

Harnessing the Power of Leading Risk Indicators— Your Safety Observations Could Tell You Where Your Next Accident is Coming From

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What Safety Observations Tell Us About Project Risk and Future Worker Injuries

Today, literally millions of safety observations will be made around the world. Thousands of workers will consciously or unconsciously make decisions regarding their behaviors, their coworkers' behaviors and the environment of their work site. Some will write these observations down and others won't. Some will summarize these observations and submit them to a home office, where they will be neatly filed or summarized in a monthly PowerPoint slide. Some will stick them in a folder. Others will simply throw them away. Until recently, very few people knew that those scribbles, checks and notes would enable them to single out a worksite on the brink of an injury. On top of that, they could have this knowledge without ever setting foot on a site a thousand miles away and still be right about 80% of the time.

In order to use observations to reduce injuries we have to solve two problems. First, we need to identify the risk in time to do something about it. Second, we need to know enough about the type of risk we have in order to deploy appropriate resources for prevention. Unfortunately, many of the methods we use to identify risk today have significant limitations. These limitations require us to look more closely at field observations as a superior alternative.

For the past two years, we have employed the most rigorous and advanced analytical models available to scrutinize safety observations from 76 companies. The end result is a wealth of insight that will be useful for any organization interested in lowering the cost of sustaining their zero injury culture or breaking through the common plateaus en route to world class safety performance. We confirmed that the leading indicators in these observations reveal a lot about observers and their worksites. Our research identifies observers who are in need of training or are not culturally aligned with other team members.

In addition, we are able to isolate and validate work areas or projects that are more at risk for a number of reasons.

In this paper, we will share our experience in tapping into these observations and tackling the age-old issues associated with field observations everywhere. We will explain why there is a need to measure the quality of an observer and their observations and share a few ideas about what this might mean for your company. Building upon the link between observations and project risk, we will describe how we developed a predictive model that demonstrates a significant correlation between safety observations and claims. The average correlation to claims for the companies in the study was 78% although in some cases this model has a 90% correlation to claims with an error margin of around 3%.

Traditional Barriers and the Bad Rap on Observations

Traditional approaches to measuring safety performance rely on field observations, or worse, claims that are too late and don't provide the information needed to take preventative action. As leading safety expert E. Scott Geller says, "Both the quantity and quality of participation in BBS activities depend on the numbers you use to evaluate success or failure. The bottom-line measure – total recordable injury rate (TRIR) – provides neither instructive guidance nor motivation to continue a particular safety process."¹ In addition, it is well known that many observers may consciously or unconsciously manipulate numbers by failing to mark unsafe behaviors or over-counting safe observations. One reason that "pencil-whipping" persists is the perception that management expects to see only good safety performance, not safety problems. Our research in fact demonstrates that the number of safe observations increases at a similar rate to the number of unsafe observations with both safety professionals and non-safety professionals.

In our example, over four million cumulative observations show that the overall safe percentage for fall protection across the board was 93%. But when we look at this more closely, we find that one in four observations for fall protection has an unsafe condition or behavior and that safety professionals on average find 60% more unsafe observations than non-safety professionals during the same period on the same work sites. While both numbers are technically accurate, they also communicate two very different perspectives. As has often been said, "facts are facts, but facts can always be manipulated."

Relying exclusively on a safe or unsafe percentage number is flat out dangerous. Too often, a high percentage of safe observations promotes the opinion that everything is okay, but a job that is 99% safe may not, *in reality*, be any safer than a job that is 87% safe. Our research does not indicate that a high percentage of safe observations correlates to lower risk or fewer injuries. On the contrary, we found that many projects which resulted in worker injuries were in fact marked "100% safe." When observers on these projects were

¹ Geller, E. S, "How to Get More People Involved in Behavior-Based Safety: Selling an Effective Process." Cambridge Center for Behavioral Studies, <http://www.behavior.org/safety/geller.pdf> (accessed March 10, 2006).

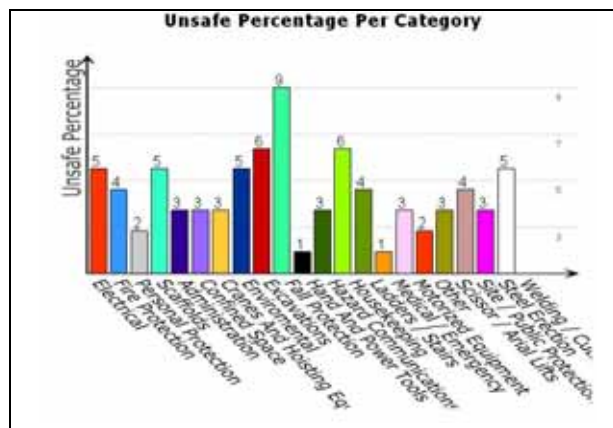
questioned about the gap between their perception of what constituted a 100% safe project and reality, common responses included variations of “I didn’t see anything...” or “I thought we were supposed to mark it down this way so our project numbers would look right.”

Traditional observation metrics or summaries are misleading in other ways. While tracking whether someone is doing an inspection is better than not tracking it at all, it is overly simplistic to look only at whether inspections were performed. For example, large jobs with a longer duration tend to have more inspections than smaller, quick-turn projects. If we look only at the raw number of inspections completed, we might conclude that larger jobs are safer because they have a higher number of inspections. In reality, they may not be safer than smaller jobs; they simply present more time and opportunities for people to conduct inspections.

One example from our research involves a large project that produced several injuries. This project accumulated hundreds of completed inspections and thousands of observations. For each inspection, observers found and corrected a multitude of unsafe conditions and behaviors. The team was so busy observing and correcting unsafe issues that they failed to use their insight to identify and resolve the root cause of the problems. As a result, this well-intentioned team was unable to prevent over 20 subsequent worker injuries.

It’s also not surprising that observations are highly perishable. In today’s fast-paced world, the quicker we collect, analyze and distribute observations, the more likely we are to derive value from their insight. This fact is particularly relevant in cases of highly transient employees or service providers. In the past, it was impractical to collect, analyze and distribute insight from field observations in a timely fashion. But today, safety audits that use new low cost technologies (Exhibit 1) help to eliminate these time barriers and enable almost instant feedback, which is another reason these observations are so much more valuable today.

Exhibit 1. This displays a graphic from a DBO² SafetyNet report, which updates and depicts unsafe percentages per safety category for inspections on a real-time basis.



The Confidence and Risk Indexes: Organizing and Simplifying Observations

When looking at observations, we considered over a thousand different metrics relative to observations and predictive capacity for risk. For example, we looked at fall protection, the role of the person who made the observation and how fast he/she resolved open issues once they were identified. One of the reasons we considered so many alternatives is that we wanted to know which ones mattered the most or had the least influence in terms of indicating future risk or the quality of an observation. As our work progressed, we also determined that both workers in the field and management wanted and needed two things:

1. A simple indicator of confidence in a particular individual's observations
2. A number which denotes the relative risk of a group of observers (such as those working on a construction project) as compared to others

For individuals, we call this single number a **confidence index** (see Exhibits 2 and 3). For projects, we generated a **risk index** (see Exhibit 4) to indicate relative site risk. The calculation of these indexes was adjusted based on the differences between individual observations and groups of observations. For example, a compounding effect occurs when numerous individuals find a disproportionate number of safe and unsafe observations on a particular site, and the potential distortion created by this effect was accounted for in our calculations.

Participation	Normal Safe Range	Normal Unsafe Range	Awareness	Alignment	3-Month Index	12-Month Index
45	46	32	100	75	57	54
65	78	42	100	60	55	55
67	24	37	100	68	54	52
61	59	63	100	44	53	56
71	38	32	100	65	51	44
46	67	35	100	62	51	51
57	65	32	100	63	51	47
36	88	35	100	57	50	55
62	34	26	100	68	49	52
46	43	53	100	49	49	48
67	47	21	100	66	48	51
36	56	27	100	63	47	49
46	45	31	100	60	47	50
61	66	26	100	60	47	57
57	99	45	100	41	47	51
52	54	19	100	65	46	36
54	0	35	100	62	46	48
47	19	58	100	43	46	52

Exhibit 2. A confidence index report with individual component scores is shown above. Scores highlighted in red and yellow signal potential problems. Columns for “Observer” and “Region” are omitted to protect privacy.

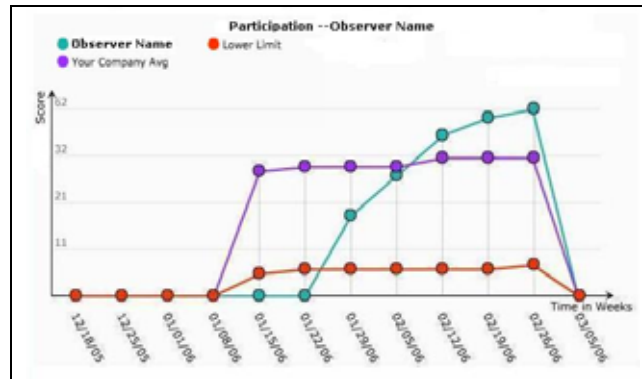


Exhibit 3. By clicking the scores in the confidence index report, a pop-up window with three trend lines graphically compares the observer, company and industry scores by week.

Participation	Normal Safe Range	Normal Unsafe Range	Awareness	Alignment	3-Month Index	12-Month Index
70	78	100	97	48	87	81
71	72	100	100	41	92	95
72	83	100	76	23	89	84
39	84	65	22	37	86	81
67	78	98	88	37	84	89
66	78	100	82	26	84	86
58	75	98	91	43	84	84
52	67	99	97	54	84	84
75	62	100	100	21	81	73
64	22	91	26	78	81	78
63	72	100	100	30	81	73
61	92	92	100	41	78	95
72	44	88	96	54	76	70
26	0	86	100	93	76	65
43	32	91	100	22	76	78
82	28	89	100	43	72	78

Exhibit 4. A risk index report with component scores is shown above. Scores highlighted in red and yellow signal potential problems. Columns for “Project” and “Region” are omitted to protect privacy.

The first step toward developing our observation indexes was to recognize the relationship between observations and increased risk in general. We found it important to understand an observer’s and a project’s relative risk in comparison to their organization and to the industry in general. If we use credit rating scores as an analogy, just because you have a poor credit score does not mean you will default on a loan. Similarly, a poor confidence index for an observer does not mean that this person is dangerous or is likely to hurt someone. Rather, this observer warrants more attention. His/her observations fit a pattern similar to those where we have less confidence in the observer or find the situation

to be of a higher risk. A high risk index for a project likewise does not mean that worker injuries are imminent. Instead, it provides an objective way for the safety team to focus its attention, ask “why?” and act appropriately.

Assessing the Quality of an Observation

Based on our research and customer feedback from the past five years, we chose to consider and appropriately weigh five separate indicators of confidence and risk. We deconstructed a large data set—four million observations from 76 different companies, 1500 users and 3000 projects—into five leading risk indicators: **participation, normal safe range, normal unsafe range, awareness and alignment between safety and non-safety professionals.** Below, we describe in more detail the components of our indexes and the logic behind the selection of these components.

Participation

Participation is at the heart of any safety process. At a basic level, it drives knowledge of and familiarity with unsafe conditions or behaviors. The act of making an observation helps to reduce injuries by simply raising awareness and affording the opportunity to coach someone on unsafe behaviors or conditions.

In the words of safety guru Dan Petersen: “Safety is about one-to-one interactions, supervisors to managers, supervisors to workers, managers to workers. Safety is about these interactions happening every day. It's people every day looking out for each other. That's how safety is achieved.”²

An organization's true participation in its safety process is a leading indicator for risk. We wanted to know how one observer's participation truly compares to his team's participation and how one project's participation level compares to another project's. Because projects, individuals and risks are different, we adopted a range of tolerances for participation rather than adhering to an absolute number. To determine this range, we looked at several inspection frequencies including the average number of inspections per week and the average number of days between inspections. For both of these metrics, we created an industry benchmark and a benchmark for each organization. Using these two baselines, we were able to measure if an individual or project was significantly different from the industry as a whole or their company in particular. It also allowed an organization to see how actively involved their entire team or group of projects was relative to the industry.

Normal Safe and Normal Unsafe Range of Observations

Because they deviate from the normal range, an unusually low or high number of safe or unsafe observations signals potential problems. Unusually safe jobs may indicate that observers are unaware of hazards or have not been properly trained. Alternatively,

² Johnson, Dave, “Interview with Dan Petersen.” Industrial Safety & Hygiene News, http://www.ishn.com/CDA/Articles/Newsletter_Archive/cfd852d5810c7010VgnVCM100000f932a8c0 (accessed March 10, 2006).

employees may have the perception that management does not want them to find anything wrong and thus, unwittingly contribute to increased potential for accidents by not sharing a possible hazard.

For obvious reasons, an unusually unsafe job raises red flags, too, particularly if the job reflects a larger pattern or trend for the same organization. For example, when we see 1.5 unsafe housekeeping conditions per inspection, when the typical count at a similar job during the same period is 1 unsafe housekeeping condition per inspection, the observers are giving us a hint that something is different. In and of itself, this might not tell us much; but in combination with other metrics, anomalies like this one prove to be helpful in identifying work groups that are at greater risk.

We included five safety categories in our consideration of normal safe and normal unsafe observations: fall protection, personal protective equipment (PPE), electrical, housekeeping, ladders and stairs (see Exhibit 5 for safe percentages for each category). Our objective was to highlight observations that were unusual relative to the industry and unusual relative to a specific organization. We selected these five indicators because out of almost eight million observations, these are the five most observed categories and are generally acknowledged to be the basic building blocks of safety. As such, they are also not particularly complex or difficult to define for workers in the field.

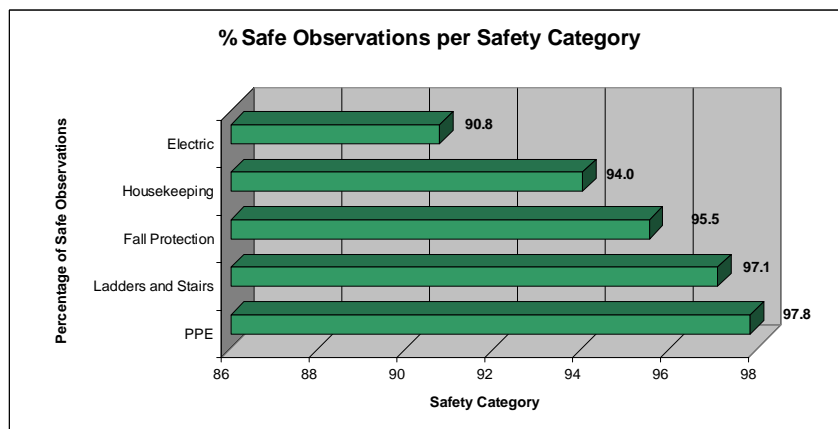


Exhibit 5. This graph shows the percentage of safe observations for the five safety categories considered for the normal safe and normal unsafe components of our index.

Awareness

Certain outliers or statistical anomalies may indicate a lack of observer awareness that warrants further investigation. One outlier uncovered in our research was the percentage of inspections conducted that were 100% safe. Several users consistently fail to recognize unsafe behaviors or conditions when doing observations and may present a risk to the project or the company. This pattern of observations often indicates that an individual lacks the awareness or knowledge necessary to identify risks, perceives that management does not

want him/her to find risks, or has some other understanding which would compromise the integrity of his/her observations.

Alignment between Safety and Non-Safety Professionals

Both common sense and our results point to a significant difference between safety professionals and non-safety professionals. It is important for us to understand why this discrepancy exists and to highlight this misalignment. We used the same risk categories for normal safe/unsafe projects to consider these differences. We also chose to examine the differences between safety professionals and their peers, with the underlying logic being that the entire set of safety professionals would serve as a type of control group or more trustworthy baseline. We believe that these individuals comprise the most competent group in an organization and should generally be aligned with each other.

A Quick Look at the Industry

Analyzing components of the confidence index at the industry level provides some interesting insight into observation patterns which may offer some context and perspective for your organization. Each component of the confidence index is scored on a 0-100 scale, with a higher score indicating superior performance.

In terms of participation (see Exhibit 6 below), our industry-wide scores are fairly evenly distributed, with 46% of the scores being 59 or below. Because this score looks at active participation, we would expect to see a few scores on either end of the spectrum, indicating that some observers fall short of, while others exceed, expectations for participation. The majority of observers fall in the 40 to 60 range. We believe that participation is a great metric for positive recognition. Aside from being fair and objective, it promotes positive, proactive involvement in the behaviors that reduce accidents and incidents. Organizations would benefit greatly from taking measures to drive their participation scores towards 100.

Exhibit 6. The median scores for participation are reasonably distributed.

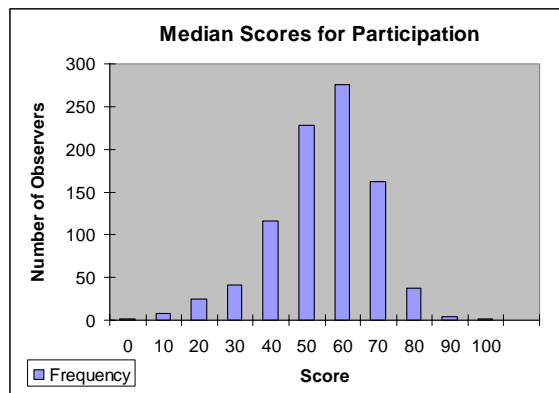
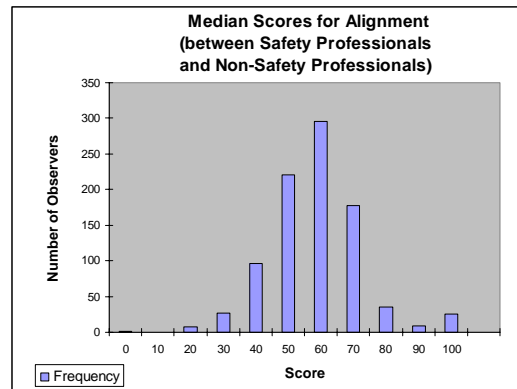


Exhibit 7. The median scores for alignment between safety and non-safety professionals tend to cluster around the middle, indicating a fair degree of misalignment.



In Exhibit 7 you will see the distribution of scores measuring alignment between safety and non-safety professionals. In this case, a high score indicates that observation patterns are closely aligned between safety professionals (SPs) and non-safety professionals (NSPs). Here, we see that 58% of the scores are clustered in the middle of the distribution, between 40 and 79, suggesting that in many organizations, there still exists a fair degree of misalignment between SPs and NSPs.

Case Study: Applying the Confidence Index to Two Companies

An organization as a whole would ideally strive to have all of its component scores skewing or moving to the right, toward the higher numbers. For each of these metrics, it is critical for leaders to understand their organization's norms and to scrutinize any observers or groups of observers whose observation patterns differ significantly from the rest of the safety team.

To illustrate our case, Exhibit 8 shows how Company A, a general contractor in Texas, compares with the industry benchmark, which is comprised of over four million observations from 76 companies. In this company, participation scores between SPs and NSPs are very similar, which is a good sign. Overall participation is slightly below the median for all observers, suggesting some room for improvement. The score for normal unsafe observations is relatively high for SPs, another good sign. What is potentially concerning is the significant difference between the SPs and NSPs here. Why are NSPs finding a different number of unsafe observations than SPs? We want to uncover the root cause of this difference and develop an action plan to address this discrepancy. This lower rate may result from either inadequate training or a false perception of management expectations.

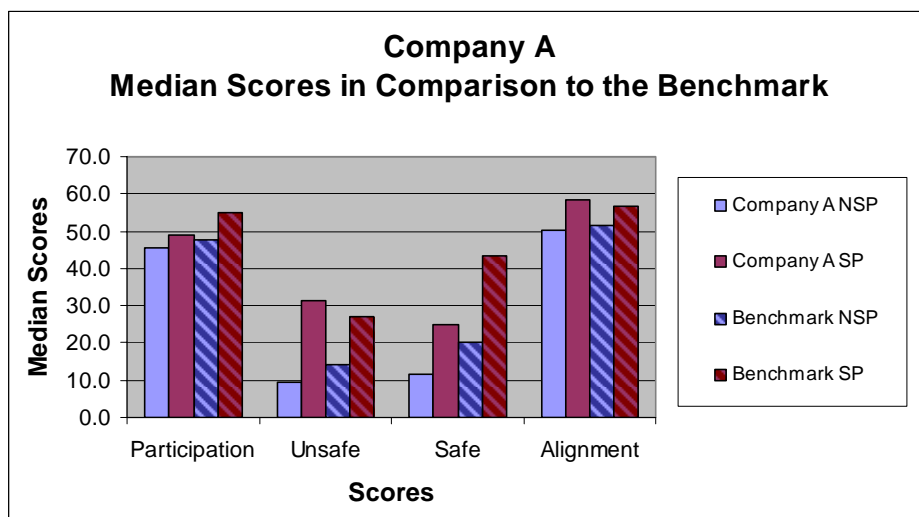


Exhibit 8. This exhibit shows how Company A compares to the benchmark.

Next, we consider Company B (Exhibit 9), a large general contractor in California. In terms of participation for Company B, the SPs are in alignment with the rest of the industry, while there exists significant opportunity for improvement among NSPs. It is important for the SP team to understand the potential barriers that NSPs may experience when completing these observations. This kind of result is typical when a company has not been using the information collected by NSPs on a regular basis or when field teams are unaware of how to use the observation information to improve safety.

These same NSPs actually score better than their NSP industry peers and are approximately equal to their SP industry peers when identifying unsafe observations. Notice that there is a gap between NSPs and SPs for normal unsafe, while there is no gap between the same two groups for normal safe. This fact suggests that when compared to the SPs, NSPs find unusually more or less unsafe observations, but find a similar number of safe observations. It is possible that the NSPs are increasing their safe observations per inspection in order to increase their safe percentage, thereby creating the perception that things are safer than they are in reality. We might have been less concerned if both scores were aligned, but this substantial disparity warrants a closer look.

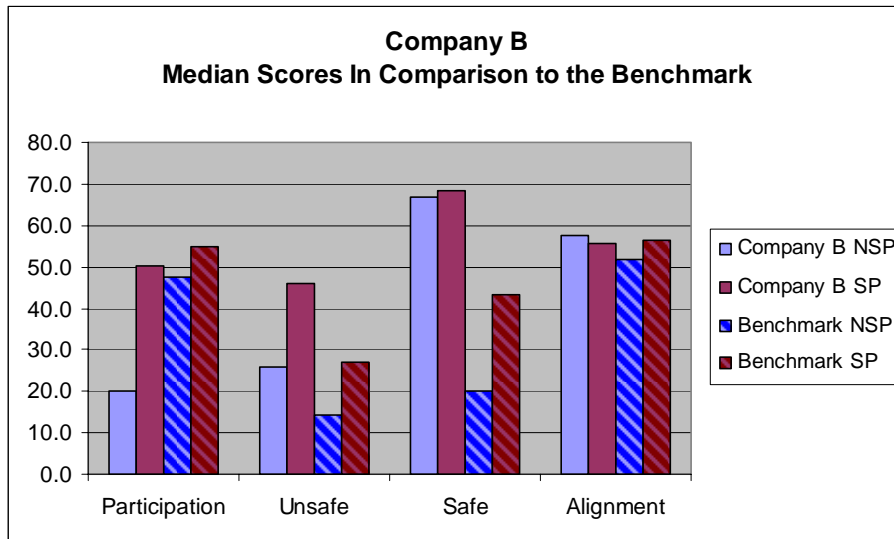


Exhibit 9. This exhibit shows how Company B compares to the national benchmark.

A Closer Look at Work Groups and Projects

The greater our confidence in our safety professionals, the more important it is for field observations to trend in line with this group. For example, a significant misalignment between safety professionals and non-safety professionals is potentially risky since it can indicate a cultural, competency or perception gap that merits further attention.

In fact, our research clearly demonstrates that the alignment between SPs and NSPs does impact whether a project is likely to have a claim. In the following example (Exhibit 10), the average alignment scores for projects without claims are lower than the average alignment scores for projects with claims. Using a logarithmic function, we were able to trend the actual numbers and test this hypothesis on each individual company considered in this study. While it can be dangerous to read too much into a single indicator, we do believe sizeable and ongoing misalignment between safety professionals and non-safety professionals is a significant indicator of risk that may warrant further investigation.

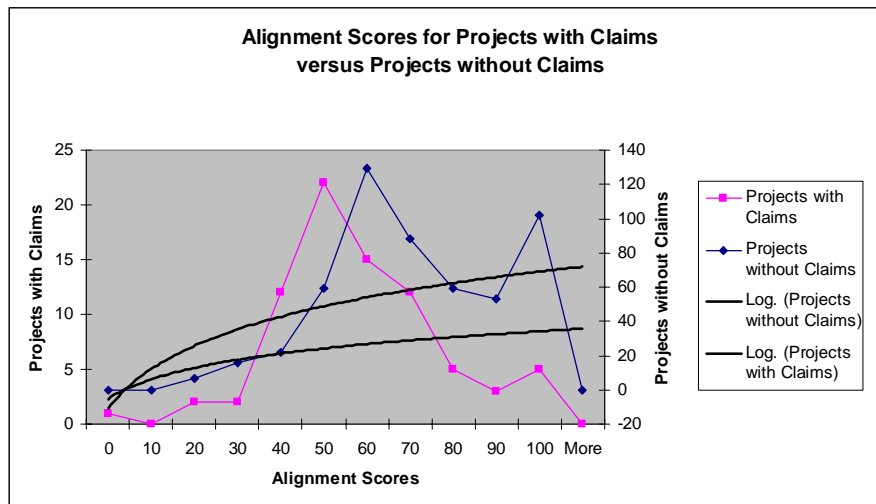


Exhibit 10. Sites with claims show greater misalignment between safety and non-safety professionals.

Moving from Observations to Claims

Oftentimes, we begin to see an increase in risk long before a claim occurs. Safety observations are the leading indicators that allow us to pinpoint the project risk areas that may lead to claims. Our work on the confidence and project indexes helped us establish the basic links between observations and risk, which we then expanded to develop a claims forecasting model.

To explore this problem, we initially looked at the simple correlations between claims and obvious factors like safe and unsafe observations for particular categories. You may recall that a correlation is a single coefficient or number that represents the relationship between two data sets. Initially, when looking at single variables our research did not yield any smoking guns; in other words, no single observation or variation on an observation showed a high correlation to claims. We next analyzed observations using regression and multivariate regression analysis. In regression analysis, a target variable such as an injury is selected and its association with one or more independent variables (such as the number of safe observations and unsafe observations) is measured. Unfortunately, we discovered that simple correlation, regression or even multi-variant regression analysis would not be sufficient in helping us to understand the relationship between observations and claims.

Given the nature, quality and diversity of the information, we were forced to move beyond these tools to more robust and flexible models currently used to solve challenges in the meteorological, pharmaceutical and banking industries—industries that have had the benefit of dissecting and analyzing significantly large data sets over a long period of time. For this paper, we used (and continue to use) a combination of statistical models and tools including, C5, CART and TreeNet analysis (see Exhibit 11). In order to develop our predictive model, we ultimately needed to consider the wide variation in the quality of the input information, taking into account factors for highly skewed metrics and the need to

normalize observations across multiple data and organizational types. Without getting into details that extend beyond the purpose of this paper, one characteristic these models share is the ability to take thousands of variables and rank them in terms of their association to a particular target variable. For more background and details on the tools and methods employed for this initiative, please feel free to contact the author.

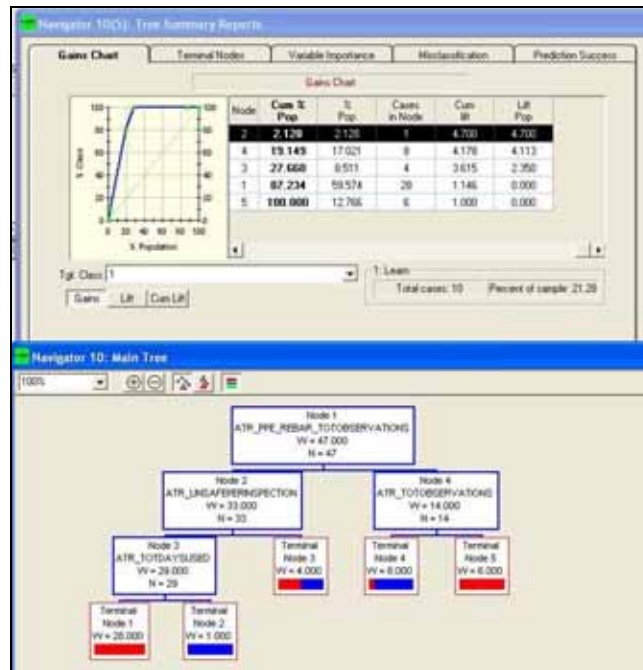


Exhibit 11. Analytical tools such as CART and C5 were employed to conduct the analysis for this study.

For the purpose of this paper, we selected six organizations for detailed modeling. The number of work sites evaluated varied by company, with the largest having almost 300 sites and the smallest having less than 50. In addition, the number of claims or injuries for each company was different; the percentage of projects with claims ranged from 6% to 24%. The quantity of observations and observed categories also varied significantly from organization to organization.

Using observations and the risk indexes described earlier, we found an average 77.4% correlation between observations and claims, with an error rate of approximately 5%. As one might expect, results varied significantly by organization; more information on the amount of claims and observations resulted in improved accuracy. In the worst case, our ability to forecast projects with a high likelihood of an accident was about 61%, while in our best case our forecasting improved to almost 90%. See Exhibit 12 below.

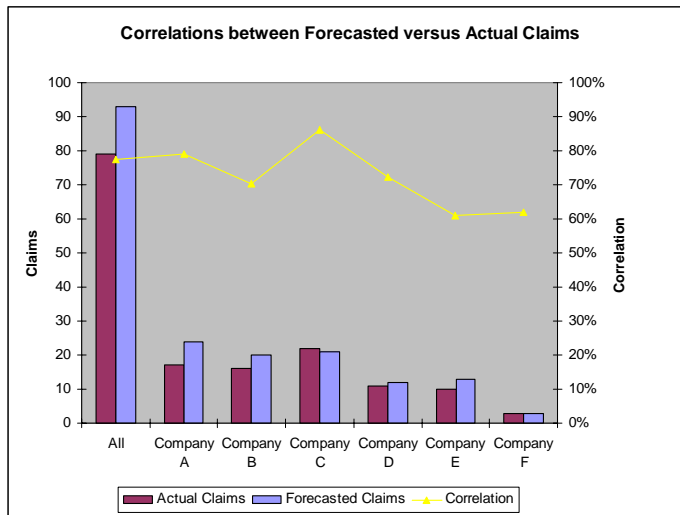


Exhibit 12. We found an average 77.4% correlation between observations and claims, with an error rate of approximately 5%.

These correlations indicate a significant relationship between safety observations and projects with claims. To test the accuracy of our model we used several different training and testing methods, including random generation of the test set, model generation of the test set and finally exclusion of a specific set, in this case, for one company. Although each test has different error rates, none exceeded 27% and the correlations were in alignment with the ones presented above. In our most conservative model, we singled out one company and did not include any observations in any of our modeling. Using the other five companies' observation information along with the confidence and project risk indexes, we created a revised model and tested it against the sixth company to see how accurate our model would be in predicting injuries on a completely independent set of observations and indexes. Out of 52 projects, this company had 11 actual claims for the period. The model forecasted 15 claims with an error rate of 27%. While we believe there is still considerable room for improving our risk forecasting model, we believe organizations that have this insight early in the process will have the ability to better prioritize their work and perhaps spend a little more time evaluating a particular project, ultimately reducing the chances of someone getting hurt.

Conclusion

We hope that you will walk away with the realization that your safety observations represent an enormous business insight and value to your organization. We confirmed that the leading indicators in these observations reveal a lot about our observers, their worksites and their relative risks. In particular, for decentralized or fragmented organizations where the potential for catastrophic loss exists, they present a progressive opportunity to focus your resources most efficiently. This proactive planning can help you achieve zero injuries and ensure long-term profitability. Just imagine knowing (with 70%+ accuracy) which of your worksites are more at risk for an injury, without ever setting foot on site. New cost-effective

technologies that eliminate time and information barriers help to make this instant feedback possible, and render your observations even more valuable and timely.

With innovative tools that break through the limitations of traditional metrics, we can now appraise our confidence in a particular individual's observations and those of a group of observers using the confidence and risk indexes to measure their risk relative to each other, their organization, or the industry as a whole. Whether you look at the information amassed from this study from an industry, organizational or individual viewpoint, there's no question that these tools represent an asset for safety professionals, who already cope on a daily basis with limited resources and time. While our models will continue to develop and grow more precise, we are confident that safety professionals are now armed with a powerful weapon that will allow them to proactively promote safety and, most importantly, consistently predict and prevent injuries on the jobsite, all by harnessing the latent power behind that simple, everyday practice known as the safety observation.

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