Predicting & Preventing: Using Leading Indicators to Assess Safety Performance

Chuck B. Pettinger, Ph.D.
Implementation & Change Manager
Predictive Solutions
Pittsburgh, PA

To increase competitiveness, 83% of CIOs have visionary plans that include business intelligence and analytics.

(The Essential CIO, IBM 2011)

Introduction

How do organizations assess their safety performance? If one were to ask a safety professional how safe of a company do they have, they typically would respond “Pretty safe”. If one were to ask their employees this question, how would they respond? Most likely, the employee would respond by quoting one of many “safety” statistics that have been tracked for generations by organizations and our government (NSC, 1955). Too often, organizations assess their safety performance solely on lagging indicators like recordable rate, total recordable rate, lost workday rate, DART rate, EMR, and fatalities to name a few (BLS, 2006). But, do these numbers assess how safe of an organization we have? These lagging indicators might tell us how risky of an organization we have, but it does not tell us how safe of an organization we have. After all, is it not possible to have no reported incidents and still have a considerable amount of risky occurring on a regular basis? So, I would put forth that many organizations are only using injury metrics and are rarely using safety metrics. In continuing efforts to reduce and/or eliminate injuries in the workplace, many companies are moving beyond assessing their safety performance through simple lagging indicators, and are moving to using predictive analytics as strong leading indicators. Lagging indicators do contribute meaning to our assessment of the effectiveness (or lack thereof) of our safety processes, engineering systems and leadership support, however lagging metrics often place organizations in a reactive or “fix-it” mentality. Many organizations, and their safety professionals, struggle with finding the “next generation” of metrics that will reliably represent their companies’ safety performance while guiding the allocation of resources to appropriate areas in order to prevent injuries.

Although it is highly unlikely that we will totally move away from reactive lagging indicators like injury rate, more and more safety professionals are looking toward proactive leading indicators to assess their safety performance. Unlike lagging indicators that generally measure undesirable events that have already occurred, leading indicators are generally activities or conditions that are desirable and if completed will prevent or alert us to potential lagging indicators. A focus on leading indicators is desirable for three reasons: (1) leading indicators keeps organizations in a "preventative" or "predictive" mindset, (2) leading indicators are achievement oriented whereas lagging metrics are avoidance oriented (Geller, 1996), and (3) many organizations have hit a "basement effect" when it comes to injury rates (they are at such a low level and the metric happens at such a low frequency, that one occurrence is seen as a "special cause" (see Latzko & Saunders, 1995) and is difficult to draw statistical conclusions). So, to be better able to predict and prevent injuries through leading indicators, organizations will first need to identify which indicators are sensitive enough to detect culture change and which will be better able to assess the safety performance of the location, business unit or project.

Leading Indicators: Assessing Performance through Cultural Proxies

Identifying leading indicators may seem overwhelming. However, if leading indicators are viewed as activities, behaviors or processes that contribute to a positive safety culture, then the only question becomes, which ones do we choose? Thus, by looking at leading indicators as cultural proxies, this gives better direction to the safety professional. A proxy can be defined as an "authorized substitution". When we speak of cultural proxies, these may refer to safety-related behaviors, compliance to rules, training activities, safety processes, VPs walking the shop floor, executives attending team meetings and/or monthly safety communications. Thus, when accurately measured, these proxies or leading indicators can be used to assess the strength of your organization's safety culture. One common method organizations use to gather cultural proxies is though performing safety inspections, audits and/ or behavioral observations. Even though inspections/observations are common in many organizations' safety processes, companies still struggle with: 1) collecting quality information regarding the health of their safety systems, and 2) using the observation intelligence to reduce error-likely situations and/or mitigate the consequences of those errors.

For many years, organizations have established some form of inspection process to assess compliance with rules/regulations and policies/procedures (See Factories Act of 1833; Raouf, & Dhillon, 1994; Weindling, 1985; Wilson, 1985). More recently, companies have begun to add an observation process to focus on safety-related behaviors (Geller, 1996; Komaki, Barwick, & Scott, 1978; Krause, Hidley, & Hodson, 1996). Having an inspection and observation process can, by themselves, increase safety awareness and impact the organization's safety culture (Tuncel, Lotlikar, Salem, & Daraiseh, 2006). But, while these methodologies are an essential part of a dynamic proactive safety culture, they do not guarantee world-class safety performance. In fact, some practitioners question the validity and effectiveness of the intelligence collected from their inspections/observations (Guastello, 1993). The following sections will discuss the next generation safety metrics made possible by using the leading indicators within your inspection, and/or observation processes.

Observation Intelligence: Keys to Assessing Your Safety Performance

The Swiss Cheese model (see Figure 1) envisioned by James Reason (1990) is progressive layers of barriers or defenses that organizations have implemented to prevent defect, property damage, human error, or injury. An example of one such barrier would be an organization's policy and procedures, followed by engineering barriers such as guards or sensors, followed by personal protective equipment. Reason hypothesizes that each of these barriers has inherent weaknesses (active and latent) that place cracks or holes in these defenses. These holes present an opportunity for error. However, because there are typically many layers or barriers in

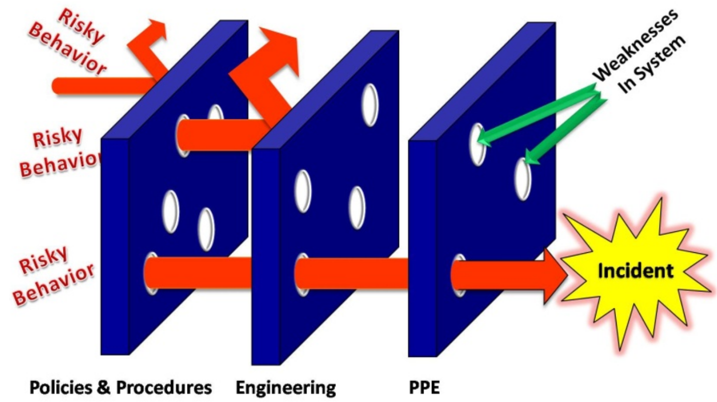

Figure 1. The Swiss Cheese Model adapted from Reason (1990)

place to prevent incidents, it is only when all the holes line up that Reason predicts an incident will occur. Over the past few decades, safety professionals, engineers, and employees have been effective at identifying when and where a new safety "barrier" is needed. Then organizations design, manufacture and implement the new barrier to prevent future incidents or reduce the consequences of an incident if it were to occur. However, from the employees' perspective the safety department is just adding "one more safety rule to make my job more difficult" or they are "wrapping us up in a cocoon of PPE to try to keep us safe." In many instances, a new process, rule, requirement or task is added to the safety system without first looking at the existing barriers for deficiencies. Thus, it is the safety professional's challenge to identify the "holes" in their safety systems and redesign the circumstances that place employees in situations that are either error-likely, or that encourage risky behavior (Rasmussen, 2003).

Safety Inspections: Assessing Compliance

Inspection processes are commonly used to proactively identify holes in organizations safety systems. Many inspection processes have safety professionals walking their organizations and/or worksites checking off boxes on a paper checklist to indicate compliance with policies, procedures, rules and/or regulations. In some cases, the organization's leadership team or formal Safety Committee is also tasked with performing compliance inspections. Following the inspections, the "observation intelligence" is either filed away in case they are needed to demonstrate due diligence, or is entered into some form of a database for analysis and examination for potential trends (i.e., holes in safety systems).

There are many benefits of a well implemented safety inspection process. First, the simple act of using a checklist as a guide (or activator) helps direct the safety practitioner to focus on critically important safety systems and assess their compliance. An additional benefit is the visibility of the inspectors. The simple act of walking the work floor, performing a ride-a-long, or inspecting the project, can send a strong message to all employees that safety is a critical business issue while additionally acting as a safety reminder (the inspector IS the Activator). Furthermore, the information gathered can not only identify holes in your safety systems, but can also be used as a positive safety metric to be shared with employees.

However, not all inspection processes are well implemented. Many, in fact, have little or no impact of the health and safety of their organizations. Guastello (1993) found that management inspections alone only reduced injuries by 19%. One explanation for the low impact of inspections may be the simple quantity of inspections completed. If safety personnel only perform monthly (announced) inspections, we only capture a small percentage of the opportunity for errors and thus limit our analysis of those safety systems keeping our employees safe. One additional issue with many inspection processes is that the information obtained is seldom used to address system-wide issues and thus demonstrate value to the inspectors walking the site. For instance, Manager A might be well intentioned and complete a detailed inspection noting many risky issues and many safe observations as well. Manager A writes several comments detailing the issues and creates action items for follow-up. From that point two things can happen to derail an inspection process. The most common problem is the issues are never followed up on and/or action items are not closed out (or neither of these is communicated back to Manager A). This lack of communication is systemic in organizations and dramatically decreases the quality of future inspections performed by Manager A. The second thing to derail the inspection process is that instead of getting praised for finding potential holes in our safety systems, well intentioned Manager A gets the critical eye turned toward his department and as a result gets either more work, or more visits from the corporate office…either of which will decrease the probability of Manager A ever turning in anything other than a sterling inspection!

Safety Observations: Assessing Behaviors

A focus on safety related behaviors is another methodology to help identify holes in safety processes and assess safety performance (Geller, 1996; Komaki, Heinzmann, Lawson, 1980; Krause, Hidley, & Hodson, 1996). Unlike inspections, observations specifically focus on the observable acts of the employees, not whether they are in compliance with rules or regulations. This is an important distinction in that it is possible for an employee to follow all the rules, regulations, policies, and procedures and still be doing something that is putting himself at risk for an injury. Thus, observations fill the gap inspections may create by focusing on what the employee does, not on whether rules are being followed. Another distinction between inspection and observation processes is that in observations processes, safety related feedback is an integral part of the process (Daniels, 1989; Petersen, 1989). This is not to say that compliance-based inspections do not provide feedback, many do.

There are many organizations who have found much success with behavioral observations. In the infancy of behavioral safety, Guastello (1993) found a dramatic 60% reduction in injury rates by using a behavioral observation process. Additionally, a well-designed behavioral observation process has many benefits. One of the largest benefits is the opportunity for employee engagement. As opposed to the compliance-based inspections, which can be misinterpreted as a method for catching an employee doing something wrong, behavioral-based observations focus on looking out for the health and safety of your coworker (e.g., Actively Caring, see Geller, 1991). Another benefit is that the observers are the ones who are most likely performing the work (or have performed the work in the past) and know where some “holes” may be hiding and thus be in a better position to recommend solutions. The final benefit of a behavioral observation process is the quantity of observations completed. In general, behavioral observations are performed by many different employees who observe many different tasks, with the resulting information helping to assess the health of their safety systems. Whereas an compliance inspection is typically done less frequently, by a limited number of inspectors.

Why Inspections and Observations Fail.

Both behavioral observations and inspections have their challenges. However, one common downfall for both methodologies is inaction. If the information collected by inspections and observations is not used, or used in a way to blame employees, the subsequent observations will be of lesser quality and even may be "pencil-whipped" (or made up on the spot). This "downward spiral" effect can dramatically impact the reliability of information collected, as well as the potential for predicting and preventing injuries. Here is a common scenario: Employee Bob has just finished conducting his safety inspection and Manager Don is in the process of reviewing all their inspections. Bob may be thinking "I'm tired of collecting observations that no one does anything with. Why do I need to write this stuff down? It just wastes time in my already busy day." Similarly, Don could be thinking: "I don't know if I can trust this information. Is it really possible that this group has not found a single risky condition in over six weeks? People are still getting hurt and nobody has seen anything risky…are we doing the inspections correctly? What are we doing with all these inspections anyway? Is anyone following-up and closing out these issues?" This downward spiral of frustration repeats itself thousands of times daily in well-intentioned organizations. Over time, this leads to disillusionment, decreasing participation and deteriorated observation quality with the result that the safety professional must go back to begging employees and his fellow managers to observe and pleading with managers to act on the information they do not trust. Frustration, anxiety and fear mount as more people get hurt. The safety professional is put in a no-win situation. So, to be better able to use inspection and observational data to assess safety performance, organizations need to make two modifications: (1) evolve the current inspection and observation process to improve quality of the leading indicator data, and (2) make use of predictive analytics to help predict and better be able to prevent injuries proactively.

Using Predictive Analytics to Assess Safety Performance

Many organizations from around the world are making better use of their critical business information. Every day people from all over the globe create 2.5 quintillion (or trillion if you are from the UK) pieces of data (that is 10^{18}) (IBM, 2011). In safety, there are many pieces of critical information that are underutilized in terms of predictive analytics. The term "Big Data" is used to describe information that is too vast for individuals to get a clear picture or assess trends though simple spreadsheets. Predictive analytics continues to revolutionize many industries like in biotechnology with the mapping the human genome and in everyday use such as in an internet Google search. Safety professionals now have the tools, though predictive analytics, to make use of this big data.

One good example of Big Data in the safety field is the information gathered from safety inspections and observations. By using predictive analytics on their inspection and observation information, safety professionals can develop true leading indicators and move beyond lagging indicators to assess safety performance. However, only recently has technology evolved to the point where it is readily available which will allow organizations to review leading indicators in real time, providing safety professionals with a new perspective and suite of tools from which to predict injuries. However, to increase the predictability of the analytics, organizations need to evolve their inspections and observations to (1) increase the quality, and (2) increase the value of the data to the organization.

Leading Indicators as Cultural Proxies

Some examples of leading indicators, relative to inspection and observations, include participation by non-safety professionals, number of inspections with 100% safe, at-risk conditions per inspection, rate of closing open issues or items and the severity of an at-risk condition or behavior. These leading indicators can be used today to measure the "holes" in an organizations safety defenses and better allocate scarce resources. Furthermore, conditions and behaviors observed tend to be "proxies" for organizational discipline and cultural evolution, and thus represent good leading indicators of the overall health of your safety systems. To be able to gather this relevant information to assess your safety performance, the safety professional will need to "evolve" their inspection and/or observation processes to gather rich leading indicators to be better able to predict and prevent injuries.

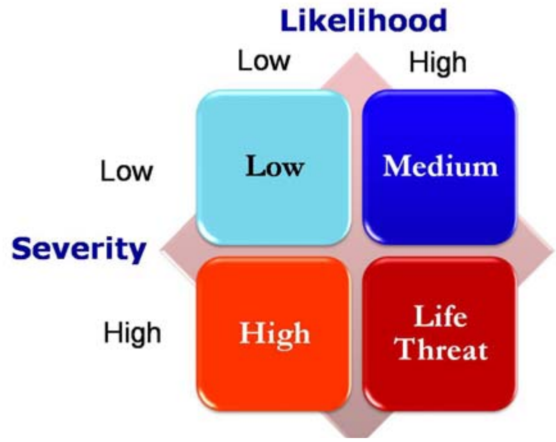

Figure 1: Add Severity to Your Inspection & Observations

<u>Evolution Step #1: Add Severity to Your Inspections & Observations</u>

When individuals observe a risky behavior or condition, this is a perfect opportunity for the person to do a simple hazard analysis and rate the riskiness of the observation. For instance, when an employee records an at-risk behavior, he or she assigns a severity level of low, medium, high, or life threatening to this behavior (See Figure 2 for a simple risk analysis). As we know, not all at-risk conditions or behaviors are equivalent. With this added degree of sensitivity, many safety professionals can more effectively assign resources to address the at-risk behavior before it turns into a near-miss or severe incident. Furthermore, the willingness for inspectors and observers to record a severe or life-threatening at-risk behavior is a good example of the aforementioned "cultural proxy." When employees or managers have enough trust in the system that they fear no repercussions for recording a severe or life-threat behavior, this signals that the organization's safety culture is focused more on fact-finding rather on fault-finding.

<u>Evolution Step #2: Assess Inspection & Observation Quality</u>

One way to stop the downward spiral of mistrust in the gathered information is to develop a method for assessing the "quality" of your inspections and observations. Many safety practitioners are often asked by their management counterparts: "can we trust this data?" or "if we are 98% safe, why are we still having injuries?" One method to address the accuracy of the inspection/observation information is to develop quality criteria. The best examples of observation quality incorporate the following criteria:

- The number of at-risk behaviors per inspection/observation card
- The number of safe behaviors per inspection/observation card
- The number of risky conditions/behaviors with a written comments per card
- The number of medium or higher severity inspection/observation per card

- Number of 100% inspections/Observation
- Participation and diversity of participation

W	Index Components	Index Percentile	Index			
			Actual	Worst	Average	Best
5	**Participation:** Number of inspections per week	☆★★★★ (60.3)	1.0	0.1	1.1	10.3
0.1	**Safe per Inspection:** Number of safe observations per inspection	☆★★★★ (61.9)	47.2	0.0	40.5	134.2
10	**At-Risk per Inspection:** Number of at-risk observations per inspection	☆☆☆★★ (23.8)	0.2	0.0	1.7	20.0
20	**Severity:** The relative severity of at-risk observations	☆☆☆★★ (36.5)	0.7	0.0	3.1	29.5
0	**Unsafe Observations With Comments** Number of Unsafe Observations with Comments per Inspection	☆☆☆★★ (25.4)	0.2	0.0	1.9	20.0
0	**All Safe Observations per Inspection** Number of All Safe Observations per Inspection	★★★★★ (93.7)	0.0	0.0	0.2	1.0
	Overall:	☆☆☆★★ (34.9)	25.9	0.5	88.2	686.1

Figure 3. Electronic scoreboards make it easy for safety professionals to assess the quality of their observations.

Tracking the quality of your observers can give safety professionals insight into cultural issues, training opportunities and team performance. The observer "quality scorecard" in Figure 3 demonstrates one way to track quality through a star rating system. In this example, based on comparative analytics, employees' observation characteristics can tell a story. Figure 3 above represents an electronic scorecard, with observer scoring a two-star rating based on a high frequency of observations, high number of safe observations, large number of "all safe" observations, but very few risky behaviors with low severity. These quality metrics tell a story that may reflect reluctance to record risky behaviors, which could point to a cultural gap that needs addressing. On the other hand, this pattern may indicate a team member not perceiving any value in performing observations and could be "pencil-whipping" (e.g., making up) the data.

In this second example (Figure 4), a three-star observer has low participation, low safe observations, yet high at-risk and severity. Again, using the predictive power of our data, this pattern tells a story that might point to a "fault-finder" or "ticket writer". In other words, the only time the ticket writer gets involved is when he or she sees a serious enough at-risk behavior, grabs a checklist and writes them up via filling out an inspection/observation. This pattern hidden in the observations is a leading indicator of a location that has more of a "fault-finding" culture. Thus, by using these quality analytics, the safety professional can move beyond focusing on the most risky or just percent safe, and use the predictive power to identify cultural or training issues.

W	Index Components	Index Percentile	Index			
			Actual	Worst	Average	Best
5	**Participation:** Number of inspections per week	(12.7)	0.1	0.1	1.1	10.3
0.1	**Safe per Inspection:** Number of safe observations per inspection	(11.1)	3.0	0.0	40.5	134.2
10	**At-Risk per Inspection:** Number of at-risk observations per inspection	(55.6)	1.0	0.0	1.7	20.0
20	**Severity:** The relative severity of at-risk observations	(61.9)	2.0	0.0	3.1	29.5
0	**Unsafe Observations With Comments** Number of Unsafe Observations with Comments per Inspection	(55.6)	1.0	0.0	1.9	20.0
0	**All Safe Observations per Inspection** Number of All Safe Observations per Inspection	(28.6)	0.0	0.0	0.2	1.0
	Overall:	(54.0)	50.7	0.5	88.2	686.1

Figure 4. Assessing the quality of your observers can be a leading indicator

Evolution Step #3: Quality Benchmarking

To gather further information regarding the quality of your inspections/observations, organizations need to develop what an "average" pattern of safe and at-risk conditions/behaviors typically look like. This benchmarking tool will have an enormous impact. First of all, it tells leadership team what to expect and therefore, when and where to act. It also helps, pinpoint specific observers or observation patterns that require further analysis. The safety professional can use these observation quality metrics to compare one group against another. For instance, compare a group of high quality observers (the informal safety "champions" or managers you know are conducting thorough inspections) with a more typical group of observers. Or, compare safety professionals against the hourly employees. One should assess the average number of at-risk behaviors observed by each group, the number of safes, number of comments for risky observations and the severity of the behaviors observed. With this information, safety practitioners are in a better place to assess the quality of their processes. More importantly, the leadership team will have much more trust in the information presented to them. The below example (see Figure 5) illustrates how one could assign these "Safety Champions" as a "Designee" and the "typical" observer as "non-designee." Figure 5 points out a big difference between what the Designee inspectors are seeing compared with the "typical" inspectors (non-designees). In this case, the typical inspectors are not observing any risky conditions. However, when the Designee (e.g., safety professional) is doing observations, they are seeing more risky things. This could represent a cultural issue where they typical observers do not trust the system enough to document it on an inspection card. Alternately, the pattern could indicate confusion or a lack of training on what a "risky" condition is and/or how it is defined.

W	Index Components	Index Percentile	Index			
			Actual	Worst	Average	Best
1	**Severity, Non-Designee:** The relative severity of unsafe observations for this contractor, as noted by non-designees	(100.0)	0.0	0.1	0.0	0.0
1	**At-Risk per Inspection, Non-Designee:** Number of at-risk observations per inspection, as noted by non-designees	(100.0)	0.0	2.0	0.3	0.0
1	**At-Risk per Inspection, Designee:** Number of at-risk observations per inspection, as noted by designees	(56.2)	0.5	5.5	0.8	0.0
1	**Severity, Designee:** The relative severity of at-risk observations for this contractor, as noted by designees	(55.1)	0.0	0.1	0.0	0.0
1	**Safe per Inspection:** Number of safe observations per inspection	(50.5)	0.7	0.1	0.6	1.4
	Overall:	(75.8)	-0.4	2.0	-0.0	-1.0

Figure 5: Assessing differences in your "Gold-Star" (Designee) observers

In Summary

Many organizations look to lagging indicators to assess the health of their safety systems. While injury rate is a metric, many organization search for other safety statistics that can help predict and prevent injuries and improve their safety cultures. These "next-generation" leading indicators help the safety professional assess their safety performance by looking for "holes" in their safety systems and other potentials for incidents. By taking your inspection and/or observation processes to their next evolutions, organizations can better assess quality and provide value to the organization. Once the quality of these leading indicators are improved, the safety practitioner can make use of predictive analytics to identify where their next injury is likely to occur, focus their resources to eliminate or mitigate the hazards and truly make a difference in their safety cultures. When this evolution occurs and we can begin to accurately predict and prevent injuries, we can ultimately end death in the workplace.

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