ERGONOMIC & SAFETY DISCUSSION PAPER

MARINER SAFETY RESEARCH INITIATIVE

Leading Safety Indicators

Issue # 13 • November 2015

INTRODUCTION

Safety performance has traditionally been measured and reported by lagging measurements such as an accounting of the injury/incident frequencies, associated costs, and other effects on people, equipment, and the environment. As a result of these accidents/incidents, much effort is put forth performing accident/incident investigations to determine causal factors. Though critically important, these efforts are all post-accident/incident and may not accurately reflect the current status of safety in the maritime (and other) industries. In fact, a low reported accident rate, even over a period of years, is not necessarily a guarantee that risks are being effectively controlled, or does not ensure the absence of injuries or accidents in the future (Lindsay, 1992).

In the past couple of decades there has been a realization that the safety of complex work systems (such as found in the maritime industry) may be improved by proactively identifying issues that may be associated with positive safety performance. Improved safety performance has been associated with a number of measurable activities in various industries (e.g. financial level of safety budget, safety audit scores, number of safety inspections, number of safety meetings/training (specifically involving management), etc.). An example of leading indicator measurement programs is the hazard identification and analyses for offshore oil and gas in the United Kingdom (Step Change in Safety, 2009).

This Leading Indicator Ergonomic Design and Safety Toolkit Module is based upon successful maritime application of the techniques discussed, as well as state-of-the-art science in a variety of peer-reviewed sources.

TERMS/DEFINITIONS

Accidents: Accidents are undesired events that result in personal injury.

Lagging Indicators: Measures of a system taken after events to assess outcomes and occurrences.

Leading Indicator: The National Academy of Engineering defines leading indicators as conditions, events, and sequences that precede and lead up to accidents (NAE, 2004). In essence, leading indicators are defined as conditions, events or measures that precede an undesirable event, and have some value in predicting the arrival of the event, whether it is an accident, incident, near miss, or undesirable safety state (Toellner, 2001).

Metrics: Metrics are a set of measurements that quantify results.

Non-parametric Test: A non-parametric statistical test does not require scores on the outcome variable to be normally distributed.

Spearman Rank Correlation: The Spearman's rank correlation coefficient or Spearman's rho is designed to measure the relationship between two ordered sets of ranks. It is similar to Pearson's Correlation except Pearson's uses values instead of ranks.

Spearman rank correlation (.): The Spearman's rank correlation coefficient or Spearman's rho, is a non-parametric measure of correlation – that is, it assesses how well an arbitrary monotonic function could describe the relationship between two variables, without making any other assumptions about the particular nature of the relationship between the variables. The Spearman Correlation Coefficient can be considered as an indicator that a relationship exists between two variables even though it is non-linear.

DISCUSSION

Leading Indicators

Leading indicators have been studied in many types of systems, with varying results. For as many as three decades, the medical, nuclear, aviation, and maritime industries have developed increasingly sophisticated leading indicator measurement systems. Review of the safety metrics identified in several major studies undertaken over the past thirty years shows that there is general agreement about the factors that influence organizational safety (Dufort and Infante-Rivard, 1998; Zimolong and Elke, 2006):

- Consistent and authentic management commitment to and promotion of safety, including:
  - prioritization of safety over production
  - maintaining a high profile for safety in meetings
  - personal attendance of managers in safety meetings and safety audits
  - face-to-face meetings with employees that feature safety as a topic
  - jobs descriptions that include safety contracts
  - providing adequate safety resources
- Communication about safety issues, including:
  - effective channels of formal and informal communication about safety issues
  - regular communications between management, supervisors and the workforce
  - providing feedback to employees on safety issues
  - ability to anonymously report
  - improved safety training (quality, effectiveness, in native language)
- Involvement of employees, including:
  - Empowerment
  - delegation of responsibility for safety
  - encouraging commitment to the organization
  - including employees in problem identification and problem solving
- Hiring quality people
- Improving safety audit procedures
- Multicultural operations

Effective leading indicators should possess the following characteristics:

- The indicators should be worth measuring. They should represent important and salient aspects of the organization's safety management system;
- The indicators should be simple to understand. Management and the workforce should be able to understand what is being measured. Overly complex indicators and measurement processes should be avoided to reduce the chance of error and miscommunication.
- The indicators should be understandable by people who need to act. People who need to act on their own behalf or that of others should be able to readily comprehend the indicators and what can be done to improve the status of those indicators.
- Measurement of the indicators over time should reflect results of action; for instance, action taken will result in improvements in some aspect of ship safety; and
- The maintenance of the indicators should be cost efficient in terms of the man hours and technology required for gathering information.

This Ergonomic Design and Safety Toolkit Module discuss the benefits of performing a leading safety indicator assessment. It is intended to provide general information. For detailed discussion on the tools and techniques of performing a leading safety indicator assessment, please refer to the ABS Guidance Notes on Safety Culture and Leading Indicators of Safety (2012).

Leading Indicators can be either objective or subjective in nature. Objective leading indicators may include (but are not limited to):

- Percentage of incident reports on which root cause analysis was undertaken
- Number of safety management meetings
- Percentage increase in annual safety budgets from previous year
- Number of safety inspections
- Procedures in the native language of the crew members (as well as English)
- Percentage of closure for corrective action reports, over 3 months old
- % of jobs for which risk assessments are carried out
- % of work site inspections carried out against planned requirement

Subjective leading indicators typically stem from completion of a safety culture assessment and may include shipboard and shore side safety culture perceptions of, but are not limited to:

- Promotion of safety
- Rewarding safety
- Hiring quality people
- Communication
- Multi-cultural operations
- Responsibility
- Feedback

The safety performance data can include vessel operations data, such as operational incidents, conditions of class, port state deficiencies, and even near miss data. The safety performance data can also include personnel safety data such as lost work day injury rates (and severity), restricted work injury rates (and severity), total recordable injury rates, etc. and again near miss data.

Organizational Requirements

The Leading Indicators approach to improving safety performance is most effective when the technical aspects of safety are performing adequately and the majority of operational incidents and accidents appear to be due to human error or organizational factors. The Leading Indicators approach is therefore only open to organizations that fulfill a number of specific criteria:

- The organization is compliant with all regulations.
- An adequate Safety Management System (SMS) is in place.
- Human error or organizational factors are causing the majority of operational incidents or personal injuries.
- The organization has a genuine desire to prevent operational incidents and personal injuries and is not solely driven by the avoidance of prosecution.
- The organization is relatively stable, not in the middle of mergers, acquisitions or significant reorganizations.
- An objective leading indicators assessment of the organization requires that safety culture metrics must have been collected for some time: five years for an organizational level analysis, and one year for the business unit level, or across the fleet.
- A subjective leading indicators assessment or an organization uses the responses on a safety culture survey.

Performing a leading indicators assessment will have costs and benefits. Costs may include resources to retrieve the objective and subjective metrics and safety performance data, knowledge of Spearman's Rho statistics test, and experience of using statistics packages or spreadsheets. Benefits may include assistance in identifying what actions have been, or could be, successful in improving safety, potential improvement of the understanding of whether or not goals are being met, providing a tool for prioritization and a basis for improving effectiveness of safety-related expenditure,

and allocation of resources, raising employee awareness of safety-related issues, and can identify areas of strength and weakness.

Importance of Measurement

Safety performance has traditionally been measured by 'after the loss' type of measurements such as accident and injury rates, incidents and dollar costs. Lagging indicators characteristically:

- Identify trends in past performance.
- Assess outcomes and occurrences.
- Have a long history of use, and so are an accepted standard.
- Are easy to calculate.

However, in the aftermath of catastrophes, it is common to find prior indicators, missed signals, and dismissed alerts which, if they have been appropriately managed at the time, may have averted the disaster.

Leading indicators are safety metrics that are associated with, and precede, an undesirable event such as an operational incident, near miss or personal injury. They can:

- Reveal areas of weakness in advance of adverse events.
- Be associated with proactive activities that identify hazards.
- Aid risk assessment and management.
- Demonstrate areas of strength that may be associated with positive safety performance

Leading Indicators may be the most important safety metrics for the organization as they correlate with the organization's safety performance.

IMPROVING SAFETY PERFORMANCE

Leading indicators of safety performance are particularly useful for crew, vessel, and fleet safety as they can help to take the luck out of managing safety by giving more recognition to the actions that are necessary to reduce risks and improve performance. The general use of leading performance indicators has been described in part one of this Toolkit Module. The general process for effective use of leading performance indicators can be summarized as:

- Identify where there are potential weaknesses or opportunities for improvement
- Identify what can be done to counter weaknesses or deliver improvement
- Set performance standards for the actions identified
- Monitor performance against the standards
- Take corrective actions to improve performance
- Repeat the process, using a continual improvement model

SUMMARY

The information contained in this Ergonomic Design and Safety Toolkit Module is based upon successful maritime application of the techniques discussed, as well as state-of-the-art science in a variety of peer-reviewed sources and were selected to provide a basic introduction to leading safety indicator assessment.

REFERENCES

ABS. Guidance Notes on Safety Culture and Leading Indicators of Safety, Houston, TX (2012).

Dufort, V. and Infante-Rivard, C. (1998). Housekeeping and Safety: An Epidemiological Review, Safety Science. 28, 127-138.

Lindsay, F. (1992). Successful Health and Safety Management. The Contribution of Management Audit. Safety Science, 15, 387-402.

National Academy of Engineering. (2004). Accident Precursor Analysis and Management: Reducing Technological Risk Through Diligence. Washington, D.C.: The National Academies Press.

Step Change in Safety (2009). Leading Performance Indicators, Guidance for Effective Use, http://stepchangeinsafety.net/ResourceFiles/LPI%20Guidance.pdf

Toellner, J. (2001). Improving Safety & Health Performance: Identifying & Measuring Leading Indicators. Professional Safety, 46(9), 42-47.

Zimolong, B, and Elke, G. (2006). Occupational Health and Safety Management. In G. Salvendy (Ed), Handbook of Human Factors & Ergonomics. New York: Wiley, 1- 66.