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A Diagnostic Tool to Evaluate the Proactivity Levels of Risk-Reporting Activities by the Workforce

Matteo Curcuruto*[a], Dina Guglielmi[b], Marco G. Mariani[a]

[a]Dipartimento di Psicologia, Università di Bologna, Viale Berti Pichat, 5, 40126 Bologna - Italy
[b]Dipartimento di Scienze dell'Educazione, Università di Bologna, Via Filippo Re, 6, 40126 Bologna - Italy
matteo.curcuruto@gmail.com

Prevention of occupational injuries is an important task of Human Resource Management. Empiric research showed that risk perception, safety communication and worker's participation in safety programs may have a relevant role in reducing accident and injury occurrence – see for example (Conchie, 2013). These considerations lead us to this study to propose a new methodology which consists in an index aimed to assess the proactivity of worker participation in safety management systems. The innovation consists in defining a diagnostic measurement model to assess the degree of workforce proactivity, considering a specific kind of participatory contribute by workers for safety promotion in the workplace, like the spontaneous risk-reporting initiatives. The measurement tool has been defined and tested by an interdisciplinary team composed of four university researchers (human factor experts) and two site safety managers of a chemical site which is chosen with the purpose to apply for the first time the new tool. Preliminary results show that different levels of proactivity were adopted and that the highest levels of proactivity are relatively less frequent. The tool offers relevant diagnostic information for the industrial organizations which aim to achieve higher level of proactivity in risk management, offering practical indications for managerial interventions focused on stimulating and improving appropriate participation by the workforce.

1. Introduction: the relevance of safety participation in industrial settings

The importance of a proactive approach toward safety management in accident reduction and injury prevention has been stressed in organizational behavior and ergonomics sciences by different authors in the last fifteen years, beyond the reactive organizational activities related to correction and monitoring of risk factors in the workplace (Hollnagel et al., 2011). All these studies underlined the importance of considering the positive adaptive contributions of single workers and work teams in achieving the desired level of safety and organizational resilience beyond the mere compliance with norms and procedures.
The present contribution is aimed to offer a conceptual model and an assessment tool to describe the characteristics of proactivity as a specific attribute of workforce participation in safety promotion in industrial settings. Conceptualized as "promoting the safety program within the workplace, demonstrating initiative and putting effort into improving safety in the workplace" (Neal and Griffin, 2006), the importance of employee participation has been recognized as a fundamental aspect of safety performance in organizational settings (Saracino et al., 2012a). While safety compliance behavior involves engaging in behaviors that may be viewed as part of an employee's work role, safety participation involves a greater voluntary element, so that it may substantially differ from safety compliance behaviors. Indeed, safety participation is very important to guarantee safety maintenance in those situations characterized by high risk uncertainty and unpredictability, especially in situations where safety standard procedures may be weak in coping with the changeable shape of risks and hazards, and in those industrial situations characterized by high conflict between production and safety instances (Hollnagel et al., 2011).

1.1 A quantitative assessment of safety participation in risk management

Whereas previous research was focused on describing different behavioral patterns and taxonomies of safety participation and extra-role safety behavior (e.g. safety citizenship; safety voice; safety initiative)

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(Conchie, 2013), the current paper proposes a different approach and a conceptual advancement in defining a general assessment tool aimed at evaluating a set of different features that entail different degrees of proactivity in participative efforts and initiatives enacted by workers in safety management systems. The general features of “Proactive Safety Behaviors in the workplace” (PRO.SA.BE’s) will be discussed below.

1.2 The conceptual features of safety proactivity in risk management

The present conceptual and methodological contribution proposes to investigate the proactive safety behaviors (PRO.SA.BE’s) as a specific kind of positive behavioral initiative by individuals aimed to improve the safety conditions in the workplace. In this perspective, PRO.SA.BE’s involves at least three general specific attributes discussed in organizational behavior and industrial psychology literature (Parker and Collins, 2010). First, given its self-started nature, proactive behavior of employees generally does not need to be formally prescribed to be enacted, nor does it require detailed instructions or formal requests. We could conceptualize a proactive safety behavior as self-started and self-determined. Despite this, many kinds of participative behaviors are usually strongly recommended by managements and organizations (i.e. spontaneous reporting of potential risk and near-misses; initiative suggestion for improvements; supporting safety activities by colleagues and supervisors), but they can hardly be prescribed or designed in advance for every situation or circumstance that requires them, because it is impossible to predict every form of risk factors in complex work environment. This space for self-started initiative by work operators may become essential when standardization may not be sufficient to cover aprioristically all the possible situations which can generate and manifest threats for safety of people and work-environment. Secondly, as anticipatory and future-oriented, proactive behavior involves acting in advance of a future situation, rather than just reacting to solve contingent problems or adjusting to an unpredictable situation. These proactive safety behaviors could be characterized by the substantial amount of anticipation activity by work-operators aimed at envisioning and preventing future problems (Parker et al., 2010), avoiding potential risk situations and the actualization of their negative consequences in the workplace, like production and safety breakdowns, property damages, minor and severe injuries. Thirdly, proactive safety behaviors are intrinsically meant to create improvements to the actual work and organizational situation. Thus, as a change-oriented behavior, behaving proactively means trying to improve one’s own work situation and organizational context, and make things happen rather than just waiting for something to happen for the initiative of someone else.

1.3 Different levels of proactivity of workforce participation in risk management

Considering the different facets of proactivity in the research domain of occupational safety, we aim to propose an assessment tool which enables researchers and practitioners to measure the levels of proactive involvement in a particular kind of participative and discretional activity in risk management in organizations on the basis of existing scientific models (reported in the 2-nd and 3-rd column of Table 1). The degree of proactivity is measured from a minimum degree of presence of proactivity attributes (i.e. spontaneous report of potential risk factors), to a maximal degree of presence of proactivity attributes (i.e. spontaneous report of risk factors with taking charge initiative suggestion for improvement). Table 1 represents the different degrees of proactivity here defined (from level one to level five) considering two theoretical models: the model of Parker and Collins (2010) on attributes of proactive behavior and the model of Hollnagel and colleagues (2011) on safety resilience capabilities. The conceptual rationales to build the 5 levels of proactivity reported in Table 1 are described in the following paragraphs, with more conceptual details and real examples from organizational life in industrial settings. In a human factor perspective, within organizational behaviors, proactive ones are characterized by being self-started, anticipatory and taking charge (Parker and Collins, 2010). Within the three characteristics listed above, taking charge in organizational behavior is the most distinctive, as it can generate improvement and then generalized learning. Moreover, as argued by Parker and colleagues (2010), proactivity should not only be “taking charge”, but it should also create a visible impact. Thus, in this study we propose to split into two parts the “taking charge” level, so that the first one includes the actions that create an impact in terms of change (max level: 4) and the second one entails those actions limited to “taking charge” (level 3). As the same time, the ergonomics considers both anticipation and learning such as proactivity elements (Hollnagel et al., 2011). Consequently, crossing ergonomics and organizational behavior, we consider implicit the aspect of learning as a vehicle for positive change, while the anticipation element is assumed to be below the “taking charge” and above the “self-started”. Finally, considering a zero level of proactivity, such as reports related to the formal pressure (because the report is a statutory requirement, the omission of which is punishable, therefore it is not proactive as supported by the scientific literature), we want to distinguish, by definition, compliance and proactivity. With these scientific bases, we obtained the five levels of proactivity in an ordinal scale (not necessarily at equivalent intervals), as proposed in the Table 1.

Table 1: Proactive participation in risk management: conceptual foundations and comparisons

Proactivity levels in risk-reporting	Attributes of proactivity (see Parker & Collins, 2010)	Resilience capabilities (see Hollnagel et al.,2011)
Level one Spontaneous reporting activities of contingent risk factors in the workplace	Low proactivity (spontaneousness)	Monitoring *(addressing the critical)* monitoring if something affect the operative abilities
Level two Self-started problem solving to correct current discrepancies from the standards	Self-started Undertaking a course of actions without no need to be asked to act	Responding *(addressing the actual)* reacting to variability and disturbances
Level three Anticipatory problem prevention of risk consequences	Future-oriented Acting in advance of a future situation, rather than just reacting	Anticipating *(addressing the potential)* envisioning developments that lie further into the future
Level four Initiatives and suggestions for safety improvement of the current risk management	Taking-charge Taking control and causing something to happen, rather than just adapting or waiting for something to happen	Learning *(addressing the factual)* Improving future performance experimenting changes as results of new experiences
Level five Improvement generalization in the broader organization	Observable improvement outcomes	--

1.4 Operative examples of the different levels of proactivity

Therefore the five levels of proactivity are: 1) spontaneous reporting activities of contingent risk factors in the workplace. An example of this first level of proactivity may be a simple spontaneous reporting of a potential danger. For instance, an operator may indicate an event or condition that can present a negative result in a hazard, without acting directly to improve or solve the problem; 2) Self-started problem solving to correct current discrepancies from the standards. An example might be a worker's advisor which also includes the description of actions aimed to correct immediately a potentially dangerous situation. For instance, the operator attempts to correct by himself the reported event, by eliminating the current situation of potential danger; 3) Anticipatory problem prevention related to the possible future consequences of risk factors. Beyond signaling or correcting the dangerous situation, the operator reports and describes possible concatenations and negative consequences of these critical events, thus providing useful information to anticipate the negative consequences of a problem before they occurrence; 4) Initiatives and suggestions for safety improvement of the current risk management in addition to correcting and anticipating the risk factors, an operator may propose one or more suggestions to improve the situation so that the problem won't come around in the future. For instance, the operator can act directly the proposed solution or he may simply present his ideas for improvement to supervisors if he is not enable or allowed to implement the proposals by himself; 5) Generalization of the stimulated improvement in the broader organization setting. The operator proposes or produces a solution that actually improves the situation of an area or a department of the company. Following the report of the operator, the EHS management staff might produce a change or innovation that represents a stable, generalizable and permanent improvement in relation to the technological structure, organizational practices and working behaviors. As in many organizational settings, risk reporting could be considered an expected or mandatory activity (level one). We will consider intermediate levels of proactivity, characterized by the presence of self-started proactive problem solving activity to address the risk and anticipatory envisioning that allows the prevention of possible future consequences associated with a specific risk. The final level of proactivity is here defined by the extension of generalizability of the employees' stimulation to the broader organizational context.

2. Assessing safety proactivity with PRISM scale

2.1 Aim and Method

Research was carried out to assess the basic psychometric properties of our tool, labeled as PRISM Scale (acronym of: Proactive Risk Management): in particular, we wanted to analyze the inter-raters reliability of the grid. On the basis of the proactivity theoretical models, an expert created grid questions which were analyzed and modified by two different judges, specialized on safety. The developed scale was composed by 15 items (5-point Likert items; 1=Strongly disagree; 2=Disagree; 3= Neither agree nor disagree; 4=Agree; 5= Strongly agree), that assess the five different facets of proactivity: 1) Spontaneous reporting activities of contingent risk factors in the workplace (three items); 2) Self-started problem solving to correct current discrepancies in the standards (three items); 3) Anticipatory problem prevention related to the possible future consequences of risk factors (three items); 4) Initiatives and suggestions for safety improvement of the current risk management (three items); 5) Generalization of the stimulated improvement in the broader organization setting (three items).

30 risk-reporting advices were collected in a chemical plant that produces plastic additives for the agriculture sector. Four judges, consisting of practitioners with experience in plant safety and in proactive behaviors, evaluated the advices on the basis of PRISM scale. Judges were trained to use the proactive grid, to identify proactive construct and to calibrate their ratings. Every judge worked alone in coding process, read a risk-reporting advice and rated one case after the other. Ratings were independent and blind in respect to other judges evaluations. Therefore a 4 (judges) X 30 (risk-reporting advices) X12 (items of assessment grid) data matrix was obtained.

This research requires the assessment of inter-rater reliability (IRR) to demonstrate consistency among observational ratings provided by multiple coders.

In literature there are numerous reliability studies with diverse statistical approaches. There are various tests for different type of reliability data. Although there is a good degree of consensus about how to treat the categorized data, there is less consensus regarding ordinal and continuous data which forms the object of the present paper. Hallgren (2012) suggests the intra-class correlation index (ICC) that is one of the most used statistics for assessing IRR for ordinal, interval, and ratio variables in studies where there are two or more coders. ICC index incorporates the magnitude of both agreements and disagreements. Higher ICC values indicate greater IRR: an ICC of 1 indicates a perfect agreement and an ICC of 0 shows only random agreement. Cicchetti (1994) proposed that ICC values less than 0.40 are insufficient, fair are the values between 0.40 and 0.59, good the values between .60 and 0.74, and excellent between 0.75 and 1.0. Since our rating procedures involve the use of two or more judges, reliability is quantified on averages of ratings provided by several coders; so we tested the reliability of the aggregations that is often identified as ICC(2).

The average measure inter classes correlation was computed by SPSS of IBM (2011). The software estimates the single measure interclass correlation coefficient by:

$$ICC\,(A,k,r) = \frac{MS_{\mathrm{BP}} - MS_{\mathrm{Res}}}{MS_{\mathrm{BP}} + \left(MS_{\mathrm{BM}} - MS_{\mathrm{Res}}\right)/W} \quad (1)$$

A(1-)100% confidence interval is given by:

$$\frac{W\left(MS_{\mathrm{BP}} - F_{\alpha/2,W-1,v}\,MS_{\mathrm{Res}}\right)}{F_{\alpha/2,W-1,v}\left(MS_{\mathrm{BM}} - MS_{\mathrm{Res}}\right) + W\cdot MS_{\mathrm{BP}}} < \rho_{(A,k,r)} < \frac{W\left(MS_{\mathrm{BP}} - F_{1-\alpha/2,W-1,v}\,MS_{\mathrm{Res}}\right)}{F_{1-\alpha/2,W-1,v}\left(MS_{\mathrm{BM}} - MS_{\mathrm{Res}}\right) + W\cdot MS_{\mathrm{BP}}} \quad (2)$$

2.2 Results

For each level of the scale (using 15 items), the ICC was computed on the basis of 30 risk-reporting advices valued by four raters. Table 2 presents reliability data for the overall rating and for every scale level. Results show good values for level 2 and level 4. Excellent are the reliability indexes for the remaining levels. Excellent is the psychometric quality of the overall index too. The average measure ICC ranged from .187 to .941. Results show excellent reliability values for 8 items, good for 3 items, fair for 2 items and insufficient for the other 2 items. The items that show an inadequate value of ICC say: “Was the event actually totally unpredictable without signaling by the operator?” and “Did the operator provide information to anticipate future occurrence of the same problem?”. The judges’ evaluation of unpredictability was not consistent as much as the codify of anticipation of future occurrence. These could be the hardest tasks for the judges.

Table 2: The PRISM assessment tool: inter-rater reliability ratings (average measure ICC)

	Check-list levels and items	ICC	95% Confidence Interval	
			Lower Bound	Upper Bound
	Level zero: spontaneous risk-reporting (expected by legal regulations)	**.907**	**.851**	**.945**
L0_1	Is the reported risk relevant for areas, activities and duties beyond the roles and competence by the operator?	.722	.459	.875
L0_2	Did the operator report "spontaneously" situations of risk, without specific indications of superiors or colleagues?	.465	.000	.754
L0_3	Did the operator report an event without having previously received specific instructions to the event by the organization?	.789	.572	.906
	Level 1: self-started problem solving	**.874**	**.814**	**.918**
L1_1	Did the operator provide information to solve the contingent event?	.604	.241	.818
L1_2	Did the operator try to solve in the first contingent event?	.941	.883	.974
L1_3	Did the operator eliminate the contingent situation of risk / potential danger?	.922	.849	.965
	Level 2: anticipatory problem prevention	**.690**	**.547**	**.796**
L2_1	Was the event actually totally unpredictable without signaling by the operator?	.378	.000	.714
L2_2	Does the operator provide useful information to anticipate the negative consequences of the contingent event?	.796	.609	.906
L2_3	Does the operator provide information to anticipate future occurrence of the same problem?	.187	.000	.626
	Level 3: taking-charge suggestion	**.852**	**.783**	**.902**
L3_1	Does the operator make suggestions for tackling the problem in the event of recurrence in the future?	.815	.645	.915
L3_2	Does the operator express valid suggestions to ensure that the problem does not recur in the future?	.831	.677	922
L3_3	Does the operator provide innovative suggestions (not currently covered) to ensure that the event does not happen again?	.892	.793	.950
	Level 4: improvement generalization	**.693**	**.550**	**.799**
L4_1	Does the operator propose a solution that produces or generates an improvement / increase the safety of his workplace?	.773	.560	.898
L4_2	Does the operator propose or produce a solution that improves the safety of the working environment generalizable to the entire department?	.510	.062	.775
L4_3	Does the operator propose or produce a solution that improves the safety of the working environment generalizable to the entire plant?	.615	.263	.823
	Overall	**.817**	**.781**	**.848**

3. Conclusions

The issue of safety at work is very timely. Despite occupational accidents are stochastic events difficult to predict, their occurrence rate may be reduced. One possible solution could be a proactive approach toward safety management based on anticipation and learning organizational mechanisms, as has been stressed in human factors and ergonomics sciences (see for example Hollnagel et al., 2012). Therefore the aim of this study was to propose a new methodology using an index that measures the degree of proactivity of worker participation in safety management systems. The role of proactivity in safety was widely discussed in the first part of this paper.

The present article shows results regarding the evaluation of an assessment tool that investigates proactive safety behaviours (PRO.SA.BE’s). The scale includes 15 items and overall it has good reliability values: the study also highlights that single levels of the scale have a good reliability.

The instrument presented in this study can therefore be considered a useful tool to monitor the levels of worker participation in risk management. Through the integration of quantitative measures (i.e., frequency of problems solved or anticipated in the safety area) and qualitative measures (that is the five levels of proactivity described herein), the tool allows a greater understanding of workers' participation in safety. This last aspect can make this tool suitable for companies, RSPP and other safety figures intended to monitor the workers' participation and build up appropriate measures to improve the participation itself and proactivity towards safety in line with the current regulations (HIS, 2008).

The tool can help the achievement of an higher level of proactivity in risk management in industrial organizations, also stimulating reflection on possible interventions which can raise awareness and participation of workers on this issue. Interventions may be both formative and focused on the continuous improvement of the safety management system or based on defining incentive strategies of the behaviors that promote safety (Saracino et al., 2012b).

The promotion of the participation can trigger a virtuous cycle that feeds on itself in increased participation, greater organizational support (see. Mariani and Battistelli, 2011) with positive effects on workers' safe behavior, and encouraging learning opportunities in the security field (Mariani et al., 2013).

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