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Pedro M. Arezes · J. Santos Baptista · Mónica P. Barroso · Paula Carneiro · Patrício Cordeiro · Nélson Costa · Rui B. Melo · A. Sérgio Miguel · Gonçalo Perestrelo *Editors*

Occupational and Environmental Safety and Health II

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Preface

Occupational and Environmental Safety and Health II is a compilation of the most recent work of some selected authors from 13 countries within the domain of occupational safety and health (OSH). The included works are focused on selected topics, including occupational safety, risk assessment, safety management, ergonomics, management systems, environmental ergonomics, physical environments, construction safety and human factors, among others.

This book represents the state of the art, and it is mainly based on research carried out at universities and other research institutions, as well as some on-field interventions and case studies. Due to the broad scope, relevance and originality of the contributions, it is expected that this book contains useful and up-to-date information, and it presents fundamental scientific research that is being carried out in the subject, as well as it contributes to the outreach of practical tools and approaches currently used by OSH practitioners in a global context. All the included contributions were selected based on their potential to show the newest research and approaches, giving visibility to emerging issues and presenting new solutions in the field of occupational safety and health.

This book is based on selected contributions presented at the 16th edition of the International Symposium on Occupational Safety and Hygiene (SHO 2020), which was held on 6–7 April, in Porto, Portugal.

All the contributions included in this book were previously peer-reviewed by, at least, two of the 131 members from 17 different countries of the International Scientific Committee of the 2020 edition. The event is organised annually by the Portuguese Society of Occupational Safety and Hygiene (SPOSHO).

Editors would like to take this opportunity to thank their academic partners, namely the School of Engineering of the University of Minho, the Faculty of Engineering of the University of Porto, the Faculty of Human Kinetics of the University of Lisbon, the Polytechnic University of Catalonia and the Technical University of Delft. The editors also would like to thank the scientific sponsorship of several academic and professional institutions, the official support of the Portuguese Authority for Working Conditions (ACT), as well as the valuable

support of several companies and institutions. Finally, the editors wish also to thank all the reviewers, listed below, who gave a critical contribution, without which it would not be possible to develop and publish the current book.

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Safety Score Permit (SSP) to Enhance Safety Performance

A. Fundo, M. Carrasqueira, B. Dias, J. Santos, D. Antunes, J. Dias and C. Jacinto

Abstract This paper addresses the need for efficient management control tools and it focuses on behavioural performance. This work aimed to develop a system to monitor and improve behaviours in Occupational Health and Safety (OHS). The new system is called Safety Score Permit (SSP) and its development was based on three main concepts, namely, the behavioural-based philosophy, the score cards system, and the reasoning underlying the "point system" in use for road safety. Behaviors are assessed by direct observation, either by OHS specialists, or by trained "observers" elected by their peers. There are bonus and penalty points, depending on the safe/unsafe behaviors observed. The SSP tool is intended to promote effective management control through the implementation of a strategy focused on collective and individual performance. This approach to reinforce OHS management could play an important role in improving workers' risk perception and encourage safe behaviours. The SSP tool will allow everyone—workers and managers—to know, at any time, their individual and collective performance, as

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well as to disseminate positively the best practices and commitment to safety, which clearly will influence the whole organization. It has the potential to become a useful and transparent tool for monitoring OHS performance of employees in all hierarchical levels.

Keywords Safety score permit · OHS performance · Behavior-based safety

1 Introduction and Background

A large part of workers' life is spent at the workplace; therefore, the relevant safety precautions should be taken in their sometimes quite hazardous workplaces to safeguard their lives and well-being [1]. Many organisations around the world support their safety management on international standards, of which the ISO 45001:2018 is the most recent and is quickly replacing the well-known OHSAS 18001:2007 widely used for certification purposes. Within the novelties brought by the ISO 45001, is the way it reinforces the importance of effective Leadership commitment and Workers participation.

Among the many strategies available to improve workplace safety is the Behaviour Based Safety (BBS) approach, which is recognized for its ability to influence attitudes, both individual and collective. BBS is becoming increasingly popular across industry sectors, and it has the "great advantage of needing the involvement of the individual employee, in addition of course, to employer commitment" [2]. Thus, this approach has great potential to assist in the implementation of ISO 45001.

Adhesion to BBS in the industry is considered beneficial, as it will increase safety culture and human welfare [3]. This topic has been well covered in the literature for decades, namely after the 1980s, giving evidence of its maturity and suitability to enhance safety. According to DePasquale and Geller [4], "behaviour-based safety starts by defining one or more critical behaviours to target. Then these behaviours are observed and recorded in particular work settings". Despite the need to ensure employers' commitment and leadership, BBS is considered an outstanding technique to improve safety among "front-line workers", and to achieve an accident-free work culture [5, 6].

In contrast with traditional safety programs, which allocate responsibility for accident prevention to top management, the BBS philosophy aims at educating employees and employers to examine the root causes of their accident-prone behaviours [7].

A more recent study [8], reports a BBS initiative based on a card-issuing system. The purpose of the study was to evaluate the effectiveness of the BBS card system as a tool for reducing accident frequencies, and the findings suggest that the card system brought a significant decrease in accident rates. These authors [8] highlight that the card system had a significant influence in the mind-set of workers towards safer working practices.

On the other hand, performance evaluation (e.g.: quality, safety, etc.) can be attained through scored-based systems. There is evidence that scorecards have been applied in different ways, and across a range of activities, and have proven to be promising tools to help organizations address challenges and support strategic decisions [9]. Among such tools, a recognized referential is the "point system" (scored system) used internationally on drivers' licenses [10, 11].

This paper describes a joint project aimed at developing a score system/tool especially designed to monitor and enhance safety performance. The system is called Safety Score Permit (SSP) and it combines the new requirements of ISO 45001, the BBS philosophy and transposes the road safety "point system" to the management of occupational health and safety.

2 Development Methodology

The development of *Safety Score Permit* (SSP) was based on both theoretical and empirical foundations. Figure 1 illustrates the general approach followed by this project for developing the proposed tool. The current paper gives account of the first stage, up to draft version "1" of the tool. This represents the conceptual stage aimed at monitoring safety performance of individuals; this version already went through a pilot testing using past records of real accidents/incidents (named here a laboratory testing).

The second and final stage will be carried out during 2020 and it includes more work, such as the inclusion of tailored safety performance indicators (at company level), field testing (i.e., with participation of companies), refinement, and validation, after which the SSP will be released for use (final version). In parallel, the corresponding SSP electronic platform is already being developed by a specialised consortium.

3 Results. Description of SSP®

3.1 Characteristics and Overview

From a management point of view, the SSP tool can provide an assessment of overall organisational performance and also reveal trends to ascertain whether the strategies/efforts are being well addressed. It can provide information at micro level by the analysis of individual performance and assess to what extent the actions adopted (when necessary) promote safe behaviours on workers. It is clearly a complementary tool for supporting continuous improvement to achieve and sustain a good level on safety culture (Fig. 2).

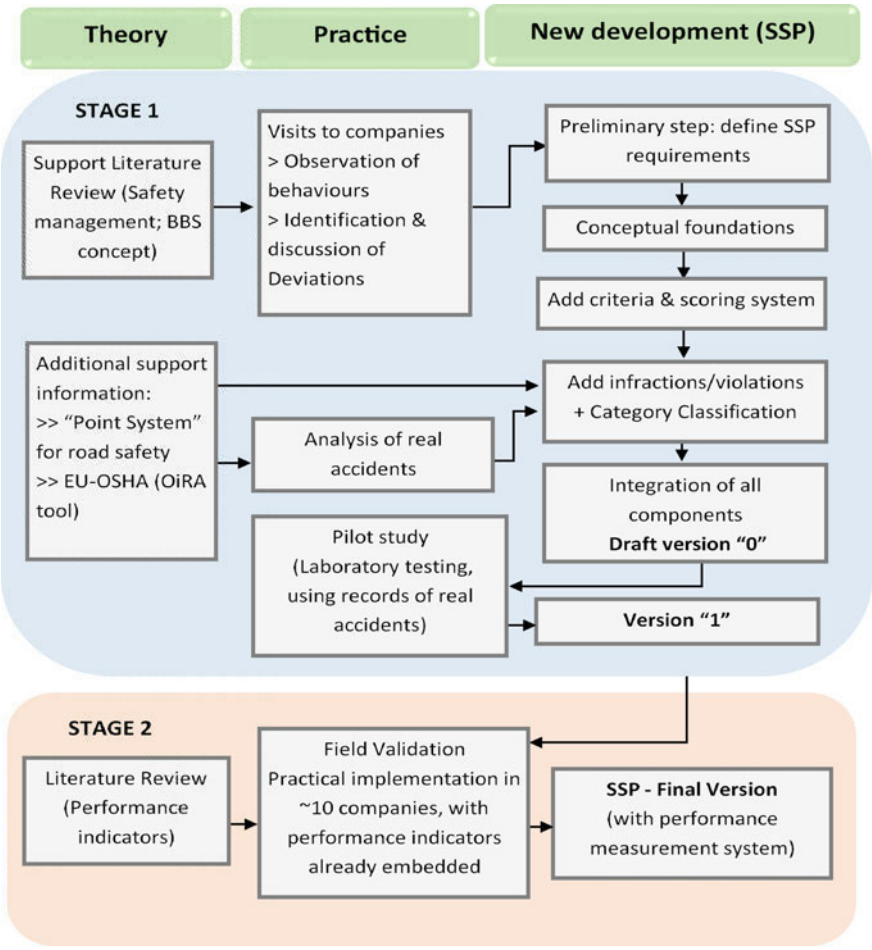

Fig. 1 Development of SSP—methodological steps

3.2 Specification of Performance Levels. Criteria

The scale of performance levels. SSP scale is designed with six performance levels (Fig. 3). The neutral level, by default, is worth 12 points. This is called the "initial level". The positive behaviours will entitle the person to climb three levels (on the right-hand side), worth 16-18-20 points respectively. Excellence is attained at 20 points. It was considered important to define a maximum limit, since there are historical data on the Demerit Point System (DPS) applied to road safety, in a study made by Castillo-Manzano [12], which proved that one of the factors that led to poor effectiveness of some long-term solutions was that the initial fear of reprisals

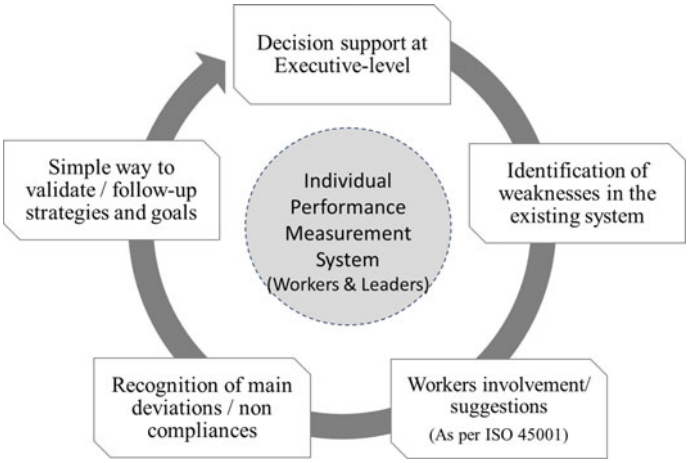

Fig. 2 Potential of SSP system as a complementary management tool

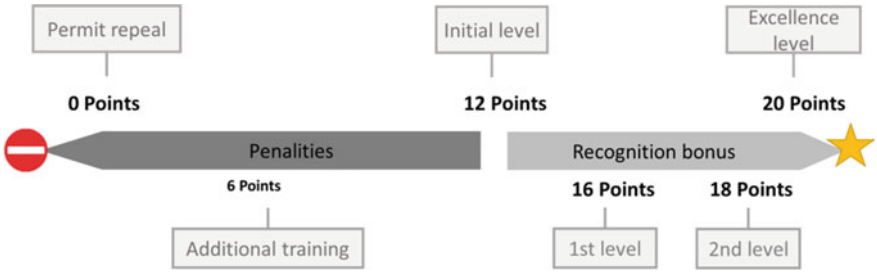

Fig. 3 Point system—recognition bonus (positive) and penalties (negative) levels

had relaxed over time. So, by setting a maximum upper limit, the SSP system prevents the employee from being over self-confident and becoming complacent.

By contrast, infractions are negative safety behaviours and, therefore, will lead to a decrease of points down to 6 and 0, respectively. The person can recover from this situation and is encouraged to do so. At the 6 point level, for instance, the employee is subjected to a compulsory training session followed by specific evaluation.

Bonus criteria. Similar to what is suggested for the implementation of a BBS in a safety management system, it is necessary to give positive feedback to reinforce exemplary behaviours and influence the other employees follow them [2].

As the objective is providing a comprehensive solution and support companies to progress to a safety excellence level, workers (at all levels) will be subsidized with points. It is suggested that organizations reward good behaviours on a regular basis to encourage discipline and recognise good examples, thus allowing every person to reach the level of excellence.

SSP is a transparent system based on direct observations; it intends to be a tool that values safe behaviours and pro-activity, giving bonus points to individuals who, during a period of time (annually), do not have any penalties and/or make efforts to propose suggestions for improving or solving problems. To earn points, such suggestions need to be evaluated by management and be considered a "viable solution that worth being implemented". However, the individuals cannot, by this way, exceed 18 points.

To achieve the top—excellence level—the employee needs to attain 20 points. If an employee has 18 points registered in his/her Safety Score Permit and, additionally, he/she is recognized as an example to follow in terms of OHS (through criteria defined in each company), the employee will receive the distinction of excellence, i.e., the person reaches the excellence level by receiving the two additional points. Thus, the transition from 18 to 20 points requires a peer recognition.

Penalties criteria. The practice of a safety infraction/violation determines the subtraction of points to the employee's permit. It was decided to relate the number of lost points to both the frequency and severity/seriousness of the infraction/violation resulting in accidents, or that could have caused an accident. This will help increase the credibility and fairness of the system. To evaluate and apply the penalties, the analysis of deviations is based on three levels, namely, Human, Technical and Organizational (Fig. 4). Moreover, the system distinguishes between an error/mistake and a violation based on Reason's classification [13]. To facilitate the evaluation and promote transparency of the whole process, a decision-tree was built and is embedded in the tool, but it can be customized by each organisation. If it is proven to be a violation, the decision-tree will help to analyse whether the situation was generated solely by the worker, or if the respective manager(s) knew or have influenced the occurrence. The SSP system covers the entire hierarchy.

The number of points to be subtracted will depend on (1) the seriousness of the occurrence, (2) whether it is a recurrence or (3) whether there are multiple

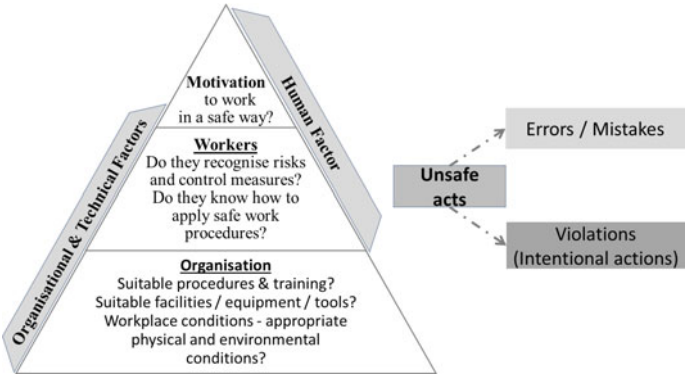

Fig. 4 Factors in which to look for deviations

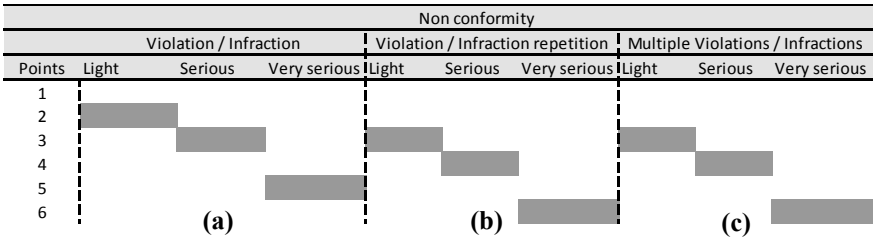

Fig. 5 Points lost depending on **a** the seriousness of occurrence, **b** recurrence, or **c** multiple violations/infractions

infractions/violations (Fig. 5). To avoid complexity in the system, and in the case of multiple infractions (Fig. 5c), 1 penalty point will be added to the most serious one. Similarly, in case of recurrence, 1 extra point is added to the respective infraction level.

Whenever an employee completes one year without committing any infraction/violation, he/she will receive a bonus point. Therefore, it will take 3 years to recover from a serious infraction, and 5 from a very serious one. In any case, as previously mentioned, the person can only accumulate 16 points due to absence of infractions. In addition to the safety training sessions that are given to all workers on a regular basis, there will be a special training scheme for those who first get down to a score of 6 points, or less. At the end of this training there will be an evaluation; if the employee achieves a grade of 95%, he/she will recover 1 point, if not additional training (on-job training) will be necessary. The permit will be cancelled when the employee reaches the lower limit of 0 points, and disciplinary measures must be applied.

3.3 Infractions. Types and Categories

The SSP considers 85 types of infractions. These 85 infractions are classified into 9 categories or classes (Fig. 6). The referred 9 categories will allow identifying where the main problems, deviations and deficiencies are located and, therefore, the system can assist in the design of prevention, and be a complementary management tool.

3.4 Preliminary Testing (Laboratory Testing)

The preliminary testing of the system's applicability and consistency was made through the analysis and categorisation of real accident records (archive records). These accidents occurred in 4 companies collaborating in the project. By analysing

Fig. 6 Categories classification for infractions

(a)

STRATEGIC	2
ETHICAL AND MORAL	4
COMMUNICATION	0
ACCESSES	0
ALCOHOL/SUBSTANCES	0
CIRCULATION	3
ORGANIZATION / HOUSEKEEPING	1
OPERATION / MAINTENANCE	30
PROTECTION MEASURES	6
TOTAL	**46**

(b)

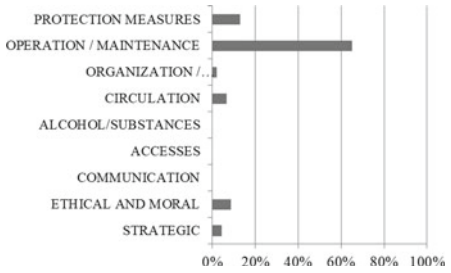

Fig. 7 Extract of human safety violations/infractions from the accidents of 4 companies' database, **a** number and **b** relative distribution by categories using the classification of SSP system

all investigation reports, the first step was to set aside all cases where any kind of "human (mis)action" had occurred and had been explicitly identified.

From this first step, a total of 211 cases were selected for testing the infraction's classification (and criteria) proposed in SSP. The results are summarized in Fig. 7. From the 211 accidents analyzed, 46 were violations/infractions and not just human errors/mistakes. In addition, from the categories' classification it was observed that the higher number of situations occurred within the category operation/maintenance. Going deeper into the system will allow identifying which are, specifically, the prevalent types of violations/infractions. This ability of the system will help to spot and understand the main problems, and consequently will help to develop strategies to continuously monitor and improve the OHS management system already in place.

The length restrictions of the paper do not allow a more in-depth description. However, the next stage is an industrial "piloting implementation", which will be carried out in 10 companies of different activity sectors and it will allow a further and more realistic validation of the system.

4 Concluding Remarks

This paper described the design and construction of a new safety tool called *Safety Score Permit* (SSP) intended to encourage positive safety behaviours of individuals (both workers and managers) that will last over time within an organisation. The prototype already developed and explained here (stage 1; Fig. 1) will proceed to stage 2, which involves further development of new functions based on key indicators to asses overall performance.

The SSP proposed herein has real potential to become a valuable new generation tool for executive decision-support, with watch-lists, configurable visualisations and customisable alerts and notifications. It is a system that perceives, and gives alert on what the weaknesses are, namely the seriousness of errors/violations that have occurred, at both individual and collective levels. It allows classifying the deviations in specific categories, and thus, facilitates taking effective preventive measures; moreover, it allows to measure and sustain results improvement, which is a top priority for industry managers. SSP tool is a transparent system, provides a means for rapid and continuing feedback, it is flexible and allows setting up individual strategies for improving safety behaviours.

Its adequate implementation is expected to decrease unsafe behaviours and incidents and, consequently, to reduce direct and indirect associated costs, namely, insurance costs, absenteeism, or shutdowns due to accidents; all such factors will contribute to an increased productivity and better health and safety at work.

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