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Masi, Donato; Cagno, E.; Hasle, Peter; Farnè, S.

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D. Masi & E. Cagno
Politecnico di Milano, Milan, Italy

P. Hasle
Aalborg University, Copenhagen, Denmark

S. Farnè
University of Pavia, Pavia, Italy

ABSTRACT: A multitude of Occupational Health and Safety (OHS) interventions have proven to be effective under controlled conditions, but their implementation in practice is often difficult and interventions may therefore not work as expected, especially when referring to Small and Medium sized Enterprises (SMEs). In order to solve this challenge, this paper proposes a model for the systematic design of OHS interventions which takes into account the underlying mechanisms and the contextual factors which can hamper or further the implementation of interventions.

1. INTRODUCTION

A multitude of Occupational Health and Safety (OHS) interventions have been proposed by researchers and practitioners. Even though the interventions as such have proven to be effective – normally under controlled conditions – implementation in practice is often difficult and interventions may therefore not work as expected. Therefore literature points out that the effects of interventions rarely are as strong as expected (see e.g. Kennedy et al. 2010). A number of researchers have tried to solve this problem by suggesting various models for the design of interventions which should secure a stronger implementation. Most of these models understand interventions as projects and they have adapted phase models from the industrial management literature (see e.g. Hare and Cameron, 2012).

However, even assisted by the phase-models, implementation of interventions is not necessarily effective, because the implementation is crucially dependent on the mechanisms promoting the social change and on the contextual factors which enable or disable these mechanisms (Pawson, 2002; Pedersen et al., 2012).

In order to consider the mechanisms and the contextual factors enabling the change process during the implementation of OHS interventions, Pedersen et al. (2012) have proposed a revised realistic evaluation model for the design and evaluation of OHS interventions. It includes factors such as role behaviour, leader and worker motivation, underreporting of injuries, production pressure, unplanned organisational change and accounting. More recently, Nielsen and Abildgaard (2013) presented an evaluation framework based on intervention research and process-oriented organization theory. The framework offers suggestions for which elements to include when evaluating organizational interventions. Within the framework, elements crucial to intervention evaluation are grouped into four overarching categories: the organizational ‘‘actors’’, the mental models of those actors, the context of the intervention, and intervention design and process.

Yet, these models are not fully exploitable by OHS practitioners during the design of OHS interventions because they do not guide practitioners into a systematic and structured fashion in the identification of the mechanisms and the contextual factors relevant for the particular OHS intervention. The models limit themselves to provide a generic definition of mechanisms and contextual factors, assuming that practitioners will be autonomously able to identify specific mechanisms and contextual factors on the basis of their skills and previous experience. The problem is that practitioners could be unable to properly identify specific mechanisms and contextual factors, since the practitioners' decision-making processes can at best be described as governed by bounded rationality, in which heuristics and prior experience play a large role (Hasle and Sorensen, 2011). Moreover, several models assessing context and behavioural mechanisms in accident analysis (see, e.g., Chang and Mosleh, 2007), or human reliability analysis (see, e.g., Kim and Jung, 2003) demonstrate that the analysis of contextual factors and mechanisms is a complex task that needs to be supported by highly structured decision making models.

Practitioners can therefore be expected to face difficulties on the one hand in carrying out a sufficient

in-depth analysis of context and mechanism, and on the other hand in keeping it sufficiently simple for utilisation in the practical situation.

This paper aims at providing a solution for this practitioners' challenge by proposing a model for the design of Occupational Safety and Health (OHS) interventions which takes into account the contextual factors and the behavioural mechanisms affecting the implementation of the intervention. The paper is structured as follows. In paragraph 2 (background), the literature related to implementation of interventions is briefly presented, with a focus on the realistic analysis and its limitations, which generated the research work. In paragraph 3, (the model), we present the model. In paragraph 4, the results of the test of the model in 20 Italian manufacturing firms are presented. Finally, in paragraph 5 some conclusions are taken.

2. BACKGROUND

The studies dealing with the implementation of OHS interventions have generally focused on a limited number of factors fostering or hindering the implementation of the interventions.

For instance, Whysall et al. (2006) explored the process of implementing interventions to tackle occupational ill-health, in particular the facilitators and barriers involved in implementing such interventions. The factors cited as key barriers and facilitators include the resistance of workers to changing their behaviour, gaining managerial commitment, and managers' general attitudes towards health and safety. Hale et al. (2010) describe the patterns of interventions distinguishing between successful and not successful projects and discuss the mechanisms lying behind them. They conclude that interventions that bring about constructive dialogue between shopfloor and line management, provide motivation to line managers and strengthen the monitoring and learning loops in the safety management system appeared more successful. There are other examples of studies which however share the same approaches, proposing one or more factors fostering or hindering the implementation of the interventions (see, e.g., Vedung, 2006; Nielsen and Randall, 2013). Thanks to their focus on behavioural characteristics and contextual factors affecting the performance of the workers, these studies help to explain the complex process necessary for the correct implementation of OHS interventions.

However, these studies cannot support practitioners in the design of more effective OHS interventions, because of a limited understanding of the role of the factors within the more general implementation process and of the way in which the factors interact. Existing studies propose factors that can actually play a key role in the implementation of interventions, such as the resistance of workers to change their behaviour or the managerial commitment and attitudes towards OHS. However, it is not clear how to promote the managerial commitment or how to overcome the resistance of workers to change their behaviour. In the same way, it is not clear whether these factors are equally important in different contextual conditions.

In order to effectively plan the implementation of OHS interventions, it is essential to have a clear understanding of the mechanisms promoting or overcoming some of the key factors listed in the literature, and it is essential to understand how these mechanisms and these factors are conditioned by the different contexts arising in different enterprises.

Realist analysis represents a valid theoretical approach for describing the mechanisms promoting or overcoming some key factors in the implementation of intervention and the interplay between those mechanisms and the context in which interventions take place (Pedersen et al., 2012). Realistic analysis was introduced by Pawson and Tilley (1997), and further developed in Pawson's later work (Pawson, 2002; Pawson et al., 2005). It is founded on the ontological position realism, and the key element is to identify what works for whom, under what circumstances, in what respects and how (Pawson and Tilley, 1997). The generative model of causality, which underpins realist enquiry, holds that to infer a causal outcome between two events, one needs to understand the underlying mechanisms that connects the events, and the context in which the relationship occurs (Pawson et al., 2005). The key elements are Context, Mechanism, and Output. Interventions are not presumed to have causal powers in themselves, instead context and mechanisms are seen as the factors which initiate or trigger the causal relationships; for instance motivation from the key actors is a necessary ingredient for the program to work. The actual outcome of the intervention will vary depending on the intervention, the context, the mechanisms, and the interplay between these, and can be categorized as positive or negative, expected and unexpected. Realist analysis represents a valid alternative for describing the interplay between personal characteristics and contextual factors within safety interventions because it turns the chain of reasoning of workers into a comprehensive theory of the mechanisms through which the desired change should happen. In the same way, the chain of reasoning and reaction is influenced by some technical and organizational features of the company, and realist analysis represents these features of the company in terms of contextual factors affecting the mechanisms through which the interventions may enter the operator's mind.

Summing up, it is essential to have a clear understanding of the mechanisms and the role of the context in the implementation of OHS interventions,

and realist analysis represents a valid theoretical approach in order to deal with these issues.

However, practitioners cannot use the realistic analysis yet for improving the implementation of OHS interventions. Indeed, in order to use realistic analysis in the industrial practice, practitioners need procedures which are simple, easy to use, systematic, but at the same time, comprehensive, valid and with a strong theoretical foundation. This aspect has not been adequately considered in the reviewed studies, which show two main limitations. Firstly, existing studies do not organize the analysed factors into a comprehensive model that can be used by practitioners in the design of OHS interventions. Each study focuses on a limited number of factors or on specific aspects, and a comprehensive view is missing. In order to properly design OHS interventions, practitioners dealing with the design of OHS interventions should identify all the relevant behavioural characteristics and contextual factors affecting the change process. Their knowledge as well as the amount of time and resources they can invest in the design of interventions is however limited. As a consequence they should be supported by a comprehensive taxonomy of contextual factors and behavioural characteristics that underlie the change process necessary for the implementation of OHS interventions. Some comprehensive taxonomies of contextual factors and behavioural mechanisms have been proposed in the accident analysis (see, e.g., Chang and Mosleh, 2007), and in the human reliability analysis (see, e.g., Kim and Jung, 2003) literature. Nevertheless, these models cannot be simply extended to OHS interventions, because they focus on specific actions in a short term temporal horizon, while the behaviour of the workers relevant for OHS interventions is made up of several different actions, that take place in a longer temporal horizon, and that are influenced by some intervention specific contextual factors. Secondly, practitioners need procedures which are simple, easy to use, and systematic. As a consequence, even if we have a clear theoretical understanding of the factors triggering the behavioural change of the workers, of the factors describing the context in which this behavioural change is embedded, and of the interplay between them, it is necessary to develop a procedure that drives practitioners in considering these factors during the design of the intervention. However, existing studies are mainly theoretical, and they do not propose any procedure that can be used by practitioners in their industrial practice.

In the light of the above limitations, in this paper we develop a model which supports practitioners in the use of the realistic analysis for an effective plan of the implementation of OHS interventions and which overcomes the abovementioned limitations.

3. THE MODEL

The model includes a taxonomy of mechanisms and contextual factors and a stepwise procedure which allows for a systematic analysis. Before developing the taxonomy, however, it has been necessary to develop a theoretical definition of mechanisms and contextual factors, presented in the following paragraph.

3.1. Theoretical definition of mechanisms and contextual factors

In order to produce a definition of mechanisms, we critically reviewed and combined previous definitions. Pedersen et al. (2012) defined mechanisms as "relevant personal characteristics of key actors or interpersonal relations between them". We picked the first part of this definition, and we focused on "relevant characteristics of key actors". In our model the mechanisms represent the thought that is instigated or "triggered" by the intervention and through which the workers' behaviour is changed. As a consequence, we narrowed the definition of Pedersen and his colleagues, and we assumed mechanisms as "mental state of key actors". Astbury and Leeuw (2010) discuss the concept of ''mechanism'' and they attempt to elucidate what mechanisms are and what they are not. They conclude that there are three essential clues located in a ''realist'' reading of mechanisms. These are that: 1) mechanisms are usually hidden; 2) mechanisms are sensitive to variations in context; and 3) mechanisms generate outcomes. We picked the last two definitions, since we are already assuming that mechanisms are hidden when we define them as mental states of key actors. In our case, the outcomes generated by mechanisms are the modifications in the performance or in the behaviour of the workers. Finally, Pawson and Tilley (1997) point out how mechanisms are "triggered by a program". We included this aspect in our definition in order to clearly make a distinction between the personal characteristics of actors that are not varying and the ones that vary with the implementation of a particular intervention. For instance, while the motivation of the workers is a personal characteristic that varies on the basis of the particular intervention implemented, the experience of the workers is a cognitive state that cannot be modified by implementing a particular intervention, at least in the short term.

On the basis of the previous arguments, we define mechanism as "mental state of key actors that are triggered by a program, that vary with changes in the context, and that produce a change in the performance or in the behaviour of the workers". It is important to notice that the change in the mechanisms could enable or disable the desired change. The purpose of practitioners is to promote the mechanisms

enabling the social change and to eliminate the mechanisms disabling the desired change.

As for contextual factors, we partially modified the definition of Pedersen et al. (2012) and we define contextual factors as "factors that are not directly related to the performance or to the behaviour of the workers, but that are expected to influence the performance or the behaviour substantially". Indeed, according to the proposed realist model, the mechanisms are directly related to the performance or to the behaviour of the workers, while the contextual factors create the conditions enabling or disabling mechanisms.

3.2. Taxonomy of mechanisms and contextual factors

Having developed a definition of mechanisms and contextual factors, we defined the criteria for the selection of mechanisms and contextual factors adequate for the purposes of the study. These criteria are listed below.

Criterion 1 - Focus on the behaviour of the workers during the implementation of OHS interventions. The amount of factors which could potentially describe the context and the mechanisms influencing OHS interventions is huge. However, it is possible to select a limited number of relevant factors by focusing on the sole factors that are relevant for the behaviour of the workers during the implementation of OHS interventions. The behaviour of the workers during the implementation of OHS interventions indicates a complex set of specific actions, which all together influence the overall implementation of OHS interventions. A specific action is for instance a wrong movement of the operator, that could provoke an accident. Such an action is relevant in a model for accident analysis, but not so relevant in the more general optic of an OHS intervention. The hypothesis done is that an isolated action has not a relevant influence on the overall effectiveness of the intervention, and it's rather necessary to focus on a more general set of actions, and to consider a longer temporal perspective.

Criterion 2 - Level of causality adequate for the assessment by SMEs' practitioners. The "level of causality" (Mohaghegh and Mosleh, 2009; Cagno et al., 2014) describes the position of the factors in the cause-to-effect chain. The choice of the level of causality answers questions such as: should the managerial decisions (hiring, training, etc.) be ''bottom layer" factors, or should we move further up in the chain of causality, to top managers' strategic decisions, and do we need to include the regulators' impacts on interventions? In our model, we decided to set the level of causality considering the factors internal to the company that are able to affect the whole behaviour of the workers during the implementation of OHS interventions. This modelling choice is justified by the assumption that it is possible to describe the effect of external factors on the performance of the workers during the implementation of OHS interventions by means of some mediating factors that are internal to the company. For instance, the conditions of the financial markets, that are considered by Pedersen et al. (2012) as a relevant contextual factor, could be described by means of the Perception of available resources, the Trust in management and in the enterprise, and the Rewards. This modelling choice offers several advantages. For instance, the factors could be easily assessed by SMEs' practitioners. It is extremely difficult for OHS practitioners to assess the conditions of the financial markets and their influence on OHS interventions, while it is easy to assess the rewards available for the workers within the company.

Criterion 3 - Level of detail adequate for the development of hypotheses on the overall intervention. The "level of detail" (Mohaghegh and Mosleh, 2009; Cagno et al., 2014) of factors depends on the importance attached to the different dimensions of the factors in terms of their impacts on the model output. For example, there are two possible approaches to make a cause-to-effect interaction between the "human resource system" and "safety climate". The modeller can consider these two factors as global factors. On the other hand, he/she can establish multiple relations between the "human resource system" and different dimensions of the "safety climate" (e.g., "perception of the reporting system", "perception of training", etc.). The latter is modelled with a higher level of details (Cagno et al., 2014). In our model, we decided to set a level of detail optimal for the needs of the realist analysis, i.e. a level of detail allowing practitioners to develop hypotheses on the whole behaviour of the workers during the implementation of intervention. In order to understand this level, we reviewed some studies specifically developing hypotheses on the mechanisms underlying the behavioural change and the success during OHS interventions. On the basis of these studies, we identified a preliminary set of mechanisms and factors that has been used as a benchmark for the level of detail to be adopted in the taxonomy.

Criterion 4 - Practicality. The factors should be used by ordinary field "safety persons", eventually of a SME, without the need for highly trained experts.

We did not find taxonomies in the literature which covered all the above aspects, neither for the mechanisms nor for the contextual factors. However, we found that some specific factors were able to satisfy all the mentioned criteria and that other factors were potentially suitable after a tailoring process. As a consequence, we performed a conceptualization work and we developed new taxonomies for mechanisms and contextual factors. In some cases, we

simply picked factors from existing taxonomies, selecting some factors and excluding others for different reasons. Some factors mentioned in literature are split in different factors. Some were found to be overly broad and as such had to be modelled through other more narrowly defined sets of factors.

We focused on three kinds of studies. First, we reviewed the studies dealing with human error analysis (HEA) or human reliability analysis (HRA) in safety assessment. These studies represent the conditions that influence human performance by means of several 'context factors'. These context factors are referred to by different terms according to method: PSF (performance shaping factors), PIF (performance influencing factors), IF (influencing factors), PAF (performance affecting factors), EPC (error producing conditions), CPC (common performance conditions), and so on. Second, we reviewed the studies dealing with barriers and drivers to OHS interventions; barriers and drivers identify all those factors of context not directly involved in workplace safety intervention, but significantly affecting, respectively hindering and fostering, the outcome of interventions. Third, we reviewed studies dealing with realistic analysis of OHS interventions.

We combined the factors in order to obtain a taxonomy that is as comprehensive as possible. The taxonomy of mechanisms is reported in Table 1, while the taxonomy of contextual factors is reported in Table 2.

Table 1. Taxonomy of mechanisms, classified in classes.

Class	Mechanism
Temporary cognitive states	Memory of previous interventions
	Anticipation
	Autonomous identification of effective behaviours
	Perception of the importance of the intervention
	Perception of the consequences associated with the own behaviour
	Expectations of the workers
	Perception of familiarity with the situation
	Proper interpretation of the own role and responsibilities
	Perception of available resources
	Perception of the complexity of the intervention
	Emulation of behaviours of the working group
Psychological states	Motivation
	Morale
	Confidence in own behaviours
	Confidence in the chosen intervention
	Trust in management and in the enterprise
	Fear of failure
	Stress due to urgent requests
	Stress due to the conflict
	Frustration
	Uncertainty
	Attention

Table 2. Taxonomy of contextual factors, classified in classes and sub-classes.

Class	Sub-class	Factor
Operators	Physical factors	Fatigue
		Physical abilities
	Cognitive factors	Skills
		Knowledge
		Experience
		Training
Physical work environment, equipment and tools	Physical work environment	Illumination
		Noise
		Air quality
		Temperature and humidity
		Freedom of movement of workers
		Freedom of communication
		Layout of the plant
		Order and cleanliness
	Equipment and tools	Availability
		Quality
Organization factors	Management and policy	Plant Policy
		Work and task organization
		Level of supervision
		Production pressure
		Rewards
		Punishments
		Safety culture
	Tasks	Task related difficulties
		Other difficulties
	Procedures	Availability
		Quality
Team factors	Features of the team	Cohesiveness
		Coordination
		Composition
	Communication	Availability
		Quality
	Leadership	Leadership

3.3. Structure of the analysis

In order to structure the analysis in a systematic and structured fashion we propose a stepwise procedure for the design of working environment programmes. The design procedure therefore adds some supplementary steps to the original procedure proposed by Hasle et al. (2012) and is made up of seven steps:

1. Define the OHS challenges of the target group.
2. Select methods and solutions that can improve the working environment by reducing the exposure and thereby producing the intended OHS outcome; for instance, the solution could consist in the introduction of personal protective equipment (PPE), or in the modification of the tasks of the target group.
3. Define the change in the behaviour or in the performance of the workers necessary to the effectiveness of the OHS intervention; for instance, following the previous examples, the change in the behaviour of the workers consists in the first case in the fact that the workers use the PPE and in the sec-

ond case in the fact that the workers accept and follow the new task.

4. Develop theories about mechanisms which can motivate the target group to initiate change, or which can hinder the change; in order to ensure the comprehensiveness of the analysis, the mechanisms should be selected from the taxonomy proposed in Table 1. For instance, following the previous examples, the mechanisms could be the "Motivation of the workers" and the "Fear of failure".

5. Analyse the influence of the context for each of the selected mechanisms; in this step, for each mechanism practitioners should select one or more contextual factors that "condition" the mechanism itself. For instance, the "Fear of failure" can be conditioned by the "punishments" adopted within the company, while the "Motivation of the workers" can be conditioned by the "rewards". In order to ensure the comprehensiveness of the analysis, the contextual factors should be selected from the taxonomy proposed in Table 2.

6. Assess the adequacy of the contextual factor in relation to the particular mechanism; for instance, practitioners should ask themselves question like: "Are the punishments adopted within my enterprise adequate in order to activate the fear of failure of the workers?" or "Are the rewards adopted within my enterprise adequate in order to activate the motivation of the workers?".

7. Develop design recommendations for the intervention which build on the results of the four preceding steps. For instance, on the basis of the previous assessment, the workers could decide to modify the reward or the punishment system.

4. TEST OF THE MODEL

4.1. Methodology

Between September 2013 and March 2014, twenty safety officers were interviewed, with the support of a questionnaire. The questionnaire was divided into three sections. In the first part, some enterprise characteristics (sector, turnover, etc.) were asked. In the second part, the safety officers used the model: the several steps of the procedure, as well as the preliminary steps necessary for the problem setting, were proposed to the practitioners by means of ten structured questions. In the third part, we asked to the practitioners to evaluate the performance of the model taking into account three main criteria: usefulness, completeness, and difficulty of use. The questions used for the evaluation of the performance are reported in Table 3.

Table 3. Questions used for the assessment of the performance of the model in the third part of the questionnaire.

Criterion	Questions
Usefulness	Was the model useful for the design of the intervention? Why? Did the model help to identify some factors that you did not identify? Did the model help you to better structure what you had in your mind? While setting the improvements of the intervention, was it helpful to consider the interaction between mechanisms and contextual factors? Why ? Were you able to identify – thanks to this interaction- some aspects of the contextual factors that you would have neglected without the model? Do the improvements introduced thanks to the model compensate the difficulty of use? Would you obtain the same results in the same time without the support of the model?
Completeness	Do you think that the list of mechanisms is complete? Do you think that the list of contextual factors is complete?
Difficulty of use	Which was the most difficult step performed during the use of the model? Why?

The distribution of sample firms by industry sectors, turnover, and number or workers is summarised in Table 4. The Small- and Medium-sized Enterprises (SMEs) – as defined in the 2003/361/EC Recommendation (European Commission, 2003) - mainly belong to the most important manufacturing sectors of the Lombardy Region in Italy in terms of employees and turnover and they have been classified according to the International Standard Industrial Classification of All Economic Activities "ISIC rev.4", as reported in Table 5. As it can be argued from Table 4, the SMEs have been divided into four classes: Micro (MiEs, employees $\leqslant$ 10), the Small (SEs, 10 < employees $\leqslant$ 49), Medium (MEs, 50 < employees $\leqslant$ 99), and Medium-Large Enterprises (MLEs; 100 < employees $\leqslant$ 250).

Table 4. Features of the companies in terms of turnover and employees.

Enterprise	Number of employees	Turnover [mln €]	Sector
1	20-49	5,9	C25
2	100-250	32,9	C25
3	20-49	3,67	C25
4	50-99	n.a.	C28
5	50-99	n.a	C10
6	100-250	n.a	Other
7	100-250	n.a	C22
8	100-250	60	C28
9	10,19	8	C22
10	20-49	5	C27
11	20-49	4,5	Other
12	20-49	12	C28
13	20-49	5	Other
14	50-99	10,5	C25
15	20-49	2,5	C25
16	10-19	3	C25
17	20-49	3	C25
18	10-19	3	C17
19	20-49	5	C22
20	50-99	10	C28

Table 5. Sectors of the companies.

Metal products, excluding machinery and equipment	C 25
Machinery and equipment n.e.c.	C 28
Food	C 10
Paper and paper products	C 17
Rubber and plastic products	C 22
Electrical equipment and non-electric domestic appliances	C 27

4.2. Results

All the twenty practitioners were able to correctly compile the second part of the questionnaire, in which they had to use the stepwise procedure and the taxonomies. The third part, in which we asked to the practitioners to evaluate the performance of the model taking into account the usefulness, the completeness, and the difficulty of use of the model was filled in by 19 of the 20 practitioners (excluded the practitioner of company 6).

In all the cases, the interviewees confirmed that the model was useful for the design of the intervention. The reasons reported by the interviewees include a higher effectiveness in the design of the solution, a better focus on the aspects that should be considered, the identification of aspects usually neglected, and a more organic and systematic way of structuring the data.

All the interviewees confirmed the usefulness of considering the interaction between mechanisms and contextual factors. The main reason was the identification of specific aspects of the contextual factors highlighted by the comparison with the mechanism. Other interviewees reported how the comparison between mechanisms and contextual factors improves the comprehensiveness of the analysis.

As for the improvements introduced compared to the difficulty of use, the answer to this question varied among the interviewees. In some cases, the interviewees reported that the improvements compensated the difficulty of use (company 1, 3, 5, 7, and 8, and 11-20); in other cases the interviewees reported that the improvements compensated the difficulty of use only partially (company 4, 9, and 10); and in one case the interviewee reported that the improvements did not compensate his difficulty of use (company 2).

As for the possibility of obtaining the same results in the same time without the support of the model, the interviewees provided different answers. In the majority of the cases, the interviewees reported that they would not obtain the same results in the same time without the support of the model (company 3, 5, 7, 8, and 9); in other cases, the interviewees were not able to answer to the question (company 1 and 4), and in other cases (company 2 and 10) the interviewees reported that they would obtain the same results in the same time without the support of the model, coherently with previous answers.

As for the completeness of the model, all the interviewees reported that the list of mechanisms and of contextual factors is complete.

There are three steps that seem to be critical. The first critical step is the selection of the mechanisms (company 3, 4, 7, 9, 11, 12, 13, 19, 20), because it is not easy to make a distinction between mechanisms "enabling" and mechanisms "disabling" a change in the behaviour of the workers (company 4) or because it is not easy to connect mechanisms with corresponding behaviours (company 9). In other cases (company 3 and 7) practitioners were not able to explain specifically the criticality of the step.

The second critical step is the combination between mechanisms and contextual factors (company 2, 10, 15, 16, 17 18), because, according to some interviewees, it requires a perfect knowledge of the context and of the workers involved in the intervention.

The third critical step is the development of the design recommendations (company 2 and 5), because, according to the two interviewees, it is difficult to identify solutions that are effective and, at the same time, realistic and feasible.

5. CONCLUSIONS

The test proved that the procedure and the proposed taxonomies can be easily used by "ordinary" safety practitioners. The practitioners identified several interesting combinations of mechanisms and contextual factors, which introduce novel insights also for the safety literature. For instance, the "Perception of familiarity with the situation" influenced by the "layout of the plant" has been identified as a mechanism disabling the desired performance. According to the authors' knowledge, the layout of the plant has never been related to the Perception of familiarity with the situation in previous safety literature.

The usefulness of the model seems to be clearly proved – although in a small sample – by the answers of the practitioners. The model does support practitioners during the design of the intervention, since it highlights specific aspects of contextual factors and mechanisms and it organizes the data in a more systematic and structured fashion. In the majority of the cases, the improvements introduced by the model compensated the difficulty of use and the model seems to be necessary for the introduction of these improvements.

The model seems to be complete, in sense that all the relevant factors and mechanisms determining the performance of the workers have been included in the taxonomies.

Some improvements could regard the difficulty of use. For instance, two critical steps are the selection of the mechanisms and combination between mech-

anisms and contextual factors; some practical examples could be helpful in these tasks. Examples can be progressively collected with the use of the model.

This test involved twenty companies and, as a consequence, the results can be considered as a preliminary validation of the model. Further researches will repeat the same test with a broader sample.

It is important to underline how the test analysed the outcome of the design process. After the design, the intervention should be actually implemented and its effectiveness should be assessed. The improvement of the effectiveness of the intervention designed with the help of the model is the main objective of the model itself. This aspect will be investigated in further researches, also using the preliminary results of this test.

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