A NOVEL TOOL FOR EVALUATING OCCUPATIONAL HEALTH AND SAFETY PERFORMANCE IN SMALL AND MEDIUM-SIZED ENTERPRISES: THE CASE OF THE QUEBEC FORESTRY/PULP AND PAPER INDUSTRY

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Abstract

Efforts to prevent work-related injuries have met with tangible success in industrialized countries. In Quebec, workplace accidents and occupational illness have declined sharply since the end of the 1990s. However, there is still considerable room for improvement in small and medium-sized enterprises (SMEs). Expert specialists in accident prevention in SMEs are overloaded. Their interventions are repetitive and not personalised. Few tools are available for accelerating the process of evaluating occupational health and safety (OHS) performance.

The aim of this research project was to address this deficiency by proposing a novel OHS performance evaluation tool better adapted to SMEs. For this purpose, research was carried out in two distinct phases. The first phase led to the theoretical model on which the tool is based. The second phase was carried out using an action research approach. The proposed tool was designed and improved during this phase, through field-testing and the involvement of a Quebec industrial partner.

In spite of the limitations of this research, we have succeeded in developing a new tool with software support adapted specifically for the evaluation of OHS performance in SMEs. Upon completion of the project, a tested and improved version of the tool was delivered to the industrial partner. Experts in accident prevention have found the tool to be reliable and helpful. It has accelerated the identification of deficiencies in OHS management in several SMEs and has helped specialists to develop personalized and better-focused plans of action.

Keywords: Occupational health and safety (OHS), performance, measurement indicators, evaluation tool, small and medium-sized enterprises (SMEs), forestry/pulp and paper industry, continuous improvement.

1. Introduction

Efforts to prevent work-related injuries have met with tangible success in industrialized countries. In Quebec, workplace accidents and occupational illness have declined sharply since the end of the 1990s, with a drop of 50,000 in the number of injuries recorded annually from 1997 to 2013, in spite of an increase in the number of hours worked.

Although this trend is well received, there is room for improvement. The Quebec accident prevention legislative regime has been found to be one of the least effective in Canada and the USA (Block et al., 2003). In addition, the situation is similar at all scales of operation (MacEachen et al., 2010 ; Masi et al., 2014).

In Canada, a small business is defined as a company employing fewer than 100 workers, while a medium-sized business employs from 100 to 499 workers (Statistics Canada, 2013). In Quebec, small businesses represent 98 % of all companies and employ 67 % of the active population (Statistics Canada, 2013). In Quebec and around the world, the workplace accident rate is higher and occupational health and safety (OHS) performance is poorer in small and medium-sized enterprises (SMEs) than in large companies (Champoux and Brun, 2003; Vickers et al., 2005). The rates of fatal accidents recorded in association with SMEs are as much as eight times higher than for large companies (Mendeloff et al., 2006). Non-fatal accidents are also more frequent, as much as 50 % more (Fabiano et al., 2004).

Improvement of OHS performance can be achieved only by establishing preventive activities that lead to reductions in work-related injuries on the short to medium term. For the improvement of OHS performance, there is at least some consensus in the literature regarding the importance of factors related to the following six categories:

– The commitment of upper management (Abudayyeh et al., 2006; De Koster et al., 2011; Hallowell et al., 2013; Mirabi et al., 2014).
– Risk management (De Koster et al., 2011; Hallowell et al., 2013; Mirabi et al., 2014; BSI, 2007; CSA, 2006). Improved OHS performance in SMEs is not possible without control of occupational risks.
– Training of personnel in good workplace practices (Hallowell et al., 2013; Hinze et al., 2011; BSI, 2007; CSA, 2006).

– Leadership by upper management (Hinze et al., 2013; Mirabi et al., 2014; Stadnyk, 2011).

– Safe behaviour, in particular compliance with safety regulations and participation in the identification and elimination of hazards (Liu et al., 2014; Mirabi et al., 2014; Sgourou et al., 2010).

– Considering prevention as a continuous improvement (Kaizen) initiative. Although continuous improvement of OHS performance is a less-discussed subject, OHS management systems (OHSMS) are based essentially on this concept (BSI, 2007; CSA, 2006).

Improving OHS performance is no small challenge. Little information is available on the factors that lead to tangible improvements in the SMEs context (Masi et al., 2014).

As we have shown previously (Tremblay and Badri, 2017), none of six OHS performance evaluation tools identified in a systematic review of the literature are particularly well suited to the SME context. This conclusion is based on evaluation of four criteria: validity, reliability, simplicity and type of performance indicators used. The development of evaluation tools containing a choice of indicators more suitable for SMEs and offering better inter-judge reliability would be a welcome advancement in the field of OHS.

The aim of this research project was to design a novel tool for the evaluation of OHS performance, one adapted to the SMEs context and meeting the needs of experts in this field. The remainder of this article is divided as follows: Section 2 is devoted to describing and defining the problem and the elements that led us to focus on the SMEs case. Section 3 is devoted to the methodology and a description of the adopted action research approach, which involved an industrial partner in order to allow us to deliver a tool well adapted to the industrial context studied. Section 4 presents the results of the research carried out. The results and the limitations of the research are discussed in Section 5, and our conclusion is provided in Section 6.

2. The research problem

The problem investigated in this research may be summed up in terms of four essential elements that emerged from our review of the literature. Each of these key elements is described below.

2.1 Improving OHS performance: a major challenge

OHS performance is a complex concept comprising several elements such as management commitment, risk management and employee training (BSI, 2007). In order to be effective, the approach to improving OHS performance must be based on a continuous improvement effort (BSI, 2007; CSA, 2006). In other words, an employer who wishes to improve his performance must not only put these elements in place, he must above all ensure that they are efficient and allow proper control of risks. Periodic evaluation of the OHS performance management system is an indispensable part of the approach. However, this practice is often neglected in SMEs (MacEachen et al., 2010).

2.2 Constraints under which SMEs operate

As mentioned above, SMEs make up the vast majority of businesses in Quebec and are more risky workplaces than large companies. They encounter major difficulties with OHS (Breslin et al, 2010) and their OHS ratings are inferior. Among the causes of this difference in performance are insufficient financial resources, lack of knowledge, and difficulty in finding and hiring personnel qualified in OHS (MacEachen et al, 2008). One option available to managers of Quebec SMEs wishing to improve their OHS performance is the prevention-mutual.

2.3 Problems of availability of expert specialists in prevention

In the context of a prevention-mutual, the consultant's work consists of, among other things, evaluating the prevailing OHS management situation in the client businesses (SMEs) affiliated with the mutual. The consultant then advises the business managers concerning the actions to be taken in order to improve the situation. Since the points potentially requiring improvement are numerous, the consultant has no choice other than direct observation of company operations on site. Identification of shortcomings and possibilities for improvement is thus a laborious process. Specialists in this field work long

hours and still do not find the time to meet the specific needs of each client business. Interventions inevitably become repetitive and not specially tailored.

2.4 Performance evaluation tools are poorly adapted to SMEs

Experts in OHS and accident prevention have few tools at their disposal to help them with their task. Conventional tools for evaluating OHS performance are based on reactive indicators (e.g. frequency or severity of recorded injuries). Although simple enough to measure, this type of indicator turns out to be of little aid for identifying OHS deficiencies (Hinze et al, 2013). In order to obtain more accurate evaluations of the OHS performance of a business, researchers and industrial professionals are turning their attention increasingly to proactive indicators (e.g. the percentage of employees trained in OHS or the frequency of workplace inspections). These are descriptors of the effectiveness of preventive processes within a company. In other words, they make it possible to identify problems before they appear in the form of accidents or incidents (Sinelkinov, 2015). In fact, proactive indicators represent a mine of information for the OHS expert. However, they remain shrouded in mystery (Delatour et al, 2014). The scientific literature is scant on their use in existing OHS performance evaluation tools (Wright et al., 2005; Roy et al, 2008; Lingard et al, 2011; Amick et al., 2011; Liu et al, 2014; Li et al, 2015). While such tools do exist, none has been designed specifically for specialists working with SMEs.

In summary, there are several reasons why OHS performance is poorer in SMEs than in large companies. The prevention-mutual offers to employers at least the possibility of professional support in their quest to improve OHS performance. However, experts are not able to meet current demand and the effectiveness of their interventions suffers as a result. The OHS performance evaluation tools available to help them are rarely if ever adapted in any appreciable way to the SMEs context. Figure 1 illustrates the elements of the problem.

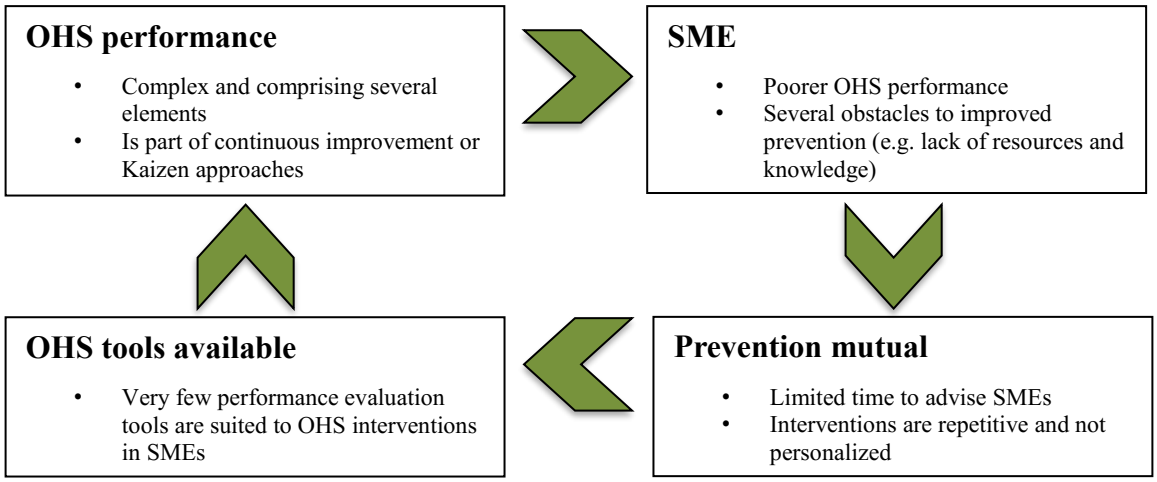

Figure 1 – Summary of the problem

The identified elements of the problem raise the principal research question:

- Would a new OHS performance evaluation tool adapted to the SMEs context allow interventions better tailored to the needs of the client?

This principal question raises two secondary questions:

- Which OHS performance indicators should be integrated into this tool?
- What features would make the tool better suited to meeting the needs of consultants and better adapted to the Quebec SMEs context?

3. Research methodology

3.1 Action research in an industrial setting

The framework for this project was an action research model. The aim of action research is to change practices in a setting. It implies, among other things, the two-fold goal of solving a problem and advancing scientific knowledge (Liu, 1997; Badri, 2015). In other words, action research is a joint effort of industrial partners and researchers in order to solve a real problem and to learn from it (Liu, 1997). The researchers must get directly involved in operations in order to feel the reality of working in the industrial setting. This involvement makes it possible to test theories proposed in the scientific literature against what is actually observed in the field and to make adjustments to them accordingly (Morin and Cardinal, 1993).

The research project is divided into two distinct phases: theoretical and practical. The goal of the former is to establish a model for OHS performance evaluation. The goal of the latter is to validate the model and to develop the tool in direct collaboration with the industrial partner.

The industrial partner is the Quebec association of occupational health and safety in the pulp/paper and forestry industries (Association de la santé et de la sécurité du travail des pâtes et papiers et des industries de la forêt du Quebec, ASSIFQ-ASSPPQ), a non-profit organisation whose mission is to accompany and support businesses in their continued efforts to improve OHS (Prévibois, 2016). Funding for this organisation comes from client businesses (affiliated SMEs) in the pulp/paper and forestry industries (Quebec, Canada) including primary, secondary and tertiary processing plants, that is, tree-cutters, sawmills, and manufacturers of paper, lumber and construction materials and furniture. Nearly 300 affiliated large forestry companies also benefit from the expertise of ASSIFQ-ASSPPQ, as do a few research centres and numerous companies in various other sectors such as mining, plastic products manufacturing.

About half of the ASSIFQ-ASSPPQ membership (nearly 350 client businesses) is made up of SMEs. Association directors are involved actively in this project in the hope of solving the problem of the shortage of experts able to provide solutions adapted to the specific OHS problems in this business category.

3.2 Steps of the research project

This project received approval from the research ethics committee at Université du Quebec à Trois-Rivières (UQTR). The project comprises six steps, described in detail below.

3.2.1 Literature search

The *Scopus* database, the *Google* and *Google Scholar* search engines and website of the Robert-Sauvé occupational health and safety research institute (Institut de recherche Robert-Sauvé en santé et en sécurité du travail, IRSST) were queried. The keywords included performance, safety, OHS, indicator, leading, evaluation, assessment, SME, and audit. Only peer-reviewed articles, research reports, theses, standards and legislative documents were included. Conference presentations, professional articles and articles more

than 10 years old were excluded, except for a few older articles used to support the definition of concepts.

3.2.2 Theoretical modeling

A first version of the tool was modeled on the basis of information gathered from the documents retrieved in the literature review regarding the requirements to be met in order to make an OHS performance evaluation tool suitable for the SME setting. The key themes of OHS performance were thus identified and organised into a logical structure presented as flow chart. Experts in prevention examined and approved this initial version then expressed their needs and suggested ideas to improve the model. In other words, the initial model was theoretical and based essentially on ideas proposed in the scientific literature and then improved using input from prevention experts. This process is summarized in Figure 2.

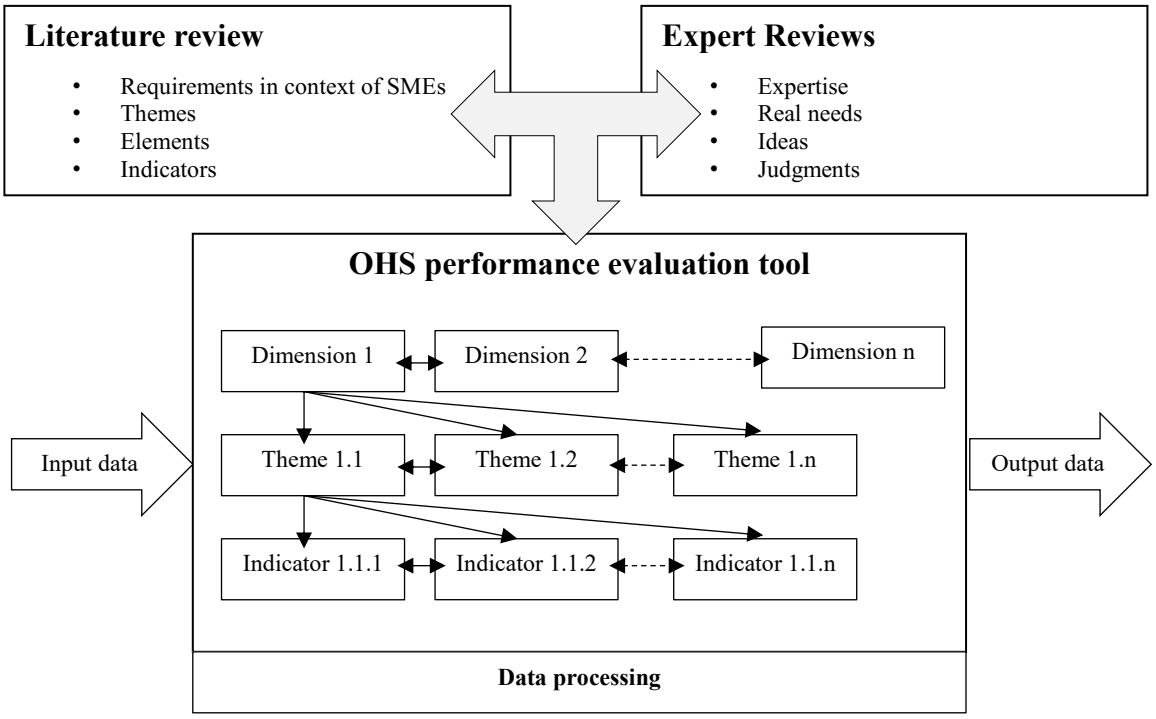

Figure 2 – Theoretical modeling

3.2.3 Writing of specifications

The third step of the process consisted of writing specifications for the tool. For this purpose, we began by observing prevention specialists during their interventions at SMEs. This provided us with better understanding of the challenges they face and their needs. Discussions were then held with the industrial partner, that is, prevention specialists and ASSIFQ-ASSPPQ directors, in order to define the technical requirements to be met. Finally, the tool theoretical model was presented to prevention specialists and to management. Several adjustments were made to the model prior to approval in order to comply with the needs of the industrial partner. This step also provided the opportunity to refine the orientation of the design process and thereby minimize the risk of developing a tool that met the needs of the industrial partner only partially. Completion of the specifications thus allowed us to: (1) summarize the requirements of the industrial partner and (2) obtain the partner's approval for the tool theoretical model.

3.2.4 Structuring and programming

Structuring and programming of the tool was carried out through an iterative process involving the prevention experts. A list of performance indicators suggested in the literature was defined in accordance with the key themes of OHS performance determined previously in the specifications. Only themes judged exploitable in the partner's industrial setting were retained. At the same time, the software was programed to enable the specifications. Figure 3 (below) illustrates the process of designing the OHS performance evaluation tool.

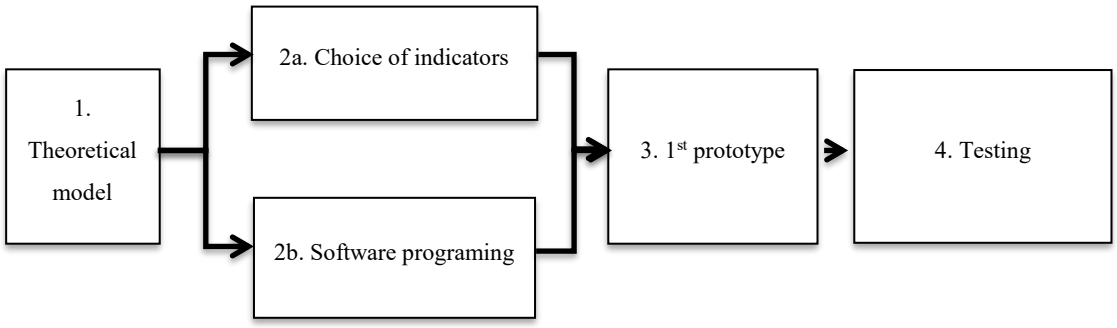

Figure 3 – Process of designing the OHS performance evaluation tool

3.2.5 Field-testing

The fifth step consisted of testing the tool on the premises of client companies affiliated with our industrial partner. This testing allowed us to determine whether or not the requirements implicit in the specifications were met.

a) Details of the experimental sample

In order to ensure that the tool was adapted to the context in which our partner was intervening, testing was conducted in each of the sectors of activity. Five SMEs were thus solicited: a tree-cutting business, a sawmill, a furniture manufacturer, a paper manufacturer and a manufacturer of various derivative products (Table 1).

Table 1 – Summary of the participating ASSIFQ-ASSPPQ client businesses

Type of business (sector)	**Number of employees**	**Size of company**	**Prevention mutual affiliation**	**Years of member ship**	**Representative**
Sawmill	< 99	Small	Yes	10	Plant manager
Furniture manufacturer	< 99	Small	Yes	6	HR manager
Paper manufacturer	~ 200	Medium	No	19	OHS representative
Coverings manufacturer	< 99	Small	Yes	2	HR manager
Logging	< 99	Small	Yes	4	HR manager
Logging	< 99	Small	Yes	10	OHS representative

Two categories of participants were involved: prevention specialists (employees of the industrial partner) and representatives of affiliated SMEs (private-sector clients of the industrial partner). Each of the 10 participating specialists used the tool in the production setting and participated in data gathering. The role of each of the five SME representatives was to guide the specialists at the production site and to answer the questionnaire (administered by the specialist) integrated into the tool.

b) Testing procedures

Two prevention experts were assigned randomly to each participating SME and met separately with the representative (test-retest mode). Each expert thus carried out one evaluation. In order to reduce experimental bias, assignment of the prevention experts (who differed in terms of previous experience) to the businesses was double blind.

Upon completion of the evaluations using the tool, the prevention specialist answered an overall assessment questionnaire and participated in a semi-directed interview. The questionnaire consisted of 37 closed questions with a nine-level Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (9). Values of 4 to 6 were taken to mean a neutral opinion or absence of opinion of the specialist. Its purpose was to obtain the specialist's opinion on various aspects of the tool itself, in particular the aesthetic quality, simplicity and user-friendliness of the interface as well as the relevance of the indicators used. Thirteen questions referred to characteristics of the respondent, such as age and seniority, while the other 24 were used to evaluate the tool. We obtained all 10 completed and validated questionnaires.

The semi-directed interview questions dealt with the requirements established in the specifications. The data thus gathered completed those obtained using the assessment questionnaire. Eight subjects were treated: general comments, intervention optimisation, apparent validity, client business manager accountability, client business diagnostics, prioritising of the specialist's interventions, potential for generalisation, and avenues of improvement to be explored. This interview lasted about 60 minutes. It allowed the specialists employed by the industrial partner to express their opinion after having used the tool in the field, and to comment on aspects such as satisfying the requirements set initially in the specifications. Prevention experts drew our attention to the following aspects of the PROFIL SST tool during these interviews: the choice of performance indicators, optimisation of interventions (evaluation of client business performance), client business accountability, prima facia validity (graphs and output data), diagnosis of client business deficiencies, and prioritisation of interventions following performance evaluation.

The results of the interviews were obtained using thematic analysis of the content. The interviews were first transcribed verbatim in their entirety. The opinions found expressed

therein were then assigned to one of two categories: positive (strong points) or negative (points needing improvement). We then determined the number of times each opinion or similar opinions were expressed.

Precautions were taken to ensure that the specialists did not engage in exchanges with each other prior to the questionnaire or interview portions of the study.

The tool output data, that is, the compilation of the data associated with the various indicators as well as the graphs and tables generated, were used also to verify compliance with the requirements of the industrial partner. Since the client company diagnostics were obtained using a test-retest approach with both specialists, the output data could be compared in order to verify the reliability of the evaluation.

3.2.6 Adjustment and calibration

The final step of the project was devoted to making adjustments to the OHS performance evaluation tool. Analysis of the assessment questionnaire, semi-directed interview and output data allowed us to verify whether or not the tool met the requirements of the industrial partner. Requirements found not to have been met were revised, and the tool was modified accordingly.

4. Results

4.1 Requirements to be met

Writing of the specifications took place over a period of about four weeks. It required discussions with the managerial staff of the industrial partner and the team of 10 prevention specialists. In addition, each specialist was observed during at least one of his or her interventions on the premises of the client company. These observations provided the opportunity to complete the information and make adjustments to the theoretical model as a function of the reality experienced by the specialists.

The discussions and field observations allowed clearer definition of the requirements to be met by the OHS performance evaluation tool. In order to suit our partner's needs, the tool thus had to meet four specifications:

- Able to identify the OHS deficiencies of a client company;

- Facilitate the prioritising of corrective actions;
- Standardize evaluation procedures conducted by the team of specialists;
- Simple to use and user-friendly.

4.2 Modeling of the tool

The OHS performance evaluation tool was named "PROFIL SST" (OHS Profile). The macrostructure and various other characteristics of "PROFIL SST" are presented below, along with the chosen performance indicators.

4.2.1 Structure of the tool

The tool is based on the model proposed by Sgourou et al. (2010) and revised by Liu et al. (2014). This model breaks down OHS performance into three fundamental dimensions: organisational, technical and behavioural. However, we chose to add a fourth dimension, namely continuous improvement, an underlying concept in several OHS management standards and reference systems (e.g. OHSAS 18001 and CSA Z1000).

We then subdivided the first three dimensions into several themes (sub-dimensions) based on the essential components of OHS performance outlined in the previous section and adjusted in accordance with comments of our industrial partner. The structure of "PROFIL SST" is summarized in Table 2.

Table 2 – Dimensions and themes of PROFIL SST

Dimension	Organisational	Technical	Behavioural	Continuous improvement
Themes (sub-dimension)	Commitment of upper management Risk identification and control Program of prevention Training Sub-contractor management	Lock-out/tag-out Personal protective equipment Closed spaces Work at heights High temperature WHMIS Rescue in forests Manual cutting	Supervisors Disciplinary measures Communication Worker representation	

4.2.2 Chosen performance indicators

Each of the four themes comprises several proactive performance indicators drawn from the scientific literature (Agumba and Haupt, 2012; Alolah et al., 2014; De Koster et al., 2011; Hallowell et al., 2013; Hinze et al., 2013; Li et al., 2015; Lingard et al., 2011; Liu et al., 2014; Mirabi et al., 2014; Podgórski, 2015; Sgourou et al., 2010; Wu et al., 2008).

These themes were then adjusted in accordance with proposals from our industrial partner. Tables 3, 4, 5 and 6 show the indicators retained under each theme.

Table 3 – ‘Organisational’ dimension themes and indicators

Theme	Indicator
Commitment of upper management	The OHS policy is displayed
	Has the company top executive signed on to the policy?
	(*) The OHS action plan is carried out on schedule
	The managers have OHS roles and responsibilities defined and in writing (e.g. description of tasks, mandates)
	Upper management follows up with managers to ensure that they have assumed their OHS responsibilities
	There are mechanisms of employee participation in OHS (e.g. CSS, RP, OHS meetings)
	There are forms of OHS promotion other than posters
Risk identification and control	(*) There is a first intervention/first aid registry
	The registry is used for preventive purposes (e.g. identifying recurrences, employee training, etc.)
	(*) Inquiries and analyses are conducted after accidents
	Accident inquiries and analyses are conducted after “near misses” or damage to equipment
	(*) For 2 recent inquiries, the causes were identified and appropriate corrective measures have been identified
	Members of the OHS committee, the prevention rep or employees are involved in the inquiries
	The risks inherent in each workstation are identified
	The risks inherent in each machine are identified
	The risks to be corrected are prioritized
	Production staff is involved in the risk analysis process
	(*) OHS inspections are conducted periodically
	Safeguards and locking systems are checked during OHS inspections
	Mobile equipment (e.g. forklifts, palette movers, loaders, forestry machinery, etc.) are checked during OHS inspections
	Safe work methods are checked during OHS inspections
	There are written proofs of these inspections
	(*) For 2 recent inspections, the forms are filled out properly
Prevention program	(*) The prevention program is updated
	There is written proof that each employee knows the prevention program
	Employees without responsibility in the event of emergency know the evacuation procedures
	Employees with responsibility in the event of emergency know the procedures to be followed
	(*) There is an updated emergency plan
	There is written proof that an emergency drill has been carried out during the previous year
	There is a written (formal) preventive maintenance program
	The safety devices (protectors, interlocks, etc.) are part of the preventive maintenance program
Training	(*) New employees are trained for their workstation and tasks (e.g. companioning)
	There is a written (formal) training plan
	Forklift operators are properly trained
	Rescue/first-aid crew is properly trained
	Bridge/crane operators are properly trained
	The employer keeps systematically appropriate written proof that training has been dispensed

Table 3 – 'Organisational' dimension themes and indicators (continued)

Theme	Indicator
Subcontractor management	(*) Subcontractors are apprised of the company prevention program, risks and so on
	The subcontractors' prevention program is asked for, documented and filed
	The subcontractors sign on when apprised of the prevention program
	(*) There is supervision to ensure that subcontractors comply with company procedures
	(*) There is written proof of subcontractor supervision (e.g. spot checks, inspection form, etc.)

(*) Critical indicators

Table 4 – 'Technical' dimension themes and indicators

Theme	Indicator
Lock-out/tag-out	(*) There is a lock-out/tag-out system (codification, form, procedure)
	The employees have received lock-out/tag-out training beyond simple explaining of the procedure
	(*) The workers have access to the material (e.g. lock-out/tag-out station)
	There is written proof of compliance with periodic lock-out/tag-out practices (audits)
Personal protective devices	(*) The employer is apprised of mandatory personal protective devices
	(*) The mandatory devices provide adequate protection against the principal risks
	The employer provides the devices or a fixed allowance to purchase them
	The employer ensures that the employees wear the devices
Closed spaces	(*) There is a procedure for work in closed spaces
	The closed spaces are listed in an updated document
	The employees have received closed spaces training from a certified license-issuing organisation
	Monitors and passers-through have received appropriate closed spaces training
	There is a records sheet for each closed space
	For 2 recent closed space permits, the permits are filled out properly
	(*) The company possesses the necessary devices for entry into closed spaces
	The company has a closed spaces rescue procedure
Work at heights	(*) The anti-fall personal protection devices are in compliance (e.g. CSA certified)
	The employees concerned have received training for working at heights
	There is written proof that the devices are inspected by a qualified person
	The employer ensures that the employees always use the devices
Work at high temperatures	(*) There is a procedure for tasks performed at high temperatures
	The employees concerned know the procedure
	The company uses a high temperature work permit system
	For 2 recent work permits, the permits are properly filled out
	The employees have received training beyond simple explaining for high-temperature work

Table 4 – 'Technical' dimension themes and indicators (continued)

Theme	Indicator
Rescue in forests	There is an established protocol for the rescue of injured workers
	(*) The employees know the emergency procedure (interview 2 workers)
	(*) The number of trained rescuers is compliant with regulations (at least 1 worker out of 5)
	The workers know which ones are the rescuers
	There are employees trained to stabilise injured individuals on a back board
	Functional communications devices are readily available for emergency use
	There is a monitoring procedure for lone and isolated workers
	The employer is able to prove that he applies his lone and isolated worker procedure
	(*) The material for use in case of emergency is available at the work site
Manual cutting of trees	(*) Manual tree-fellers have a card issued by an accredited organisation
	The employer monitors the skill (analyses stumps) of each manual cutter
	For 2 recent stump analyses, all sections of the inspection form are filled out properly
	The employer is able to demonstrate follow-up of the corrective actions

(*) Critical indicators

Table 5 – 'Behavioural' dimension themes and indicators

Theme	Indicator
Supervisors	(*) Managers ensure compliance with work regulations and methods
	Managers participate in risk identification (e.g. conduct accident inquiries or inspections)
	There is written proof of managerial interventions in employee behaviour (verbal notices must be documented)
Disciplinary measures	(*) There is a disciplinary measures policy
	There is written proof that the employees know the disciplinary measures policy
	Disciplinary measures are documented
Communication	Meetings of employees are organised periodically and OHS is discussed there
	(*) A member of upper management participates in the OHS committee or is present at OHS meetings
Worker representation	Members of the OHS committee, the prevention rep or employees are involved in inquiries
	Employees are involved in the risk analysis process
	Meetings of employees are organised periodically and OHS is discussed there

(*) Critical indicators

Table 6 – ‘Continuous improvement’ dimension themes and indicators

Theme	**Indicator**
Continuous improvement	The registry is used for preventive purposes (e.g. identifying recurrences, training employees, etc.)
	There is written proof of compliance with periodic lock-out/tag-out practices (audits)
	There is a system for ensuring that new products will have a material safety data sheet (e.g. purchasing policy)

4.2.3 Evaluation and critical indicators

Evaluation of proactive indicators is binary, meaning that the score may be 1 or 0, depending on the specialist’s finding that the client business meets the criteria for the performance indicator or does not. This method of evaluating these indicators was chosen for better between-judge reliability of the tool. The specialists did not wish to evaluate them on a Likert scale of five or even three levels because this already left too much room for subjective interpretation.

For the purpose of attributing an overall score representative of the evaluated client business performance, the dimensions and themes were weighted. The percentage of a dimension was the aggregate percentage of its constituent themes. The weightings (Table 7) were determined using the *analytic hierarchy process* (AHP) described in detail previously (Badri et al. 2012). For example, the result of the ‘organisational’ dimension accounts for 55 % of the overall score and the ‘upper management commitment’ score accounts for 30 % of the ‘organisational’ dimension. The ‘upper management commitment’ score thus accounts for 16.5 % of the overall score (0.55 x 0.30 = 0.165). It should be noted that this weighting is modifiable as the need may arise.

In the course of choosing the performance indicators, the specialists were required to designate critical indicators, marked with an asterisk in Tables 3, 4, 5 and 6. These correspond to preventive actions with priority. If the criteria associated with a critical indicator are not met (score 0), this is considered to indicate a major flaw to be corrected before dealing with the others.

Table 7 – Dimension and theme weightings (by AHP)

Dimension							
Organisational	55 %	Technical	25 %	Behavioural	10 %	Cont. improvement	10 %
Theme							
Upper management commitment	30 %	Lock-out/tag-out	12.5 %	Supervisor	30 %	Cont. improvement	100 %
Risk identification and control	25 %	Personal protection devices	12.5 %	Disciplinary notice	15 %		
Prevention program	25 %	Closed spaces	12.5 %	Communication	25 %		
Training	15 %	Work at heights	12.5 %	Worker representation	30 %		
Subcontractor management	5 %	Work at high temp.	12.5 %				
		WHMIS	12.5 %				
		Rescue in forests	12.5 %				
		Manual	12.5 %				
Total	100 %	Total	100 %	Total	100 %	Total	100 %

4.3 Functioning of the tool “PROFIL SST”

4.3.1 Input data

Upon opening the application, the user of the evaluation tool “PROFIL SST”, usually an OHS preventive measures specialist, selects the sector of activity of the client business being evaluated (Figure 4). Our industrial partner is active in three sectors: forestry, furniture manufacturing and sawmills. For the moment, the tool interfaces are available in French only.

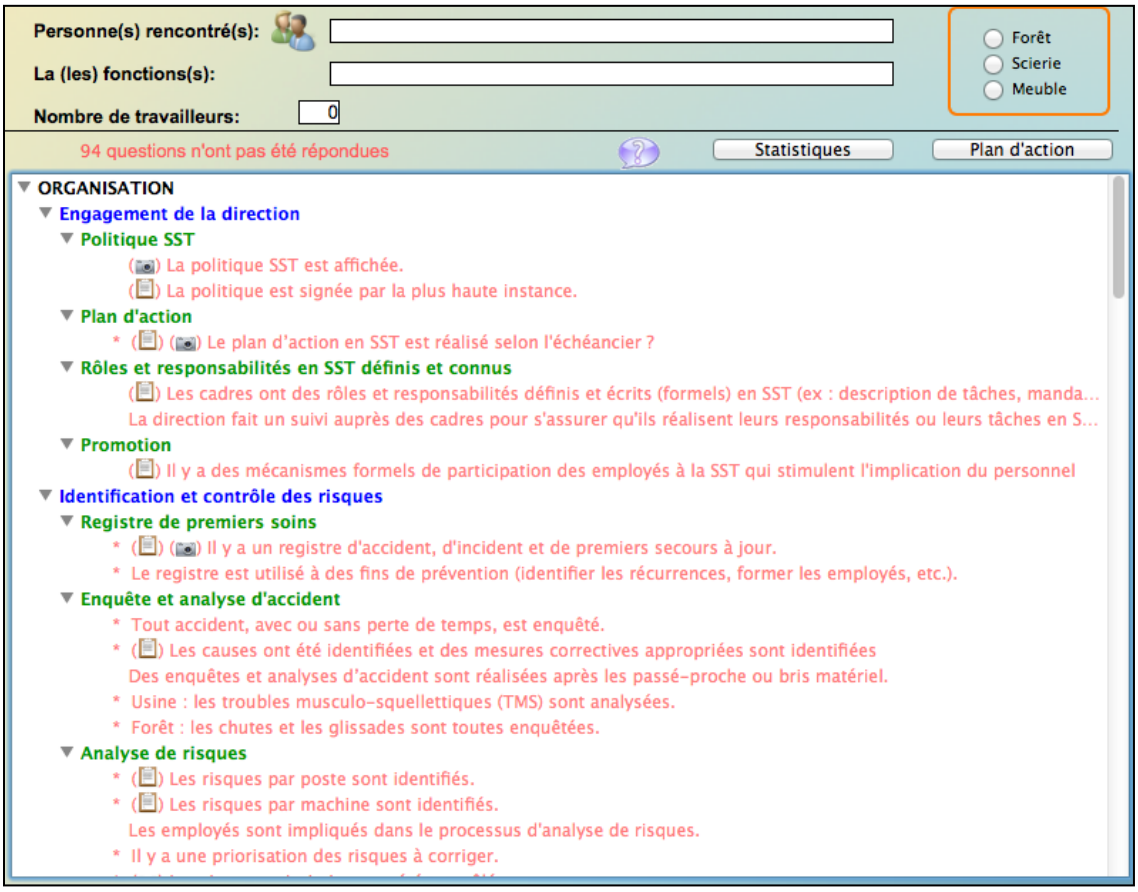

Figure 4 – Opening page of the PROFIL SST user interface (French version)

Using the questionnaire in the evaluation tool, the OHS specialist enters the status of each indicator (1 or 0), based on the answers obtained from the representative of the client business. The representative is usually the general manager.

If written proofs were consulted in order to determine whether or not to assign a positive score, an icon appears in front of the indicator. This improves the consistency of the evaluations carried out by different users.

In some companies, not all of the indicators can be evaluated. For example, some never work in closed spaces and do not need to specify any procedure therefor. In situations such as these, the non-applicable indicators can be inactivated.

An evaluator's guide is provided to help maximise the consistency from one user to the next. This manual contains helpful interpretations of indicators with examples.

4.3.2 Data processing

Once the evaluation is completed, a percentage score is attributed automatically to each of the themes. This score is calculated from the number of indicators meeting the criteria and the total number evaluated. For example, the "upper management commitment" theme includes seven applicable indicators in the case of a particular client business. If only three of these meet their criteria, the score is 43 % (3 divided by 7). The weighted themes are then aggregated into an overall composite percentage score. (The weighting or indicator values in the tool can be modified easily.) The results for each business are then saved in the database for quick retrieval by entering the appropriate keyword in the "company name" or "location" box and clicking on SEARCH.

4.3.3 Output data

Calculated results are presented in the form of graphs at two levels, one displaying the four dimensions and thus providing an overview of the OHS performance of the evaluated business, and the second level showing in detail the results for the themes identified for each dimension.

Performance is always compared to the average of other client businesses in the same sector of activity. This average is updated systematically as the database grows. This comparison facilitates the evaluation. The Quebec commission of standards, equity and occupational health and safety (CNESST) uses such comparisons to determine fiscal contributions of businesses.

When the criteria of critical indicators (marked with an asterisk in the tool questionnaire) are not met, the corresponding theme is highlighted in red. When the result for a theme is below average for that sector of activity, the theme is highlighted in orange.

In order to simplify interpretation of the results, the themes are ordered by weighting factor, the most weighted theme appearing farthest left on the graph. Critical indicator themes not meeting their criteria and below the average result appear in red. The teams involved agreed in consultation that when several themes appear highlighted in red or orange, the specialist's intervention must focus on the red ones first.

Double-clicking on a theme displayed in a graph opens a new window in which the answers provided on that theme are shown in detail.

5. Discussion

In this section, we discuss the degree to which PROFIL SST satisfied the four requirements specified by our industrial partner, namely:

- Identifies client business OHS deficiencies correctly;
- Helps with the prioritising of corrective actions;
- Standardises evaluation practices within the team of specialists;
- Is simple and user-friendly.

5.1 Correct identification of OHS deficiencies

Regarding the relevance, clarity and adequacy of the indicators chosen for each OHS performance theme, the specialists were in general agreement, although 11 indicators received poor ratings. Nine of the 10 specialists expressed the opinion that the tool identified OHS deficiencies correctly, and eight found that the indicators were well adapted to the companies that they evaluated. Four of the 10 found that the indicators did not cover all possible risks, and 3 felt that the proactive indicators were not helpful for identifying deficiencies in the enforcement of OHS in the workplace.

In view of the diversity of the opinions shared by the specialists, we concluded that the choice of OHS performance indicators could be improved. We therefore held an additional interview to review all of the choices. This led to deletions, additions and modifications in

an attempt to satisfy all of the specialists. The final choices of performance indicators are listed in Tables 8, 9, 10 and 11.

Table 8 – 'Organisational' dimension final themes and indicators

Theme	**Indicator**
Commitment of upper management	The OHS policy is displayed
	Has the company top executive signed on to the policy?
	(*) The OHS action plan is carried out on schedule
	The managers have OHS roles and responsibilities defined and in writing (e.g. description of tasks, mandates)
	Upper management follows up with managers to ensure that they have assumed their OHS responsibilities
	There are formal mechanisms of employee participation in OHS that stimulate the involvement of staff
Risk identification and control	(*) There is a first intervention/first aid registry
	(*) The registry is used for preventive purposes (e.g. identifying recurrences, employee training, etc.)
	(*) All accidents, with or without downtime, are investigated
	(*) The causes and appropriate corrective measures have been identified
	Accident inquiries and analyses are conducted after "near misses" or damage to equipment
	(*) Factory: musculoskeletal injuries are analysed
	(*) Forest: all falls and slips are investigated
	(*) The risks inherent in each workstation are identified
	(*) The risks inherent in each machine are identified
	Employees are involved in the risk analysis process
	(*) There is prioritising of the risks to be corrected
	(*) The high-priority risks have been monitored
	(*) In the risk analysis, particular attention is paid to monitoring musculoskeletal injuries
	OHS inspections are conducted periodically
	Safeguards and locking systems are checked during OHS inspections
	Mobile equipment is checked during OHS inspections
	Safe work methods are checked during OHS inspections
	There are written proofs of these inspections
	OHS inspections are filled out correctly
Prevention program	(*) The prevention program is updated
	The prevention program is accessible to the workers
	The emergency plan is up to date
	The employees know the rescue procedures
	Employees with responsibility in the event of emergency know the procedures to be followed
	There is written proof that an emergency drill has been carried out during the previous year
	There is a written (formal) preventive maintenance program
	There are safety guidelines or safe work methods for each workstation
	(*) There are safety guidelines or in-house rules regarding safety
Training	The employer keeps systematically appropriate written proof that training has been dispensed
	The employees concerned have been trained in the transport of dangerous substances
	Forklift operators are properly trained
	Rescue/first-aid crew is properly trained
	Bridge/crane operators are properly trained
Subcontractor management	Subcontractors are apprised of the company prevention program, risks and so on
	The subcontractors' prevention program is asked for, documented and filed
	There is supervision to ensure that subcontractors comply with company procedures
	There is written proof of subcontractor supervision (e.g. spot checks, inspection form, etc.)

(*) Critical indicators

Table 9 – 'Technical' dimension final themes and indicators

Theme	Indicator
Lock-out/tag-out	(*) There is a lock-out/tag-out system (codification, form, procedure)
	(*) The employees have received lock-out/tag-out training beyond simple explaining of the procedure
	(*) The workers have access to the material (e.g. lock-out/tag-out station)
	(*) There is written proof of compliance with periodic lock-out/tag-out practices (audits)
Personal protective devices	The employer is apprised of mandatory personal protective devices
	The mandatory devices provide adequate protection against the principal risks
	The employer provides the devices or a fixed allowance to purchase them
	The employer ensures that the employees wear the devices
Closed spaces	There is a procedure for work in closed spaces
	The closed spaces are listed in an updated document
	The workers know the procedure
	The company possesses the necessary devices for entry into closed spaces
Work at heights	The anti-fall personal protection devices are in compliance (e.g. CSA certified)
	The employees concerned have received training for working at heights
	There is written proof that the devices are inspected by a qualified person
WHMIS	The safety information and data sheets are clearly visible to the workers
	Employees concerned with WHMIS have received the training
	There are emergency eyewashes (eye and/or body)
	There is a system in place to ensure that new products have a safety data sheet (e.g. purchasing policy)
Rescue in forests	There is an established protocol for the rescue of injured workers
	The employees know the emergency procedure (interview 2 workers)
	(*) The number of trained rescuers is compliant with regulations (at least 1 worker out of 5)
	The workers know which ones are the rescuers
	There are employees trained to stabilise injured individuals on a backboard
	Functional communications devices are readily available for emergency use
	There is a monitoring procedure for lone and isolated workers
	The employer is able to prove that he applies his lone and isolated worker procedure
	The material for use in case of emergency is available at the work site
Manual cutting of trees	Manual tree-fellers have a card issued by an accredited organisation
	The employer monitors the skill (analyses stumps) of each manual cutter
	For 2 recent stump analyses, all sections of the inspection form are filled out properly

(*) Critical indicators

Table 10 – 'Behavioural' dimension final themes and indicators

Theme	Indicator
Supervisors	Managers ensure compliance with work regulations and methods
	Managers participate in risk identification (e.g. conduct accident inquiries or inspections)
	OHS disciplinary measures concerning workers are enforced
Reception and integration of new workers	(*) New workers are informed regarding the risks associated with the work and apprised of the in-house rules and prevention program
	(*) There is documented proof that the integration procedure has been followed
	(*) New employees or employees changing tasks are trained at their workstation for their new tasks
Worker representation	There are formal mechanisms of employee participation in OHS that stimulate the involvement of staff
	Employees are involved in the risk analysis process

(*) Critical indicators

Table 11 – ‘Continuous improvement’ dimension final themes and indicators

Theme	Indicator
Continuous improvement	(*) Forest: when a slip or a fall has occurred, the form is filled out
	(*) Factory: particular attention is paid to manual handling tasks
	The certificate of mutual membership is up to date and on display
	When an employee is injured and leaves for consultation, he receives systematically a temporary job assignment form
	There is written proof that temporary assignment jobs have been properly identified
	Managers have quick access to these job description forms
	Managers follow up the return of the employee to ensure that the form has been filled out

(*) Critical indicators

5.2 Helpful prioritising of corrective actions

With regard to the development of corrective action plans, only three specialists mentioned in the semi-directed interviews that the tool facilitated this process. Six out of 10 participants said that the priorities set by the tool created confusion. In addition, 53 % of the ideas expressed on this subject were considered negative. Among the negative feedbacks, we received comments such as “I’m confused, the priorities flagged by the tool differ from what I thought they should be”, “the tool doesn’t help to prioritize corrective measures when several are needed” and “the tool doesn’t help to build an action plan”.

Given that the critical indicators were proactive indicators that the specialists themselves had designated as indispensible in the business setting, if the criteria for such an indicator were not met, the deficiency was to be considered major and the corresponding theme was flagged in red. Since field-testing showed that this informal designation did not necessarily help the specialists prioritise the interventions, we decided to try a different approach. Using a database provided by our industrial partner, we analysed all recorded workplace accidents that had occurred among its clients during the previous year (2015), categorising them in terms of type, cause and frequency. The lists shown in Tables 8, 9, 10 and 11 were obtained in fact by designating as critical the indicators that were most consistent with the accident frequency pattern observed. Also, the industrial partner senior executives identified the proactive indicators that must be met in order to satisfy their annual action plan. By combining conclusions drawn from the analysis of workplace accidents and clear directives from upper management, we were able to identify a limited number of critical indicators. At the end of this process, the participants were pleased with the selection of critical indicators, and this selection did help them to prioritise corrective measures.

5.3 Standardising evaluation practices

Based on comparison of output data and analysis of the opinions expressed, 5 out of 10 specialists found that the tool allowed standardising of the questions put to the employers, and 4 out of 10 stated that it helped them structure their interventions. No specialist expressed any negative criticism of this aspect of the OHS performance evaluation tool.

The level of agreement and the similarity of the results obtained for each indicator as provided by the experts were calculated respectively in terms of "percent agreement" and Cohen's kappa statistic. Percent agreement is obtained from the number of answers in agreement divided by the total number of answers (e.g. 50 % if 5 out of 10 answers provided are in agreement). Cohen's kappa test measures similarity using percent agreement and a 'chance factor' that accounts for the possibility that agreement is due entirely to chance (McHugh, 2012). This test is used in psychology and medicine to evaluate between-judge reliability. It is also used in OHS, in particular to evaluate management system audit methods (Robson and Bigelow, 2010). For an evaluation method to be considered reliable, the agreement must be at least 70 % (Li and Buckle, 1998) and the kappa score at least 0.41 (McHugh, 2012). Table 12 summarises the results obtained for testing of the OHS performance evaluation tool. The assessments by the experts were thus found reliable, with agreement averaging 85 % and a kappa score averaging 0.6.

Table 12 – Reliability of PROFIL SST assessment results based on expert agreement and Cohen's kappa test

Business	Experts	Agreement	Kappa score
E1	P1 and P2	84 %	0.54 %
E2	P3 and P4	87 %	0.61 %
E3	P5 and P6	87 %	0.60 %
E4	P7 and P8	83 %	0.65 %
E5	P9	Not calculated	Not calculated
E6	P10	Not calculated	Not calculated
	Average	85.25 %	0.60

Although our initial goal was to conduct testing on the premises of five client businesses, one of the participating experts was not able to participate at one of the locations. A sixth business was therefore included to allow this participant to test the tool. Although the assessment questionnaire and semi-directed interview were obtained in this case, the output data could not be paired with any other case for a fifth comparison.

In view of the percent agreement and kappa score (85 % and 0.60) for this aspect of the evaluations, we felt that PROFIL SST met the specification and needed no modification in this regard.

5.4 Simplicity and user-friendliness

The tool questionnaire and semi-directed interview results were combined for this analysis. The average scores (Likert) obtained for each aspect of this specification using the questionnaire are as follows:

- Simplicity of the tool: 7 (agreement)
- Aesthetics: 6.1 (neutral)
- Ease of interpretation of results: 6.5 (neutral)
- Ease of use of the tool: 7.4 (agreement)
- Time required is acceptable: 8.1 (agreement)

The specialists thus had a neutral or slightly favourable opinion of this aspect of the tool, based on the questionnaire. However, the interviews revealed more divergent opinions. Five participants mentioned that the results were easy to interpret. Four disagreed. We concluded that the tool needed further simplification. For this purpose, it was integrated into other computer tools used by the specialists. To facilitate interpretation of results, the industrial partner managers developed an in-house procedural framework that required the specialists to focus first on correcting non-compliant critical indicators. In addition, the evaluator's manual was integrated into the software. The user can now click on a tab for help with interpreting an indicator. Increasing the font size and window size brought some improvement in terms of readability and aesthetics.

5.5 Summary of compliance with requirements

Table 13 shows the degree of satisfaction with PROFIL SST expressed for each of the requirements established in the product specifications, as well as the modifications implemented in the course of this research project.

Table 13 – Summary of the degree of satisfaction of the requirements

Requirement	Satisfaction (Initial)	Explanation	Corrective modification	Satisfaction (Final)
Identifies client business OHS deficiencies correctly	Partial	Divergent opinion among the participants	Addition, deletion or modification of performance indicators	Yes
Helps with the prioritising of corrective actions	No	Negative opinion of the participants	Modification of critical indicators, based on analysis of workplace accidents and upper management's action plan.	Yes
Standardises evaluation practices within the team of experts	Yes	Cohen's kappa score > 0.41	None	Yes
Is simple and user-friendly	Partial	Divergent opinions among the participants	Integration of the evaluation tool into other computer tools. Development of an in-house procedural framework. Integration of the evaluator's manual into the software. Improvement of interface aesthetics.	Yes

Field-testing of the tool allowed identification of aspects that needed improvement (as shown in Table 13). The industrial partner validated the changes made and the prevention experts were satisfied with the modifications. In fact, one year after the first field-testing, the tool is now part of the standard procedures, and the prevention experts use it on a daily basis. The tool has been used so far in 200 SMEs (forestry/pulp and paper industry in Quebec). One of its biggest advantages is the standardisation of evaluations among

prevention experts. Since prevention experts come from very different backgrounds (industrial hygiene, human resources, engineering and administration), their focus during their interventions is in accordance with their respective expertise and they tend to neglect aspects with which they are not as familiar (Badri et al., 2013). The proactive indicators thus help them assess the performance of a SME independently of their expertise and not forget or neglect an element of evaluation. Also, the proactive and critical indicators used in this tool have helped identify shortcomings in the services offered by our industrial partner. For example, analysis of workplace accidents showed that musculoskeletal disorders were the most frequent type of injury among our partner's clients, and yet proactive indicators showed that most SMEs did not manage musculoskeletal risks. In light of this observation, our industrial partner has developed new services such as ergonomic assessments or manual handling trainings.

As far as we know, this is the only OHS performance evaluation tool designed specifically for the SME context that meets the validity, reliability, simplicity and performance indicator criteria set. Among the OHS performance evaluation tools identified in the literature (Tremblay and Badri, 2017), this is the one with the most shared information about its hierarchy and content. Even though it was applied to the forest product and wood processing industries, the same approach and integrated key elements (four OHS dimensions, binary evaluation, critical indicators, etc.) could be used to adapt a valid and reliable tool to other industrial sectors. Finally, some authors have emphasized the importance of using both reactive and proactive indicators (Lingard et al., 2011), but few have suggested how to combine them effectively. This has been achieved in the present tool in a way that satisfies the needs of OHS experts (critical indicators based on workplace accident frequency).

5.6 Limitations and avenues of research

A new tool for OHS performance evaluation was field-tested within an action research initiative that benefited from the participation of an industrial partner throughout the project. This partner has an interest in the development of an effective and reliable tool and therefore brought objectivity to the study. Although some of the results are encouraging, certain limitations need to be addressed.

To begin with, the experimental sample size was relatively small (10 OHS intervention specialists and 6 small and medium-sized businesses). A larger experiment would allow us to uncover new avenues of improvement and provide more certainty regarding the reliability and consistency of the tool from one user to the next. Also, the tool was designed and tested only in the context of the forestry and pulp and paper sector. The selection of proactive indicators would likely require adjustment to make the tool as effective in other industrial sectors.

We have shown previously the advantages and drawbacks of using reactive and proactive indicators and have suggested that both types might be combined advantageously in a decision-aid tool. However, we encountered difficulty in our attempts to integrate relevant and non-redundant reactive indicators into the design of the present OHS performance evaluation tool. This was largely because our industrial partner already uses reactive indicators (cost and workplace accident statistics) to prioritise its interventions on behalf of clients. The redundancy would be even exaggerated now that the tool is integrated into other application software used by this organisation. Nevertheless, it should be noted that reactive indicators were used to select the critical proactive indicators in the final version.

Having completed this work, we envisage three promising avenues of research. First of all, it should be possible to associate evaluation results with auto-programed corrective actions to facilitate further the intervention specialists' task. This list of corrective actions could be upgraded continually. Next, the correlation between the use of proactive indicators and the OHS financial performance (e.g. number of days compensated, total compensation, CNESST contributions, etc.) of the company should be tested. Finally, we need to measure how much the refinement of the proactive indicators over the years actually improves OHS financial performance. The goal of such a study would be to quantify in monetary terms the benefits associated with OHS interventions.

6. Conclusion

In spite of the abundance of theory on the concept of OHS performance, there is little helpful information available to professionals trying to improve it in the field. Managers of SMEs have limited means at their disposal and it is difficult for them to set up the types of management system that are commonplace in large corporations.

This project has provided us with a glimpse of the numerous questions that remain unanswered in relation to improving OHS performance in SMEs. Management tools, methods and systems designed to optimise preventive interventions are rare, especially for use in the SME context. Even for those that exist, there are few data available on their effectiveness or real usefulness in the actual work environment. Since the majority of workers are employed by SMEs, the poorer OHS performance characterising these settings must be taken seriously. Our initial question remains relevant: what type of remedy is needed in order to improve this situation? We believe that better decision-aid tools will provide at least part of the solution.

Our focus on the development of a novel tool for evaluating OHS performance in the SME context was fruitful insofar as our industrial partner is amply satisfied with the results. Prevention specialists are now using the tool on a daily basis. The reliability of the data gathered and the improved standardisation of interventions have been of real benefit in terms of quick highlighting of deficiencies in ASSIFQ-ASSPPQ in-house procedures and services offered to client businesses. In keeping with their continuous improvement initiative, methods have been reviewed and new services have been developed. For prevention specialists, integrating the use of the tool into their daily activities led within a few months to the unanticipated benefits of better teamwork and increased sharing of information among colleagues.

In summary, the proposed tool allows prevention specialists to standardise and structure their interventions more effectively. However, a complementary study is necessary in order to identify preventive activities that reduce the frequency of work-related injuries directly. In spite of the encouraging results of the present project, it represents only a drop in the bucket. The clients of our industrial partner comprise only a small fraction of the SMEs in

Quebec. Furthermore, it is still too early to assess the actual impact of such a tool on improvement of OHS performance.

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