2.3. Evaluation of Safety Programs

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2.3. Evaluation of Safety Programs

Program evaluation refers to the use of scientific methods to systematically exam the design, implementation, and outcomes of a program or intervention (e.g., a safety intervention). Program evaluation examines what needs should be addressed by the program, how these needs will be addressed, as well as the expected and unexpected outcomes of the program. Program evaluation is a useful means of assessing how effective a company's safety programs are by determining whether the intervention is having the desired outcomes and resulting in a safer workplace. Process evaluation can also determine the specific aspects of an intervention that are improving safety and differentiate unnecessary aspects, which can aid in improving the cost-effectiveness of the intervention program. Additional goals of program evaluation include demonstrating the program's effectiveness to funders, improving the effectiveness and efficiency of the program, documenting the program's accomplishments, and aiding in replication of the program in other contexts.

There are numerous types of evaluations, each with a different purpose and result: *formative evaluations* examine the early stages of a program's development and determines what needs a program should fulfil; *process evaluations* examine the implementation and operation of program components; *outcome evaluations* examine the short-term, long-term, and unintended results of a program; and *economic evaluations* systematically measure the inputs and outputs of a program in order to determine the cost (i.e., resources used) and consequences (i.e., outcomes and effects). There are a variety of types of economic evaluations including cost benefit analysis, cost utility analysis, and cost effectiveness analysis. The purpose of an economic evaluation is to determine the best course of action based on the cost and consequences of the intervention. The indicators and metrics discussed in this chapter are useful for all forms of program and economic evaluations.

Method

Search strategy. The majority of articles included in this chapter were retrieved through the search strategies created for the original "Behaviour Changing Strategies" and "Existing Safety Interventions" topics that were since re-structured for the final report. That is, the current topic emerged post-hoc and thus did not have its own search strategy or inclusion/exclusion criteria. The search strategies developed for the original topics, which generated articles included here, included:

1. Programs (safety program, applied psychology, engineering psychology, environmental psychology, "industrial and organizational psychology", social psychology, strategies, safety approach, intervention, group intervention, safety procedures, safety protocols, program evaluation, program development, evaluation, evaluation criteria, safety intervention, accident prevention)
2. Safety engagement (see General Methods section)

These searches were undertaken between September 2014 and April 2015.

Screening strategy. Articles ultimately included in this topic were first screened in the original "Behaviour Changing Strategies" and "Existing Safety Interventions" topics. This initial screening process was similar to other topics such that articles were excluded for publication date (e.g., published before 2010), irrelevant records (e.g. non English), irrelevant medium (e.g., book reviews, letters to editor, etc.), irrelevant safety domain (e.g., sexual risk taking, gambling, etc.), or other irrelevant content based on the inclusion/exclusion criteria listed below. After this initial screen, articles unique to program evaluation and indicators were extracted to form the current topic. Thus, unique inclusion and exclusion criteria were not created.

Results

Description of included articles. A brief summary of all articles including the location, population studied, main issue addressed, comparison group, and primary outcomes is provided in Appendix G. The following is an overview of included articles.

Table 1 General Evaluations of Safety Programs Number of Articles by types, countries, and population

Type of Publication:	Country of Publication:	Population Studied:
- 4 systematic literature reviews - 17 original research - 9 summary discussions - 1 theoretical review - 1 meta-analysis - 1 scoping review - 6 tool development - 4 interviews - 4 archival data - 4 survey questionnaire - 3 case study	- 9 USA - 6 Italy - 3 Greece - 2 Finland - 2 Netherlands - 2 Portugal - 1 Australia - 1 Bangladesh - 1 Canada - 1 China - 1 Denmark - 1 Norway - 1 Spain - 1 Sweden - 1 Switzerland - 1 UK - 1 a variety of European countries	- 5 construction industry - 3 manufacturing industry - 2 agricultural businesses - 1 shipping company - 1 hospital - 1 chemical plant - 1 pipefitters and plumbers - OHS workers - 1 mining industry - 1 civil service - 17 general employees

Description of Identified Organizational Factors. Based on a descriptive analysis of the selected articles conducted in Stage 1, six themes of general evaluation of safety programs emerged: indicators and metrics, program evaluation of safety interventions, effectiveness of program evaluation, and effectiveness of economic evaluation (cost of accidents and cost of safety programs). The primary results and potential applications of each identified factor are discussed. All definitions of concepts as used in the current literature are provided in Appendix D.

Indicators and Metrics. Eighteen articles were related to indicators and metrics used to evaluate safety programs. Ten of these articles cover scales that can be used in a variety of industries (Table 4) while the remainder discuss indicators that should be assessed in industry. According to Reiman (2012), there are three main types of indicators: *drive indicators* refer to measures that fulfil selected safety management activities; *monitor indicators* reflect the potential capacity for the organization to perform safely; and *outcomes* measures the safety consequences of the organization (i.e., injury rates). There are also two main methods of obtaining safety data: leading and lagging. Drive and monitor indicators are considered leading while outcomes are lagging. Lagging indicators follow an event and provide a historical record of the incidents that have occurred (i.e., measuring safety by looking at lost-time injury rates). Leading indicators are measures that can be used as predictors of future levels of safety performance (i.e., number of employees engaging in new safety intervention program). Effective evaluations should employ multiple indicators, using both lagging and leading means of data gathering.

Several articles within this literature review indicate various performance indicators that could be assessed by industry. First, Basso and colleagues (2004) argue that industry should assess the following safety performance indicators: organization and personnel, identification and evaluation of major hazards, operational control and management of change, planning for emergencies, and audit and review. Conversely, Hallowell and colleagues (2013) suggest thirteen leading indicators that should be assessed: near miss reporting, project management team safety process involvement, worker observation process, stop work authority, auditing program, pre-task planning, housekeeping program, owner's participation in worker orientation sessions, foremen discussions and feedback meetings, owner safety walkthroughs, pre-task planning for vendor activities, vendor safety audits, and vendor exit debrief. Niskanen, Naumanen, and Hirvonen (2012) provide several indicators that should be addressed regarding safety legislation: commitment of upper management (e.g., prioritization of proactive safety measures, policy, and guidelines), contribution measures, concrete preventive measures, and risk assessment process. Additionally, Boyle (2010) suggests that driving simulators are useful means of determining driver performance as well as an effective way to train employees on new equipment.

Furthermore, Fung, Ivan, and Vivian (2013) claim that management often does not consider the theoretical causes of accidents when implementing safety measures. However, two models are proposed by Andersson (2012) for industry members to consider. First, the systems approach is a multidimensional approach that claims accidents have multiple causes and, if stability and control are to be achieved, then these multiple factors must be addressed. The second approach is the injury prevention approach which views injuries as being linear and only caused by one specific factor. Both of these approaches should be considered by industry members when conducting an accident investigation (Andersson, 2012). Finally, Table 2 lists all scales that emerged from the literature review, including the contexts these scales are useful and whether they have been assessed for reliability and validity.

Table 2 Reliability and Validity of Reviewed Scales

Author	Scale Name	Intended Context	Reliability	Validity
Biggs & Biggs, 2013	Safety Effectiveness Indicators (SEI)	Construction industry Based on successful safety performance rather than failure	Not assessed	Face validity was examined with focus groups and pilot feedback
Buckley, Cooney, Sills, & Sullivan, 2014	Safety Thermometer	Nurses in a hospital Used to assess the prevalence of 4 common harms	Not assessed	Not assessed
Curcuruto, Guglielmi, & Mariani, 2014	Proactive Risk Management (PRISM) Scale	Chemical plant Measures workers' proactive participation in safety	Inter-rater reliability was assessed and found to be adequate for 13 out of 15 items	Not assessed

DeArmond, Smith, Wilson, Chen, & Cigularov 2011	Safety Performance Measure	Construction industry Measures safety compliance and safety participation	Internal consistency was assessed, and was adequate for both compliance (.70) and participation (.88)	Criterion-related validity was adequate, as there was a relationship between the scale and workplace injuries
Kongsvik, Almklov, & Fenstad, 2010	Operational Safety Condition (OSC)	Installation plant Measures organizational safety conditions	Not assessed	Face validity was adequate
Marcatto Colautti, Filon, Luis, & Ferrante, 2014	Health and Safety Executive Management Standards Indicator Tool (HSE-MS IT)	General employees in Italy Measures satisfaction, job motivation, and work stress	Not assessed	Both concurrent and construct validity were found to be adequate.
Orsulak, Kecojevic, Grayson & Nieto, 2010	Safety Standards Scale	Coal mine industry in the USA Measures risks from safety violations	Not assessed	Not assessed
Sgourou, Katsakiori, Goutsos, & Manatakis, 2010	Safety Element Method (SEM); Universal Assessment Instrument (UAI); Safety Culture Questionnaire (SCQ); Safety Diagnosis Criteria (SDC); Occupational Health and Safety Self-Diagnostic Tool (OHS-SDT); PyraMAP	Developed for a variety of industry settings Measures organizational, human factors, and their inter-relations	Only SCQ was assessed for internal consistency	SEM, SCQ, and OHS-SDT had adequate construct validity. UAI and SCQ had adequate concurrent validity. SEM and SDT had adequate convergent validity.
Sgourou, Katsakiori, Papaioannou, Goutsos, & Adamides, 2012	Soft Systems Methodology (SSM)	Greek civil service organization Evaluates Occupational Safety & Health performance and supports decision making	Not assessed	Not assessed
Targoutzidis, 2010	Human Factors Scale	General industry Incorporates human factors into risk assessment in the workplace	Not assessed	Not assessed

Program Evaluation of Interventions. One article discussed formal program evaluations of safety interventions. DeRoo and Rautiainen (2000) conducted a systematic literature review of two types of farm safety intervention programs: educational programs directed at children and practical farm safety intervention plans directed at farm operators. The educational farm safety intervention programs resulted in increased correct responses regarding farm safety questions, safer attitudes about farm equipment, and increased intentions to behave safely when on a farm. Among the farm operators, the various intervention programs all resulted in positive changes (i.e., increased farm safety awareness and behaviors). One specific intervention program found that injury rates dropped from 33 to 20 injuries per 100,000 work hours, while the non-intervention group had no reduction in injuries. The intervention group also exhibited safer behavior on 66 different work tasks.

Effectiveness of Program Evaluation. Four articles were related to the effectiveness of program evaluation. These articles discuss weaknesses in current program evaluation practises (DeRoo & Rautiainen, 2000), as well as how to improve program evaluations that are directed towards safety (Pedersen, Nielsen, & Kines., 2012; Schuh, Camelio, & Woodall, 2014; Zwerling et al., 1997). DeRoo and Rautiainen (2000) found that program evaluations of agricultural businesses had weak methodology and design. Many of the intervention evaluations lacked a control group when comparing outcome factors and response rates were often low. Furthermore, the majority of the studies relied on self-report measures and, while self-report measures are a useful and quick means of obtaining data, they are best used in conjunction with other methods such as observation or interviews. Self-report measures may not always be an accurate measure of participants' actual behavior and participants' responses may not always reflect how they actually feel.

Despite these limitations in program evaluation design, Pedersen and colleagues (2012) suggest an improved means of conducting these evaluations: realistic evaluation. Realistic evaluation focuses on identifying what techniques work for whom, under what circumstances, and in what respects. In sum, realist evaluation determines the underlying mechanism of the safety issues in a specific context. The "context" can include anything from national structures to company size, production pressure, or norms within the company. The underlying mechanism refers to key individuals involved in the safety process and the relationship between them. Common mechanisms for the success or failure of an intervention include motivation, role behavior, and trust. Realistic evaluation also incorporates theory to provide a greater understanding of how the safety intervention is affected and qualitative methods are used in order to ensure an equal breadth and depth of data is obtained.

Additionally, Schuh and colleagues (2014) suggest using daily time-between-incidences monitoring. This refers to continuous monitoring that provides timely signals of increasing the frequency of safety incidents whereby incidents and near-misses are reported daily. Safety incident data should be collected as often as possible as this leads to faster hazard identification and reduced accidents, usually between 30 to 75% depending on how quickly the hazard was identified and addressed.

Zwerling, Daltroy, Fine, Johnston, Melius and Silverstein (1997) also provide several recommendations when conducting quality safety evaluations. Firstly, the authors recommend separating injury measurements into two categories (1) acute traumatic injuries (i.e., an injury that occurred suddenly), and (2) work-related musculoskeletal disorders (i.e., an injury caused by repetitive motions and awkward postures). Second, the authors recommend that unexpected outcomes of the evaluations be examined and that both qualitative and quantitative research be conducted. Finally, the authors state that longitudinal evaluations on a large sample of participants should be used in order to determine the true impact of the intervention program.

Effectiveness of Economic Evaluation. Six articles were related to the effectiveness of economic evaluations. Two articles demonstrate the weaknesses with current economic evaluations (Tompa et al., 2009; Uegaki et al., 2010) while the other four provide resources for how an effective cost-benefit analysis can be conducted (Cagno, Micheli, Masi, & Jacinto, 2011; Cagno, Micheli, Masi, & Jacinto, 2013; Fernaud et al., 2012).

First, Tompa and colleagues (2009) found that a large number of safety interventions and programs do not adequately examine the economic aspect of the program. Similar to the weak methodology and design of program evaluations (DeRoo & Rautiainen, 2000), many of the economic evaluation designs were weak and allowed extraneous contextual factors to be unaccounted for. Furthermore, within Tompa and colleagues' (2009) systematic review of 72 articles, the majority assessed the effectiveness of the intervention, but very few assessed the cost of the intervention or how much the safety improvements saved on expenses. The evaluations that did examine the economic aspect only used worker compensation as a measure of the economic consequences. None of the evaluations used productivity losses, time off work due to injury or disability, or the emotional consequences of the injured employee and their family as an indicator.

Uegaki and colleagues (2010) conducted a systematic literature review to assess the methodological rigor used when conducting economic evaluations. They assessed 34 studies and found that only 44% met half of the quality criteria the studies were assessed on. Quality criteria included aspects such as whether the population was clearly described, if the time horizon was long enough to assess relevant costs, if costs were measured and valued appropriately, if future costs and outcomes were taken into account, and if conclusions were in line with reported data. The most prevalent methodological weaknesses among these economic evaluations included lack of clear description of population, lack of well-defined research question, inappropriate measure of outcomes, inappropriate value assigned to costs, lack of discussion regarding ethical issues and conflict of interest. As such, it is clear that a large proportion of economic evaluations have serious methodological concerns, and greater rigor is needed in the future to determine an accurate account of the costs and benefits associated with safety interventions.

In order to remedy these current weaknesses, Fernaud and colleagues (2012) provide a three-step guide to conducting more effective economic evaluations which will result in a better understanding of the costs-and-benefits of investing in safety prevention measures. The first step is risk identification wherein the company determines the frequency of incidents and the extent of their damage (i.e., both individual and collective incident risk are taken into account). The second step is risk evaluation which compares the safety level to the hazard level and takes into account economic and psychosocial factors. The final stage is called the planning of measures stage. In this stage, safety measures are checked to ensure they ask questions related to their specific safety criteria; it demonstrates the risk reduction of the proposed measures as well as the cost to the company.

Additionally, Tompa and colleagues (2010) suggest that economic evaluations should take into account the perspective of a broad range of workers (i.e., managers, front-line workers, insurer, and the company as a whole). When a company choses to conduct an economic evaluation, they should carefully consider the type of economic evaluation they chose, as each has different strengths and weaknesses (i.e., cost-utility analysis, cost-effectiveness analysis, cost-benefit analysis, etc.). Finally, Cagno and colleagues (2011; 2013) provide models and assessment tools that can be used by companies in order to conduct an effective cost-benefit analysis of the safety programs in their organization. These models and assessment tools are outlined in Table 3.

Table 3 Models and Measures for Cost-Benefit Analysis

Model/Method	Description
1. Inventory of socioeconomic costs of work accidents	Considers causal relationships between the working conditions and accidents as well as between prevention and its effects. Draws attention to the principle "multiple causes, multiple effects"; thus, it strongly suggests that quantitative financial indicators should be complemented with qualitative indicators (e.g. use scoring systems).
2. Participants for Understanding	Considers causal relationships between OSH factors and prevention. This is a general methodology rather than a method itself; it is intended to be more user-friendly than SW tools. Limitation: requires experts for the interviews. Advantage: more "flexible" than others and requires less data.
3. ROHSEI –Return on Health, Safety, and Environmental Investments	Considers accounting data; traditional HS&E data are translated into financial metrics (e.g. lost days, property loss, compensation costs, fines, behavioral observations, etc.) This model evaluates individual projects rather than the whole HS&E state of affairs in a company.
4. Net Costs Method	Data is collected by means of a questionnaire and then converted into monetary units. Limitations pointed out by AIHA [27] (p.63): complex accounting approach; evaluation of qualitative benefits are not included; and, does not provide a way for determining the effectiveness of the intervention.
5. Product Ability	Considers hours paid by employer and nonproductive hours (when worker is not actively producing). The difference is converted in money using average wage by occupation. This method is relatively simple to apply. Limitation: best suited for short-term interventions and pay-back period between 6-12 months. This model does not account for "qualitative" criteria (e.g., changes in quality).
6. Tool Kit-TK	Considers causal relationships and OSH factors for deciding the interventions. Allows users to collect data from scratch (e.g., epidemiologic data, risk assessment, clinic, engineering, and accounting) Practical tool to help companies self-diagnose their site hazards and to estimate the costs and benefits of investing in OSH. The process starts with risk assessments and provides a general overview of the OSH state of affairs.
7. Potential (method for economic analysis)	Considers productive work hours and average labor cost (after and before intervention). This method highlights the difficultly in establishing cause-effect relations, especially when interventions take place at the same time, and thus provides a good indicator of the effects of OSH interventions. The entire framework includes more than 300 variables but only requires values (inputs) of about 12 of these to obtain an economic analysis concerning a change (intervention).
8. IH Value Strategy	Considers accounting data; traditional industrial hygiene data are translated into financial metrics. For evaluating "investment projects" (single interventions). This model does not provide a general overview of the OSH state of affairs in the enterprise but is comprehensive and complex; it requires accurate detailed data (just as its predecessor ROHSEI).
9. INAIL method	Since smaller enterprises may not have OSH statistical data to work with, this model uses national data from INAIL. Developed by the Italian Workers' Compensation Authority (INAIL). Estimates by analogy (using data sub-sets including same sector of activity, same size and same region).

*Cost of Accidents***.** Three articles were related to the cost of accidents. Lopez-Alonso and colleagues (2013) conducted a survey on 40 construction projects in southern Spain. They found that the average *number* of accidents on a project increased as the number of workers and subcontractors increased. Furthermore, the average *costs* of the accidents increased as the number of workers and subcontractors working on the project increased. Most interestingly, increased investment into safety prevention measures was related to decreased accidents *and* lower cost when accidents did occur. Thus, the more money spent on accident prevention, the less that is spent on accident costs.

While researchers have examined the cost of accidents in a variety of contexts, few industrial companies have examined their own accident costs at length, perhaps because they have no way of calculating this cost. As such, Jallon (2011) developed an accident cost calculation model that was tested on 10 companies in Montreal, Canada. It was found that direct and indirect costs vary significantly depending on the type and site of the injury. It was also found that the number of days of work stoppage was a major influence on direct costs, while the number of days of light work was a major influence on indirect costs. Examination of the total cost, including the company's group insurance premium, shows that it is slightly more profitable for the company to keep an injured employee at work, even if he or she is unproductive, than off work altogether. Furthermore, this cost calculation tool can be used by industries to calculate the cost of accidents (Jallon, 2011). Battaglia and colleagues (2014) developed another cost analysis tool based on the accidents at an Italian company. They classified accidents into two categories: simple or complex. Approximately 19 hours were dedicated to remedying simple accidents and 27 hours were dedicated to complex accidents. Furthermore, a simple accident could cost the company up to € 6,000, while a complex accident could cost the company € 12,000. The Italian company under study spent over € 1.6 million on accident costs in one year. This cost analysis tool is available for use by other companies and is a useful means of determining how much money the company is spending on preventable accidents.

*Cost of Safety Programs***.** Two articles were related to the cost of safety programs. One determined the most cost effective elements in a safety program (Hallowell, 2010) while another expanded on the financial benefits of investing in an improved safety program (Thiede & Thiede, 2015). Hallowell (2010) looked at the cost effectiveness of 13 safety elements that are common within safety programs at twenty-six construction firms (i.e., upper management support, subcontractor selecting and management, employee involvement and evaluation, job hazard analyses, project-specific training-meetings, frequent worksite inspections, safety manager on site, substance abuse programs, safety and health committees, OHS orientation/training, written safety and health plan, record keeping/analyses, and emergency response planning). It was found that the most cost effective elements were: subcontractor selection, management and upper management support, management commitment, and substance abuse programs. The least cost effective programs included employing a full-time safety manager, record-keeping, and regular meetings. However, although management support was the second most cost-effective element, safety committees and meetings were necessary for safety management to demonstrate their support. Consequently, while safety meetings may not be cost-effective, they are necessary for other safety elements (i.e., management commitment to safety, communication, etc.) to occur.

Thiede and Thiede (2015) examined a shipping company in Bangladesh that recently implemented Occupational Health & Safety measures. They found that improving the safety standards at this shipbuilding company resulted in injuries dropping from 500 to nearly zero in only a few months.

The company was also able to reduce their hiring and training costs as their employees were likely to remain on the job longer and potential employees were more likely to apply for the job. Productivity and efficiency also increased as there were fewer accidents and less uncertainty over how to complete the job safely. The company had decreased healthcare costs, increased access to bank loans, and lower insurance premiums. While this specific study does not directly relate to the safety standards in Saskatchewan mines, it does illustrate the financial benefits of improving safety, despite the initial cost of these safety programs.

Discussion

Overall, the literature on safety program evaluation suggests that it is a successful means of determining the effectiveness of current safety interventions. However, increased research is needed on program and economic evaluation in regards to safety, and these evaluations must be conducted with greater rigor. Out of fifteen included studies, only one (DeRoo & Rautiainen, 2000) had the specific purpose of evaluating a safety program and it was within the agricultural industry. Rather, the majority of emergent literature proposed ways of improving the effectiveness and rigor of current program and economic evaluations, with several studies suggesting additional tools or models that may be of use. In particular, it is necessary to examine program and economic evaluation within the context of safety in the mining industry as literature in this area is significantly lacking.

Gaps in the Literature. The most glaring gap within the literature is on the lack of studies examining the program evaluation and economic evaluation within industry, particularly in the mining industry. While several studies point out weaknesses in the current evaluations and even more suggest ways they can be improved, very few put these suggestions into practise. Furthermore, the tools and models suggested by Cagno and colleagues (2011; 2013) should be tested and examined within industry to determine which are the most appropriate under specific contexts. Safety researchers should also examine Hallowell's (2010) safety elements to determine if this is an all-encompassing list or if additional safety elements are necessary. These safety elements should also be examined in the mining context to determine which safety elements are the most effective at improving safety as well as those that are the most cost efficient.

Recommendations. Safety specialists and evaluators may use the knowledge gleaned from psychological research to more effectively assess intervention effectiveness and accident costs, as well as to improve the current interventions in use. Managers and employees can use this information to gain a greater understanding of how accident costs and intervention effectiveness impact their company. Based on the current scoping review, future efforts should include an integration of the following recommendations:

- **Routine program and economic evaluations conducted by specialists.** A focus on program evaluation is needed to determine which safety interventions are effective and if there are ways these interventions could be made more efficient or cost effective. These evaluations should be conducted as rigorously as possible; for example, use of a control group, a variety of assessment tools, longitudinal studies, large sample sizes, and both qualitative and quantitative methods would be especially worthwhile (DeRoo & Rautiainen, 2000; Zwerling et al., 1997).

- **Use realistic evaluation.** Companies aiming to conduct a thorough and effective program evaluation of their intervention programs should considering using realistic evaluation if appropriate. Realistic evaluation examines which safety elements are working in a specific context and identifies the underlying causal mechanisms that are causing safety accidents (Pedersen, et al., 2012).
- **Use daily-incident monitoring.** Daily incident monitoring is a useful means of identifying and addressing hazards quickly as well as a useful means of thoroughly recording incidents for a more effective evaluation of the intervention.
- **Examine the cost of accidents within one's company.** The mining industry should use the cost analysis tools developed by Battaglia and colleagues (2014) or by Jallon (2011) to determine how much money is being spent on current accidents as this is the only way an accurate cost-analysis report can be achieved. By determining the amount of money spent on accidents per year, the company will have a better understanding of how much money will be saved if preventative safety measures are implemented.
- **Be open to both a systems approach and an injury prevention approach.** When assessing the cause of accidents, industry members should assess the accident from both a systems approach and an injury prevention approach. A systems approach views accidents as being caused by multiple factors and vies for stability and control. Injury prevention views accidents as caused by one specific factor and this causation is viewed as linear (Andersson, 2012)
- **When conducting a cost-benefit analysis, follow Fernaud's three-steps.** Fernaud and colleagues (2012) provides three steps (i.e., risk identification, risk evaluation, planning of measures) that should be followed in order to conduct a more rigorous cost-benefit analysis.
- **Carefully consider the perspectives and evaluation types used.** When conducting an economic evaluation, include the perspectives of the company, the workers, and the insurer. Also, determine whether a cost-benefit analysis, a cost utility analysis, or a cost effectiveness analysis is most beneficial for your objectives (Tompa et al., 2010).
- **Use a broad range of measures to assess economic consequences.** Many economic evaluations only use worker's compensation as a measure of economic consequences; however, evaluations should also examine time off work due to injury, time off work due to disability, and the emotional and financial cost to the family and individual who was injured (Tompa, et al., 2009). It is also important that an accurate value is assigned to the cost of accidents and the cost of programs (Uegaki, et al., 2010).
- **Use new tools and models to examine the cost-benefit aspect of the programs in place.** Companies should use a variety of models and tools provided by Cagno and colleagues (2011; 2013) to determine the cost of the current intervention, as well as the cost-saving benefits.
- **Management should consider the theoretical causes and models that may influence safety measures.** Management does not always have a theoretical background that explains the underlying causes for the safety models currently in place and this results in a safety system that is in use but has no underlying evidence for its success or failure.

- **Industry should use both leading and lagging indicators.** In order to assess the effectiveness of a safety intervention program.
- **Industry should utilize the scales in Table 4 where appropriate.** Several scales that have been verified within industry are provided in Table 4 and these scales may be useful to the mining industry. However, scales that have not been verified for both reliability and validity should be critically reviewed.
- **Identify effective safety elements.** Companies should assess the following safety elements (i.e., upper management support, subcontractor selecting and management, employee involvement and evaluation, job hazard analyses, project-specific training-meetings, frequent worksite inspections, safety manager on site, substance abuse programs, safety and health committees, S&H orientation/training, written safety and health plan, recording keeping/analyses, emergency response planning) to determine which are the most effective at improving the company's safety and which are the most cost effective. However, just because a safety element is not cost effective does not mean it should be removed. If it is improving the company's safety at a significant amount then it should remain in place and ways of improving the cost efficiency can be examined (Hallowell, 2010).

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