemical Plant

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Organizational safety is not only influenced by technological aspects and technical skills, but also by such factors, as regulatory and business pressures, job demands, workers' behaviours and skill. However, a need to consider Non-Technical Skills (NTS), that can contribute to a safer and more efficient task performance should be considered A research group of the University of Bologna developed an organizational intervention named "NoTeS – Non-Technical Skills for Safety", which aims to give an effective answer to companies that want to enhance safety in their own work environment. The paper describes the four phases of this intervention. In addition, safety interventions in chemical plants are analysed. Finally, the first positive outcome of improving safety in chemical plants based on participants' reactions, behaviour and interesting perspectives is discussed.

1. Introduction

Currently, managing safety issues relying exclusively on technological aspects and workers technical skills demonstrated to not be effective, but, at the same time, technical skills are crucial, although not sufficient in maintaining high safety levels over time (Yule, 2006).Thus, further aspects concerning workers' abilities and an understanding of human characteristics associated with each workers' task should be taken into consideration.

Non-Technical Skills (NTS) are defined as "cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance". (Flin et al., 2013, p.1)They refer to specific kinds of skills, defined by Soares et al. (2012) as "unspoken skills" that are not explicitly considered in the organization of work, and are not in the formal socio-technical system, but support the performance adjustment to work situations and are crucial in case of incident management.

In fact, as they are less domain-specific and more generalizable (Soares et al., 2012), NTS could refer to every kind of work environment, and are crucial skills to effectively manage incidents and adverse events, as they represent changes around the expected performance.

In this context and on the basis of previous interventions conducted during 2015 and 2016 in three plants, a research group of the University of Bologna belonging to different approaches and departments (Department of Education Studies, Department of Psychology and Department of Medical and Surgical Sciences) developed an organizational intervention named "NoTeS – Non-Technical Skills for Safety", which aims to give an effective answer to companies that want to enhance safety in their own work environment.

The main objective of this paper is to present the phases of NoTes for Safety and its first application in a chemical plant.

2. NoTeS for Safety

NoTeS for safety intervention is grounded on a deep analysis of scientific literature on safety at work, conducting and combining different approaches to the topic (mainly medical and psychological approaches), and, at the same time, it is the result of the application and experimentation of this scientific knowledge on real contexts, specifically chemical plants.

NoTeS for Safety is a dynamic organizational intervention aimed to deliver effective training and is composed of four main phases, described below in Figure 1.

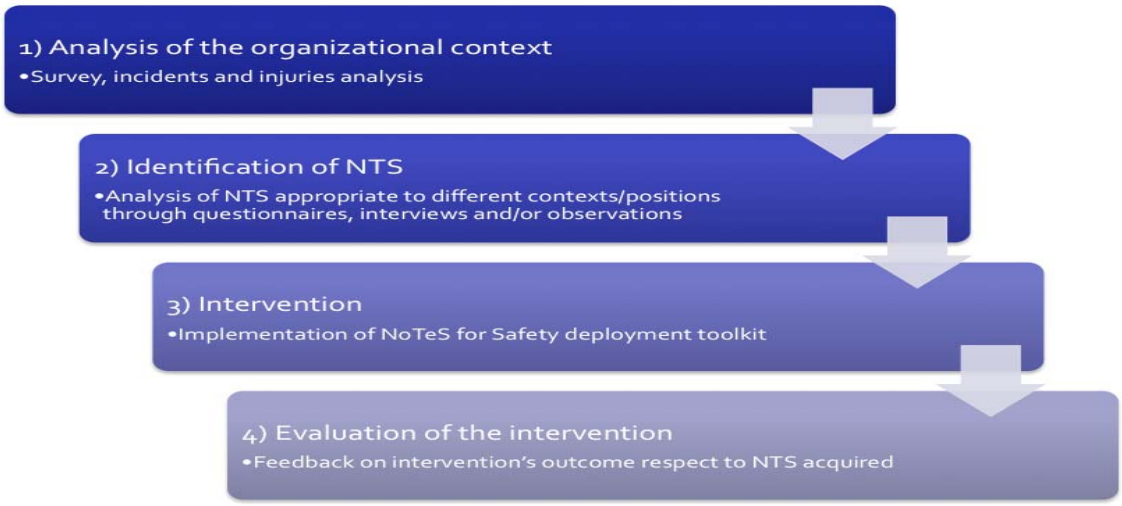


Figure 1 – Process and phases of NoTeS for Safety

The preliminary diagnosis (Phase 1) consists in the collection of both objective and subjective information on organization, for example information concerning the plant's history, the type of production, the organizational structure, data on injuries, near-misses, critical incidents previously occurred, procedure and rules on safety.
As of yet, numerous studies have demonstrated that safety climate, compliance behaviors and active participation are important predictors of safety behaviours and safety outcomes as incidents and injuries (Curcuruto, et al., 2015). Both academic literature and previous experiences in chemical plants showed how those aspects could be measured through depth surveys.
Phase 2 requires the identification of NTS. Following the approach of Flin, O´Connor and Crichton (2013), the identification of NTS is based on various forms of task analysis (e.g. interviews, structured observations, focus groups),.Indeed, in order to define goals and evaluation criteria of the training, it is necessary to define technical and non-technical skills and their behavioural markers referring to the specificity of the workplace.
Behavioural markers refer to behaviours that can affect safety job performance and can be attributed to both a group or a person. Non-technical skills vary among professions, organizations and positions. Consequently, their behavioural markers will be different for contexts that entail not comparable risks (Prati et al., 2006). Identifying behavioural markers is necessary in order to select, evaluate and develop non-technical skills. Behavioural marker systems are used to structure observation and evaluation of NTS aimed to enhance safety and efficiency, specifically when professions are characterized by high job demands. The main objective of these systems is to identify the specific behavioural markers of non-technical skills which can be observed and that contribute to a safety performance above or below the average (Flin and Martin, 2001).
The joint information collection of Phases 1 and 2 lead to an appropriate identification of the non-technical skills which will be the focus of the training intervention, directed to specific groups of workers belonging to different plants.
The design of the training intervention is the core activity of Phase 3 and includes the selection of teaching methods and the delivery of the training. The training intervention is modular and its length depends on the quantity of NTS that results from the previous phases and on the level of depth agreed with the company, that the training intends to achieve. The training intervention relies on active teaching methods, which directly involve the trainees. This is because different teaching methods make the difference in terms of effectiveness and transfer of what has been learned. In fact, Burke et al. (2006) demonstrated that high engaging teaching methods are three times more effective compared to low engaging training methods in the area of safety training. On the basis of what has been previously done in chemical plants, every training unit is composed of: 30% theory highlights, 60% practical exercises, 10% individual work. Furthermore, NoTeS for Safety also contemplates the involvement/training of safety managers (Ricci et al., 2016).
The training intervention usually takes place in an equipped room of the plant, with the aim to shape practical simulations in the real workplace. All documentation concerning training is collected in the NoTeS for Safety deployment toolkit.

Learning new skills does not guarantee that they will be automatically transferred into work behaviours. This has been demonstrated in numerous studies that highlighted that only 50% of training activities usually led to changes in work behaviours (Burke and Hutchins, 2007).
For this reason, NoTeS for Safety also includes the evaluation of the training intervention by means of both subjective (e.g. workers' perceptions) and objective (e.g. numbers of injuries, near miss) data collection (Phase 4). This, in accordance with the "Conceptual Model for workplace training interventions for primary prevention in Organization Health and Safety" (shown in Figure 2) developed by Robson and colleagues (2012), considers the results of safety training on immediate effects (e.g. knowledge), intermediate effects (e.g. behaviours) and impacts (e.g. injuries). Data collection occurs at least in two different moments (before and after the intervention) and finally, a few months after the end of the intervention, participants' anonymity is guaranteed.

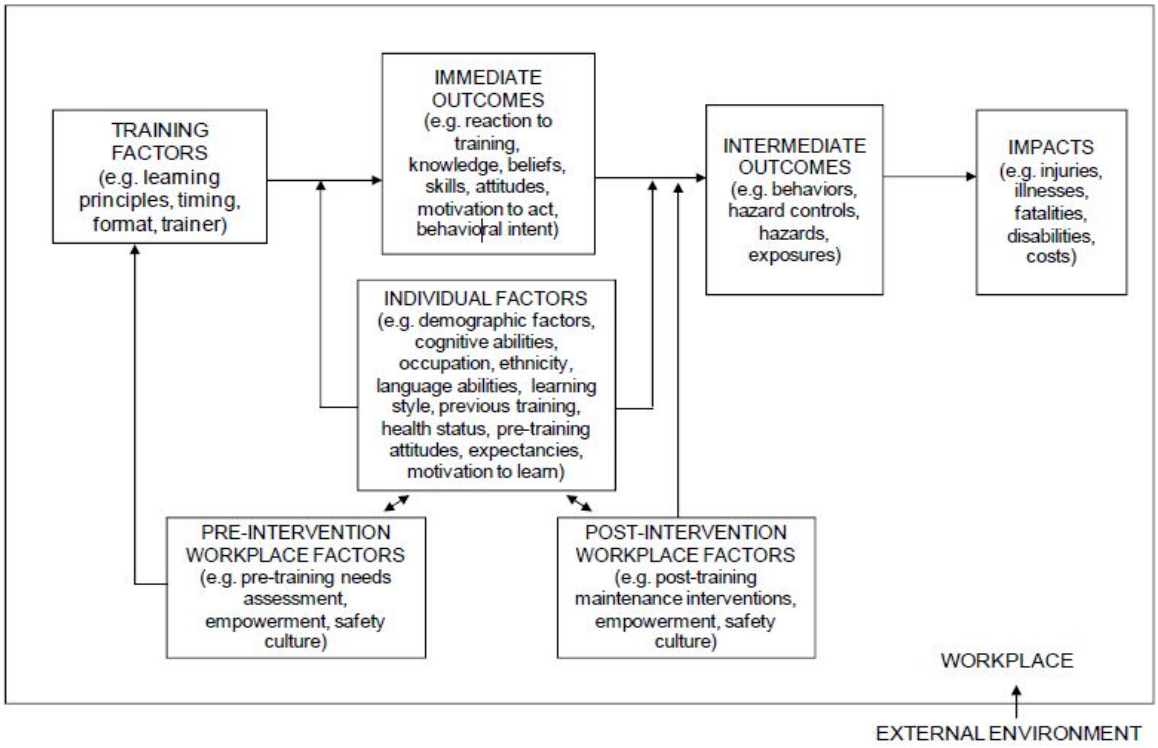


Figure 2 – A conceptual model of workplace training interventions for primary prevention in OHS (Robson et al., 2012)

2.1 The implementation of intervention

The first implementation of NoTeS was carried out in a chemical plant of North Italy, where 78 employees worked in different sectors (production, logistic maintenance, quality assurance, office/administrative). Moreover, 11 contractors of third-party companies were involved in the project.
The intervention followed what NoTeS protocol prescribes and started with the presentation of the project to managers and with the communication to employees.
The organizational context analysis was conducted in the first phase. Data of the last five years showed very low levels of injuries, incidents and near-misses; the results of the survey presented a good level of compliance and a fair/sufficient level of participative behaviour for safety. The objective data received from the companies and subjective data collected by questionnaire from the workers was integrated and confirmed by five interviews that involved the plant manager and managers of specific sectors.
The second phase was aimed at the identification of NTSs: starting from plant safety regulations, data collected in the first phase intervention (by archival research on injuries, incidents and near-misses, survey and interviews) and the scientific literature evidence (i.e. Flin et al., 2013), three safety expert psychologists identified the five most important NTS for safety specific to the context, following the approach of Flin, O´Connor and Crichton (2013). The criteria to select the NTS was also based on the hazard risk assessment matrix (likelihood x consequence), that permitted the evaluation of the main hazards and, therefore, the

related NTS for their prevention. The five selected NTS were: Situational awareness, Decision-making, Communication, Leadership and Fatigue/Stress Management. This description is reported in Table 1.

Table 1. Non-Technical Skills for Safety: description of taxonomies

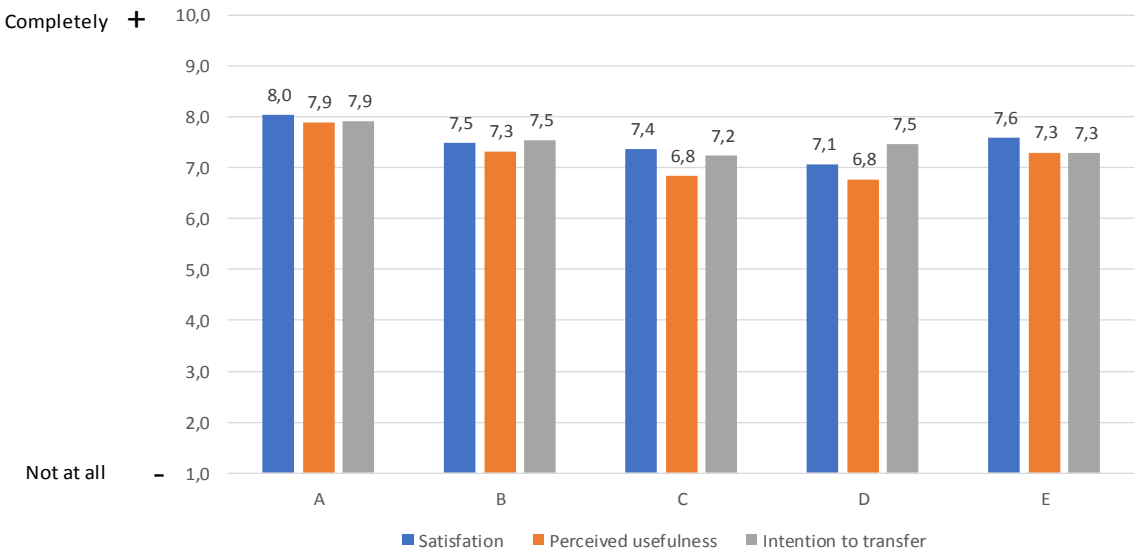
NTS	*Description*
Situational awareness	Situation awareness can be described as the skill to know what is going on around an employee, in safety perspective. It consists in a constant monitoring of the workplace, observing what is going on and detecting any changes in the environment (Flin, 2013).
Decision-making	This taxonomy can be described as the process of reaching a judgement or choosing an option, in safety perspective. Usually in operational work settings, there is a continuous cycle of monitoring and evaluating the task environment, and then the employees have to take appropriate action.
Communication	Communication is a basic element of good teamwork and is vital to workplace efficiency and safety and is based on the exchange of information, feedback or response, ideas and feelings, in safety perspective.
Leadership	The taxonomy has been defined as the skill of getting others to do (and want to do) something that the leader believes should be (must be) done, in safety perspective, involving interpersonal influence, goal-setting and communication (Furnham, 2005).
Fatigue/stress management	Many chemical plants necessitate 24 hours of operation, seven days a week, and consequently this can require long shift work. Consequently fatigue is acknowledged to be a significant safety concern (Rosekind et al., 1995). Fatigue is generally considered to be a decline in mental and/or physical performance on the basis of prolonged exertion, sleep loss and/or disruption of the internal clock.

As a result of the first two phases, three training programmes were developed: one for managers, one for blue-collar and one for white collars. The contractors of third-party companies were involved in the course for workers. In the third phase, the training intervention was implemented. Table 2 shows the process and the structure of the three training programmes.

Table 2. Description of the three courses.

Timetable (Months)	Participants	Hours	Contents
1^	Managers	12	Theoretical elements of the five NTS were presented. Individual and group exercises for each NTS were purposed. Particular focus was on leadership and feedback (communication section) for improving safe behaviours of the subordinates. The course was in a meeting room. The trainers were two NTS experts and the safety/health manager had an active role. Seven managers attended.
2^-7^	Blue collars	16	Theoretical elements of the five NTS were presented. Individual and group exercises for each NTS were purposed. Particular focus was on exercise in the plant, designed on the basis of safety regulations. Trainers were NTS experts and the safety/health manager had an active role. 58 workers attended in 5 editions of the course. For each edition, participants came from different organizational sectors to improve the collaboration on procedures of safety.
7^-9^	White collars	8	Theoretical elements of the five NTS were presented. Individual and group exercises for each NTS were purposed. Particular focus was on communication and stress management exercise. Trainers were NTS experts and the safety/health manager had an active role. 13 employees attended only one edition of the course.

The fourth phase of program regarded the monitoring and the evaluation of the intervention.
The data was collected by a questionnaire at the end of every lesson. Figure 3 shows the results in terms of satisfaction, perceived usefulness and intention to transfer the learning, in respect to the training programme of blue/white collar participants.



A	Situational awareness	C	Leadership	E	Fatigue/stress management
B	Communication	D	Decision-making		

Figure 3. Satisfaction, perceived usefulness and intention to transfer of training

The results show good/fair levels of satisfaction and perceived usefulness of the training program. The highest values were assigned to Situational awareness lessons, in which exercises of hazard hunting, conducted directly in the plant or in photo/pictures, were adopted. The lowest values were assigned to Decision-making lessons, which asked participants to choose the personal protective equipment (PPE) for doing some specific tasks in the plants. The levels of intention to transfer the learning index are also fair, the highest regarding Situational awareness and the lowest Leadership skills. Obviously, the importance of leadership skills depends on different job positions, therefore, this is an expected result.
The minutes of trainers, the results of the exercises and the questionnaire at the end of each lesson permitted to write an analytic report, useful for the management of behavioral safety. All data was presented and discussed with the plant managers in order to project new strategies for safety improvement.
Moreover, new data of injuries, incidents and near-misses will be collected for the next three years. Finally, a survey is scheduled 12 months after the end of the intervention. It will be further checked to analyse the safety climate and its improvements.

3. Conclusions

The application of the NoTeS protocol within a chemical plant showed the flexibility of the proposal, but also its potential in identifying the Non Technical Skills for safety relevant to a determined workplace context. The transformation of these NTS analysis in specific training programmes showed positive immediate outcomes. Indeed, the results relative to the evaluation of intervention, briefly reported above, confirmed that the protocol of NoTeS was a satisfactory experience, and was perceived as useful. However, the most important result/outcome was that participants declared their intention to transfer the learning to their daily behaviours. Obviously, an important limitation of this case was that we did not have a measure of NTS before and after the courses, but it would be scheduled for the next application of the NoTeS protocols. Moreover, the intervention permitted improvement of the active role of safety/health managers and workers, collecting information and suggestions on safety in the plant directly from them. Furthermore, NoTeS for Safety also contemplated the involvement/training of safety managers. In fact, in safety context it is important to consider employees, safety supervisors and managers (Vignoli et al., 2014). Many studies (e.g. Bonsall-Clarke and Pugh, 2013) highlighted the importance of managers' support and their sponsorship of the NTS as key factors in determining the success of a NTS training intervention. For example, a recent study aimed to investigate which factors were able to influence transfer of safety training showed that safety transformational leadership of the supervisor was related to intention to transfer (Vignoli et al., 2018).
Obviously, during the lessons, problems relating to safety declared by attendants need to be collected and answered with useful actions.

It is important to also consider the evaluation of the safety intervention or training proposed by the current protocol. Future research should analyze the measured levels of the relevant NTSs before and after training to study the effects of the courses. Indeed, according to other models existing in the literature on health and safety in general (e.g. Vignoli et al., 2014; Guglielmi et al., 2013) both quantitative and qualitative measures (e.g. using data obtained from interviews and injuries or near misses rates) are considered in order to have reliable results. Finally, when further experiences of NoTeS for Safety protocol application will have been collected from different plants, a wider and deeper analysis of Human and Organizational Factors in chemical safety will be carried out.

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