Session No. 658

Using the Last Several Years of QHSE Data to Improve the Next Several Years of QHSE Performance

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Introduction

On an enterprise-wide scale, worldwide operations from major "operators" such as ExxonMobil, Shell, and ConocoPhillips and "service" companies such as MI-SWACO, Premium Drilling, Scorpion, and Exterran as well as multiple others, are applying a common approach to collect and analyze data from a myriad of "risk reduction" activities. These risk reduction activities, ranging from reactive (incident-based) to proactive (assessment-based), provide a wealth of data and information that can be mined to determine risk and to improve processes and performance.

On the surface, each of these organizations simply use a common "mechanism" to manage their own unique set of QHSE risk reduction processes and ultimately analyze the resulting data – i.e. the "outcome" data. However, at a deeper level, these companies are not only collecting data resulting from the outcomes (e.g. incident reports, spill quantities, near miss types, root causes, inspection findings, etc.) but also the "work practice behaviors" that reflect the organization's tendencies in executing such processes.

With such a vast dataset from both "outcomes" and "work practice behaviors", these companies have created a unique opportunity to find the "real" leading indicators of performance – i.e. those activities, practices, factors, conditions, etc. that are both practically measurable and proven to have a mathematical relationship to loss outcomes. Along with a structured process improvement approach, such as the Six-Sigma DMAIC framework, organizations can leverage this unique opportunity to find (Define, Measure, Analyze) and execute (Improve, Control) the Leading Indicators which truly do affect performance outcomes.

Many companies track and analyze Leading Indicators in isolated areas of their businesses but few are applying Leading Indicators to rival the age-old "incident rate" as the primary Key Performance Indicator (KPI) for judging an operation's QHSE performance. There are several reasons for this dominance including the practicality of a "near" standard, normalized performance metric that can deliver an "apples to apples" comparison of loss rates across the enterprise, difficulty in consolidating the "outcome" data and the "work practice behaviors" from these events on a corporate scale, and other cultural and marketplace obstacles (i.e. lack of top management buy-in, resource costs, etc.).

To overcome these obstacles, the most effective Leading Indicators must 1) minimize "additional" resources required for execution and 2) provide sufficient proof that executing Leading Indicators will improve QHSE performance. This can be done by implementing an integrated enterprise-wide tool to consolidate data from business practices that fit a common risk reduction cycle "pattern" and utilizing the existing field-level activities to leverage and minimize the effort of gathering leading indicator data.

Syntex Management Systems, Inc. offers such a solution with its web-enabled, enterprise-class software solution, **IMPACT ERM® Suite** that facilitates corporate-wide risk management through enabling improved management system execution. In most businesses, **IMPACT** integrates with or replaces multiple software applications that have various operational management objectives while providing a central conduit for more open risk communication between leadership and the workforce.

Background

On an enterprise-wide scale, Syntex is engaged with the operating facilities of global energy industry businesses spanning over 100 countries around the globe from major "operators" such as ExxonMobil, Shell, ConocoPhillips, and Chevron as well as "service" companies such as MI-SWACO, Premium Drilling, Scorpion, Exterran and multiple others.

Each of these companies are applying a common approach to collect and analyze data from a myriad of "risk reduction" activities such as incident investigations, near miss reports, management system audits, risk assessments, assurance reviews, behavioral observations, field-level inspection programs, hazard analysis, and many other processes. A recent analysis of a data set spanning 14 companies showed an average of 58 such sources of data totaling millions of records over several years.

On the surface, each of these organizations has simply been using a common "mechanism" to manage their own unique set of QHSE risk reduction processes and ultimately analyze the resulting data. However, at a deeper level, these companies are not only collecting data resulting from the outcomes (e.g. incident reports, injury details, spill quantities, near miss types, root causes, audit results, assessment scores, inspection findings, etc.) but also the "work practice behaviors" reflecting the organization's tendencies in executing such processes (e.g. mean-times between completion of "critical" process steps, rate of leadership involvement in non-mandatory proactive steps, distribution of employee involvement in proactive activities, etc.).

With such a vast data set from both the outcomes and the work practice behaviors, these companies have created a unique opportunity not only for themselves but also for anyone in the industry who is interested in finding the "real" leading indicators of performance – i.e. those activities, practices, factors, conditions, etc. that both are practically measurable and are proven to have a mathematical relationship to loss prevention outcomes.

The following paper will describe how a structured process improvement approach like the 6-Sigma DMAIC framework can leverage this unique opportunity to find (Define, Measure, Analyze) and execute (Improve, Control) the Leading Indicators which truly do affect performance outcomes. In doing so, this paper will show how the last several years of QHSE data is being used to improve the next several years of QHSE performance.

First, Why Do Lagging Metrics Dominate Corporate KPI's?

Many companies are tracking and analyzing Leading Indicators in isolated areas of their businesses but few are applying Leading Indicators to rival the age-old incident rate as the primary Key Performance Indicator (KPI) for judging an operation's QHSE performance. One reason for this dominance is the practicality of having a near standard in producing a normalized performance metric, which can deliver an "apples to apples" comparison of loss rates across the enterprise.

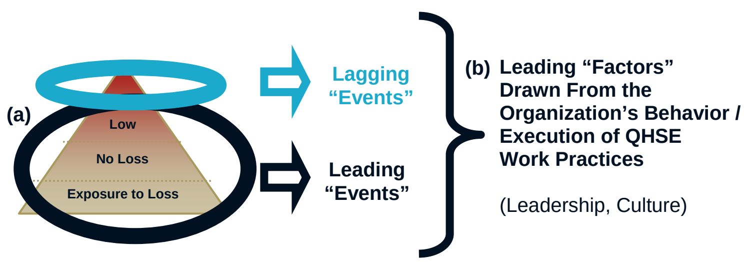
Figure 1

Lagging "outcome" data widely applicable and measurable

As depicted in the above diagram of the industry-accepted "Heinrich triangle" shown in Figure 1, reporting the data from incident events of the highest severity is routinely governed by a corporate standard—thus rendering this lagging "outcome" data widely applicable and measurable across the enterprise.

Figure 2

Additional measures drawn from leading events and organizational behavior



As depicted in Figure 2, additional measures may be drawn from both (a) the events which are "non-mandatory" for corporate level reporting and (b) the tendencies in execution of the work practices associated to these events.

Due to the typically non-standard nature of the leading events (near misses, un-safe acts, un-safe conditions, self-assessments, behavioral observations, corporate audits, internal reviews, field inspections, etc.), many companies have trouble consolidating the outcome data—much less the work practice behaviors from these events on a corporate scale–-thus rendering the effort to extract leading indicators from these types of events highly impractical.

In contrast, whether a company uses a calculation similar to the American OSHA standard or prefers the more internationally utilized denominator of a million exposure hours, the two key components of the "lagging" safety loss rate measurement – number of incidents and quantity of work hours – are much more broadly applicable and readily measurable, thus rendering this type of lagging indicator a much more efficient and practical alternative.

In addition to the convenience of lagging indicators, how many times have you heard: "it hasn't happened here, so it is not a problem here"? Given both this human reactionary tendency and the convenience of lagging metrics, Leading Indicators have quite a battle ahead if they are to gain equal share of the KPI landscape for operations management.

The Key: Buy-in from Operational Management

Gaining the support of top management is in the critical path for Leading Indicators to capture their fair share of this KPI landscape. In a recent workshop conducted with QHSE leadership from several global operator and service companies in the energy industry, the overwhelming choice for the biggest obstacle to executing Leading Indicators was the propensity of top leadership to use lagging metrics in annual management performance objectives and in some cases as key components of manager incentive-pay programs.

> *"We have attempted to define a set of Leading Indicators to shift management attention but business managers are not compelled to use them."*
> -- *QHSE Leadership*

In today's cost competitive marketplace, costly human resources are already "tight." Therefore, convincing operational management to allocate the necessary resources for execution of the programs that underlie a leading indicator initiative is met with resistance rooted in skepticism. If you cannot **CONVINCINGLY** demonstrate that investing in such "leading" activities will result in better QHSE performance, they won't allocate the resources to execute such a program.

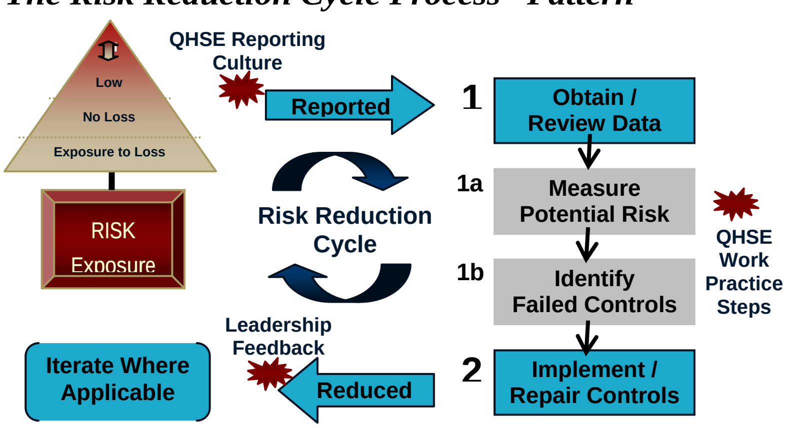
To overcome this obstacle, the most effective Leading Indicators must meet the two following criteria:

1. Minimize "additional" resources required for execution;
2. Provide sufficient proof that executing Leading Indicators will improve QHSE performance.

Leveraging Existing Practices to Minimize the Effort

By implementing an integrated enterprise-wide tool to consolidate data from business practices that fit a common "pattern", existing field-level activities can be leveraged to minimize the effort to obtain leading indicator data. The following pattern of "risk reduction cycle" activities applies to many QHSE processes found in routine operations.

Figure 3
The Risk Reduction Cycle Process "Pattern"



As depicted in Figure 3 to the left, the two primary elements common to all risk reduction cycle processes are:

(1) obtaining awareness via "reported" events, and (2) implementing corrections to reduce the reported risk exposure. *The Core*

The following describes how each element of the risk reduction cycle generally maps to the key steps in work practices resulting from both reactive (incident-based) events and proactive (assessment-based) events.

1. Obtain/review data

If you do not know about the risk, you cannot reduce it. This element maps to the initial incident and assessment-based process steps whereby event data is gathered and people are assigned to contribute expertise / input and to review / approve the report.

1a. Measure potential risk

For incident events, this is an optional / advanced practice of classifying "how bad it could have been" by using a risk matrix. Risk assessments, PHA's, and various other proactive processes include this as a key process step where the risk level is formally scored.

1b. Identify failed controls

For incident events, this element maps to the "investigation" process. Since many companies only investigate high-severity events, this step is optional as well. An advanced practice is to apply an "informal" investigation to classify root causes and map those causes to Management System elements for ALL incident events – including near misses. For assessment-based processes, this element often represents the core purpose of the event – i.e. to identify the areas where control activities need improvement (e.g. worker competence, employee behavior, maintenance, facility / process design, engineering, etc.)

2. Implement / repair controls

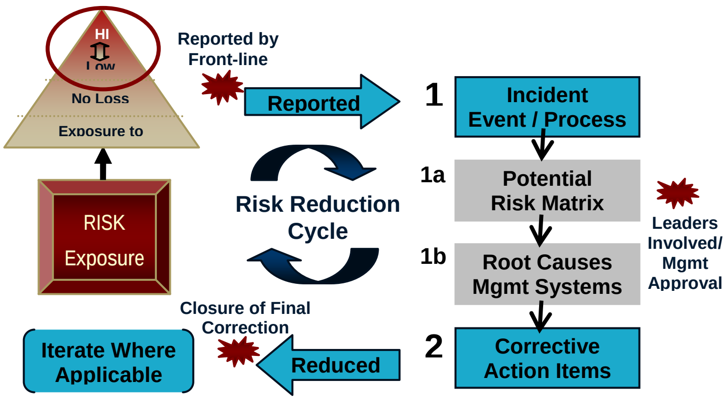
For incident events and proactive events alike, this element maps to the most important step in all risk reduction processes – the execution of tasks to repair broken controls or implement new ones to ultimately reduce exposure to risk.

Data from Incidents /Near Miss Processes

It has become more common to find companies that have implemented an enterprise-wide incident database to collect data resulting from the outcomes of incidents. However, some companies are also executing corporate-wide incident management process improvement projects along with an information system that not only collects incident data but also enables / facilitates each major step of the business process.

As depicted in Figure 4, applying a risk-reduction solution for managing incident / near-miss events enables the full event life-cycle from front-line worker reporting events to leadership involvement and the action items closure steps of the business process.

Figure 4
Reactive (Incident / Near Miss) Risk Reduction



By comprehensively facilitating the entire risk reduction cycle business process, the various levels of the workforce are simply carrying out the routine "incident / near miss" work practice using a business process automation (BPA) tool. However, the by-product of facilitating each major step of ALL near miss and incident events on an integrated software platform is the ability to practically draw measurements from BOTH the incident / near-miss event outcome data AND the data reflecting the workers' interaction with each step of those business processes.

By analyzing the business process data to study the organizational treatment of these "lagging" events, leading metrics such as percent of the workforce involved in near-miss reporting, the ratio of near-miss to high-consequence reports, the rate of leadership participating in non-mandatory events, consistency of manager response to key steps; and many other potential Leading Indicators of culture and leadership can be created.

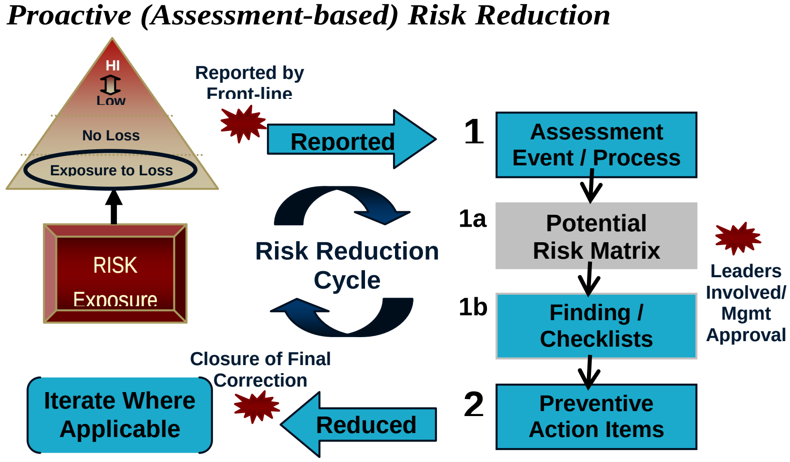
Simply as a by-product of using an enterprise-level BPA tool and integrated database to automate the "lagging" incident/near miss business processes, the data for calculating both lagging outcome metrics and Leading Indicators is efficiently generated. The companies executing in this manner are achieving the ironic accomplishment of drawing "leading" data values from the occurrence of lagging incident / near miss events.

Data from Proactive Assessment-based Processes

Most companies deploy a vast array of different "proactive" business processes that fit the risk reduction cycle pattern – ranging from formal corporate-level auditing-type processes to more casual field-level suggestion box / hazard ID type initiatives. Typically the data resulting from the outcomes of such proactive activities is scattered throughout the organization on pieces of paper, spreadsheets, isolated databases, and other non-integrated systems – rendering broad measurements highly impractical.

As depicted in Figure 5 shown below, an enterprise-wide risk-reduction solution enables the integration of the key work practice steps and data elements across a wide array of different proactive processes that fit the pattern.

Figure 5
Proactive (Assessment-based) Risk Reduction



Per the aforementioned average of 58 sources of activities fitting this pattern, roughly 90% of those activities are proactive "assessment-based" activities. By facilitating a wide array of processes on a common BPA tool, the data from both the outcomes of the activities and the work practice behaviors is available for trending across previously segregated processes.

With this approach, common measurements can be drawn from processes, which are routinely viewed as dissimilar. For example, the rate of employee participation per a Behavioral-based Safety (BBS) process can be combined with the rate of participation in other dissimilar processes such as risk assessments, hazard ID reports, inspections, self-assessments, walk-through audits, and many others – to calculate a comprehensive rate of proactive employee involvement – a key measure of reporting culture.

In addition, the final major step for all risk reduction cycle activities entails the process of managing the Action items required to install protective controls and ultimately reduce the risk. With such efficient access to action item data from so many different processes, the Leading Indicator metrics that can be drawn from Action item execution are broadly applicable and readily measurable as well.

Providing Proof of IMPACT on QHSE Performance

After consolidating data from the myriad of proactive and reactive risk reduction cycle processes, statistical methods can be applied to BOTH produce indices that improve the usability of the measurements AND identify which measurements have a mathematical association to performance outcomes.

As previously mentioned, practically usable, efficiently calculated metrics with some proof of performance IMPACT are required to compel top leadership to give Leading Indicators a prominent place on the KPI scorecards of operational management. A structured continuous improvement program, like 6-Sigma's Define, Measure, Analyze, Improve, Control (DMAIC) approach, provides a framework for finding and executing such Leading Indicators.

A Structured Approach: DMAIC

Below is an overview of how each stage of the DMAIC process facilitates finding and executing Leading Indicators.

Define

- ***Work*** with a consortium of risk reduction cycle process Subject Matter Experts (SME's) to identify potential X's
- ***Identify*** means of calculating X's from multi-business data set – thus requiring broadly applicable definitions

Measure

- ***Conduct*** Factor Analysis to create "indices"
- ***Select*** and name indices (e.g. culture, leadership, etc.) to simplify usage

Analyze

- ***Conduct*** correlation analysis (multi-variable regression, etc.) to identify indices with strongest association to the outcome Y (losses) – i.e. yielding the TRUE Leading Indicators of QHSE performance

Execution of Leading Indicators

- ***Improve*** – Use indices as KPI's to drive behaviors of operational leadership
- ***Control*** – Use SPC to control X's and Y's

IMPACT Math 101: "Defining" Leading Indicators – Getting Started

The key components of Leading Indicators, which may effectively rival the practicality, and importance of lagging metrics as KPI's to be executed on an enterprise scale are:

- Simple, close connectivity to the outcome/results
- Objectively and reliably measurable
- Interpreted by different groups in the same way
- Broadly applicable across company operations
- Easily and accurately communicated

A consortium including the direct involvement of roughly a dozen global Energy Industry companies are collectively engaged in defining the potential Leading Indicator metrics (X's) that can be drawn from their use of a common set of risk reduction cycle tools. Whereas most companies have some level of experience with the internal use of Leading Indicators, it has clearly been new territory to define metrics, which are applicable and measurable across / beyond company lines.

IMPACT Math 201: "Measuring" to Establish Indices

The X's in Figure 6 represent individual metrics calculated over a chosen period of time – usually aggregated over a years time or more – at each site. The definition of each X includes a method of "normalizing" (e.g. percentages, ratio's, per-employee rates, etc.) to assure apples to apples comparisons across the sites in the data set.

Figure 6

The Data Set for "Measure"

Sites	X_1	X_2	…	X_n
Site 1				
Site 2				
Site 3				
.				
.				
Site N				

Input: **X's are individual IMPACT metrics**

Statistical Method: **Factor Analysis**

Output: **"Indices" as key metrics**

Factor Analysis is conducted on the data set to reveal those metrics, which are associated to each other – i.e. those that appear to have a common inference.

For example, consider the following 3 leading X's:

- X_1 = percent involvement of leadership in assessment-based processes;
- X_2 = mean-time to completion of the leadership incident report approval step; and
- X_3 = percent on-time closure of medium to high risk proactive action items.

The results of running Factor Analysis on the data set may reveal that X1, X2, and X3 are all relatively strong at the same time and place and weak at the same time and place. The SME's would be consulted to assess the underlying meaning of the apparent relationship between these 3 variables, which in this case might be interpreted as "leadership commitment". For this example, Factor Analysis would also reveal the coefficients for each of the 3 variables to provide an f(x) for the index – i.e. a "leadership commitment index" in this case.

Combining these 3 X's into a single index provides a stronger measurement of leadership than any one of the X's independently. In addition, the use of the index can also help prevent "gaming" the system to falsely manipulate key metrics. Iterations of Factor Analysis are run to identify a multitude of indices to establish the data set, which is used for Analysis.

IMPACT Math 202: "Analyzing" to Find the True Leading Indicators

In the Analysis step, the leading indices are accompanied by a lagging outcome measure to create a data set with the following format:

Figure 7
The Data Set for "Analyze"

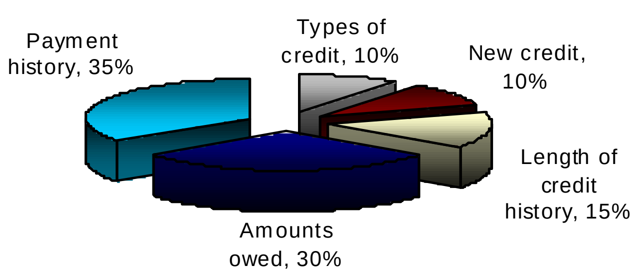
Sites	Y	F_1	F_2	...	F_n
Site 1					
Site 2					
Site 3					
Site N					

Input: F's are "indices", Y is the outcome metric.
Statistical Method: Regression Analysis
Output: Weighted formula of F's with strongest correlation.

As depicted in Figure 7, the data for leading indices (the F's) is accompanied by one column for the outcome metric (the Y).

Through the use of correlation analysis methods, the mix of indices with the strongest correlation to Y is identified. This process may be iterated multiple times to identify a weighted formula that not only delivers strong predictive ability but is also highly usable with a practical easily understood interpretation.

Figure 8
An Example: The FICO score



The FICO score, shown in Figure 8 to the right, is an example of a formula that is widely used by lending institutions in America as a leading indicator of the credit-worthiness of consumers.

The primary source of value for the FICO score and a key reason for its wide-spread use by consumer credit companies is not only the strong predictive ability but also the simple interpretation of each of its weighted components (as conveyed in the pie chart).

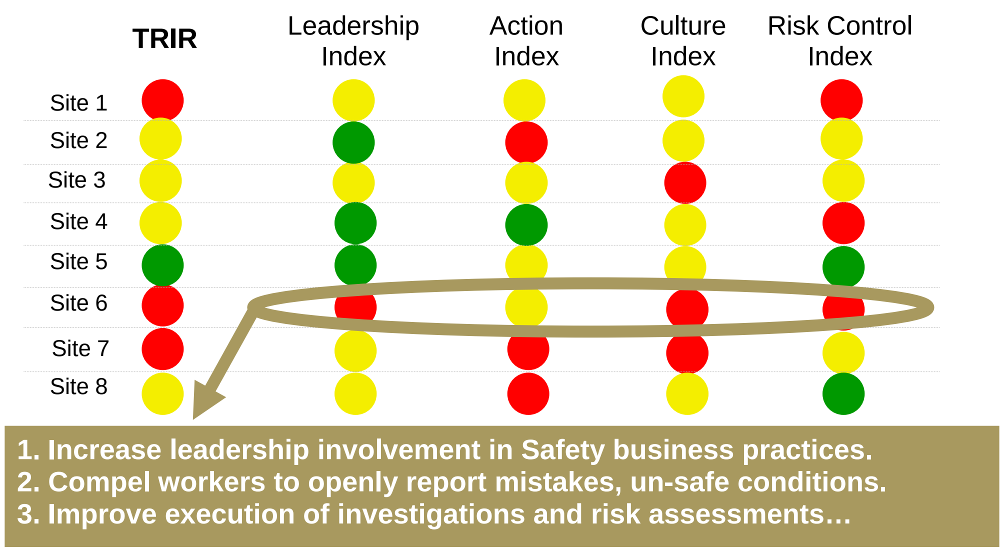
The ultimate leading indicator formula resulting from the Analyze step will have similar characteristics. Not only will the function have strong predictive ability as an indicator of an organization's risk reduction effectiveness but its weighted components should be simple to explain to operational leadership.

Executing "Continuous Improvement" with Leading Indicator KPI's

Derived from each of the weighted components (indices) in the Analyze step, these Leading Indicator calculations are included on operational KPI scorecard reports and ideally integrated as a seamless part of annual management objectives. Per the "what gets measured gets done" principle, the inclusion of the Leading Indicator KPIs will result in improvements in these activities – ultimately reducing operational losses.

As depicted in Figure 9 below, these metrics are calculated on monthly basis to deliver KPI's to operational management. The leadership response to these leading KPI's influences organizational activity which results in improvements to the sources of safety performance.

Figure 9
Example of Monthly KPI's to Drive Leadership Response



Summary

Figure 10 below summarizes the chain of events that tie safety performance improvements to gains in productivity and overall operations integrity. By executing this approach, companies can establish a continuously improving safe work environment as well as another means to yield greater return from their business operations.

Figure 10