SAFETY METRICS

Peer-Reviewed

SEVERITY-BASED LAGGING INDICATOR

An Alternative Measure of Safety Performance

By Matthew R. Hallowell and Elif Deniz Oguz Erkal

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THE WAY AN ORGANIZATION uses safety metrics to make business decisions is a direct reflection of its safety culture. Safety metrics are critical for goal setting, observing progress, benchmarking and influencing behavior (Taaffe et al., 2014). Practitioners make direct comparisons when using safety metrics to answer vital questions such as:

- "How did we perform last year compared to our peers?"
- "Did we improve as a company since last quarter?"
- "Which contractor has better safety performance?"

Ultimately, the answers to these questions drive business decisions such as resource allocation, promotion, and other forms of incentive or recognition.

Lagging indicators have been the dominant measures of safety performance for more than 50 years (Dekker & Pitzer, 2016; Lingard et al., 2017; Manjourides & Dennerlein, 2019). Among the many lagging indicators, total recordable injury rate (TRIR) is the most pervasive. Put simply, TRIR is the count of recordable injuries divided by the corresponding number of worker hours and normalized per 200,000 worker hours. TRIR persists because it is based on a single, standardized definition of a recordable injury propagated by OSHA (n.d.a). The use of a standard definition and a single method of computing a rate enables direct comparisons and simple communication. It also ensures that assessments are objective and minimally impacted by personal judgment. Although alternative measures of safety performance have emerged such as leading indicators and climate assessments, TRIR persists because it is standardized in a way that alternative metrics are not (Hinze et al., 2013; Oguz Erkal, 2022; Schwatka & Rosecrance, 2016). However, despite ubiquitous use as a comparative safety metric, recent research shows that TRIR and other traditional lagging indicators have severe statistical and philosophical limitations (Hallowell et al., 2021; Oguz Erkal et al., 2021; Toellner, 2001).

Lagging indicators such as TRIR are not inherently bad, but they are philosophically flawed because the way they are used to communicate performance and make business decisions is antithetical to modern safety principles. Here, we focus on three salient flaws. First, since lagging indicators are retrospective in nature and record information only after injuries occur, they stimulate reactive decision-making. In practice, organizations typically respond to fluctuations in injury rates by throttling the safety system (e.g., performing more safety observations or prejob briefs) rather than proactively deploying targeted safety interventions (Lingard et al., 2017). That is, the lagging indicators appear to trigger the leading indicators instead of the other way around. Second, using injury rates to make comparisons is inherently based on a conceptualization of safety as absence of injuries rather than the modern understanding of safety as the presence of safeguards (Hollnagel, 2014). For example, using TRIR to compare the safety performance of two contractors assumes that a worker hour without a recordable injury is safe simply because no recordable injury was sustained. However, it is unclear if the outcome was a product of luck or the intentional use of adequate safeguards. Finally, most injury rates are binary and based on one injury level, which means that they do not capture relative severity. For example, when calculating TRIR, all injuries that meet the definition of OSHA recordable are counted as the same regardless of their relative severity (OSHA, 2010). Therefore, a two-stitch cut to the finger is counted the same as a lost limb even though the impact of these injuries is radically different. No matter which traditional lagging indicator is used, these three philosophical limitations generally apply.

In addition, TRIR and other injury rates are statistically problematic when they are used to draw comparisons. Since most lagging indicators are based on events that are rare and random, the corresponding rates are statistically unstable even over long time frames (Hallowell et al., 2021). For example, for most companies, 10 to 100 million worker hours are required to report TRIR to one decimal place of precision. The statistical limitations are even more pronounced for more severe injuries included in days away, restricted or transferred and fatality rates.

Published literature points out that lagging indicators have major flaws that could be eliminated by leading indicators (Grabowski et al., 2007; Hinze et al., 2013). However, lagging indicators are still valuable when used effectively. Taken over enough time, they provide information related to our shared goal: fewer people being injured or killed. Lagging indicators ultimately represent an output of the safety system that helps us understand whether safety-related activities (i.e., leading indicators) translate to long-term improvement. Thus, lagging indicators can be an important part of the safety narrative when used in combination with other metrics and in a manner that is statistically appropriate. In pursuit of a more valid and meaningful lagging indicator, this article introduces and explores the concept of severity-based lagging indicator (SBLI).

KEY TAKEAWAYS

- **Recent research uncovered severe philosophical and statistical flaws with using traditional lagging indicators as comparative measures of safety performance. The severity-based lagging indicator (SBLI) is introduced as an alternative safety metric that addresses some limitations of traditional metrics while preserving some strengths.**
- **SBLI is an adjusted injury rate that weights injuries by their relative severity and aggregates them into one rate. Compared to traditional lagging indicators, SBLI produces more meaningful and statistically stable trends.**
- **Despite its strengths, SBLI has many of the same philosophical limitations of traditional lagging indicators, such as being retrospective, prone to manipulation and based on a dated view of safety as the absence of incidents.**

Severity-Based Lagging Indicator

SBLI was designed by a team of safety professionals and technical advisors to address two key limitations: counting all injuries as the same regardless of their severity and the statistical instability resulting from the inclusion of only rare and random incidents. Although SBLI is prone to many of the limitations of traditional lagging indicators, the authors found that it provides more stable and meaningful trends when used correctly.

Development & Testing Method

SBLI was developed and tested by a team of 27 safety professionals who represented 20 different electric power utilities in the U.S. and Canada that are members of the Edison Electric Institute (EEI). The team convened

TABLE 1

INJURY SEVERITY LEVEL DEFINITIONS

Injury severity level	Definition
First aid (FA)	An injury or illness that requires medical attention that is usually administered immediately after the injury occurs and at the location where it occurred. (Note: First aid incidents often consist of a one-time, short-term treatment and requires little technology or training to administer.)
Medical treatment (MT)	An injury or illness that does not involve death, 1 or more days away from work, or 1 or more days of restricted work or job transfer, and where the employee receives medical treatment beyond first aid.
Job transfer or restricted duty (JTR)	As a result of a work-related injury or illness, an employer or healthcare professional keeps, or recommends keeping, an employee from doing the routine functions of their job or from working the full workday that the employee would have been scheduled to work before the injury or illness occurred.
Days away from work (DAW)	An injury or illness that involves 1 or more days away from work.

Note. Reprinted from "Severity-Based Lagging Indicator: Making the Best of Our Injury Data," by M.R. Hallowell & E.D. Oguz Erkal, Edison Electric Institute (EEI), 2023 (https://bit.ly/4c1u0Vz).

TABLE 2

INJURY SEVERITY CATEGORY WEIGHTS

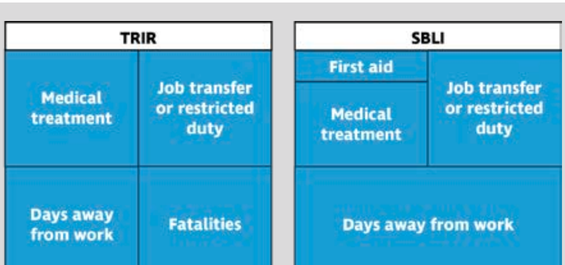
Weights derived from this study correspond directly to the average number of joules of energy associated with each severity level.

Injury severity level	Assigned weight
First aid (FA)	100
Medical treatment (MT)	500
Job transfer or restricted duty (JTR)	750
Days away from work (DAW)	1,500
Fatality (FT)	N/A

Note. Reprinted from "Severity-Based Lagging Indicator: Making the Best of Our Injury Data," by M.R. Hallowell & E.D. Oguz Erkal, Edison Electric Institute, 2023 (https://bit.ly/4c1u0Vz).

FIGURE 1

CONCEPTUAL FRAMEWORK FOR SBLI IN COMPARISON TO TRIR



monthly and was guided by two technical advisors and a program manager. The goal of this team was to define SBLI, select injury severity categories, quantify their relative weights, and test the new SBLI metric by collecting, sharing and pooling data for a 4-year period.

Definition & Structure of SBLI

SBLI is defined as an adjusted injury rate that weights injuries by their relative severity level and aggregates them into one number. Specifically, SBLI is a lagging indicator that uses a weighted sum method and the information typically reported on the OSHA 300 log to create an aggregated rate. The idea of weighting incidents based on their relative impact is not an entirely new concept. In fact, the original American Standard Method of Recording and Measuring Injury Experience (ASA Standard Z16.1-1954) included reference to weighting incidents by points assigned to various body parts affected and days of disability or total loss. The method presented in this article builds upon this early method by incorporating modern knowledge of energy transfer theory and aligning with standard OSHA recordkeeping.

Severity Categories

SBLI is predicated on the idea that injury cases should be weighted based on their relative impact. Thus, SBLI requires a clearly defined set of mutually exclusive severity levels. To ensure alignment with current incident recordkeeping, the injury categories and definitions from the OSHA 300 log were used. Table 1 explains the injury severity levels included in SBLI and presents the same definitions provided by OSHA (2002). Note that first aid cases are not recordable per OSHA recordkeeping requirements. However, since the partner utilities collected these data as defined by OSHA (n.d.b), these injury classes were included in the SBLI metric. The authors anticipate that consistency in first aid recordkeeping remains a significant limitation for SBLI at present, which must be addressed in the future to ensure that SBLI is comparable.

Selected Weights

The team's second key decision was to determine the relative weights of the selected severity levels. Creating relative weights numerically describes the relative impact of one severity level compared to the others. Therefore, weighting the severity levels required the team to answer questions such as "How many first aid injuries are equivalent to one job transfer case?" and "How many medical treatment cases are equal to a days-away-from-work case?"

To ground SBLI in scientific data rather than potentially divergent opinion, the team decided to weight each category based on the magnitude of physical energy typically associated with each severity level (measured in joules). These estimates were adapted from Hallowell et al. (2017), who found empirical evidence that the severity of an injury is directly associated with the magnitude of physical energy. Put simply, they found that more energy generally causes more harm, and that the thresholds of energy among injury severity levels can be quantified (Hallowell et al., 2017). This was found to be true across trades, geographies and hazard types. The weights derived from this study are presented in Table 2, which correspond directly to the average number of joules of energy associated with each severity level.

TABLE 3

DATA & METRIC COMPUTATIONS FOR COMPANY X

Sample shown for October 2020 through December 2021 (FA = first aid; MT = medical treatment; JTR = job transfer or restricted duty; DAW = days away from work).

Year	Month	Hours	FA	MT	JTR	DAW	TRIR	SBLI	12-month rolling SBLI	Average severity	12-month average severity
2020	Oct.	1,372,404	4	11	7	3	3.06	2.28	2.02	626	736
2020	Nov.	1,204,792	3	8	4	3	2.66	1.96	1.97	656	722
2020	Dec.	1,210,605	2	10	4	4	2.97	2.35	2.02	710	716
2021	Jan.	1,111,613	1	6	3	4	2.34	2.04	1.97	811	714
2021	Feb.	1,390,084	3	7	6	3	2.30	1.84	2.02	674	712
2021	March	1,358,667	3	7	7	4	2.50	2.22	2.08	717	713
2021	April	1,247,410	1	4	5	4	2.08	1.90	2.14	846	726
2021	May	1,266,310	1	6	7	3	2.53	2.03	2.21	756	723
2021	June	1,297,234	4	9	7	6	3.39	2.95	2.31	737	731
2021	July	1,226,443	4	7	6	2	2.45	1.86	2.25	600	723
2021	Aug.	1,214,605	4	3	3	4	1.65	1.67	2.13	725	723
2021	Sept.	1,247,748	3	4	6	6	2.56	2.53	2.14	832	724
2021	Oct.	1,229,700	2	4	5	5	2.44	2.19	2.13	841	742
2021	Nov.	1,340,905	1	6	7	4	2.54	2.14	2.14	797	754
2021	Dec.	1,123,707	2	5	5	4	2.49	2.22	2.13	778	759

Note. Reprinted from "Severity-Based Lagging Indicator: Making the Best of Our Injury Data," by M.R. Hallowell & E.D. Oguz Erkal, Edison Electric Institute, 2023 (https://bit.ly/4c1u0Vz).

The relative weights allow higher-severity and lower-severity, as it is a continuum rather than absolutes injuries in the aggregate SBLI rate, addressing a long-standing criticism of lagging indicators. For example, in TRIR a medical treatment case and a days-away-from-work case would count the same (each as one recordable). However, SBLI weights these injuries proportionally, counting a days-away-from-work case (assigned weight = 1,500) three times higher than a case involving only medical treatment (assigned weight = 500). For illustrative purposes, the conceptual framework for SBLI is compared to TRIR in Figure 1.

Intentional Exclusion of Fatalities

Through various robust discussions, the team unanimously and deliberately agreed not to include fatalities in the SBLI aggregation because of the inherent incompatibility of the weighting scheme and the philosophical implications of weighting a fatality relative to the other severity categories. In other words, including fatalities would have required consensus regarding the number of low-severity injuries that are equivalent to a fatality. During these discussions, the team contemplated questions such as "How many medical treatment injuries are equivalent to one life?" It was concluded that the weight of a fatality would be nearly infinite compared to the other injury categories, regardless of the energy level present. Therefore, including fatalities and their relative weight would make the SBLI metric binary (i.e., the relatively high weight of a fatality would make less-severe cases negligible). Although fatalities were not included, the team recommended tracking fatalities as a whole number count and reporting alongside SBLI.

Computing SBLI

SBLI is computed using a weighted sum method, which is a technique used in multicriteria decision-making to weigh and combine multiple inputs into a single number (Triantaphyllou, 2000). In the SBLI equation (Equation 1), the number of injuries for each severity level is multiplied by the weight for that category. Since all the weights are based on the same unit (energy in joules), the products can be summed to arrive at one aggregated number. The aggregate score is then divided by the number of worker hours amassed in the same reporting period. Finally, this number is multiplied by 200, which is simply a scalar value that produces a number that is easy to interpret but does not compromise comparability.

Equation 1:

$$SBLI = \frac{w_{fa} \cdot n_{fa} + w_{mt} \cdot \ n_{mt} \cdot + w_{jtr} \cdot n_{jtr} + w_{daw} \cdot n_{daw}}{e} \cdot c$$

where:

n_{fa} = the number of first aid cases during the reporting period

w_{fa} = the weight of a first aid case (w_{fa} = 100)

n_{mt} = the number of medical case incidents during the reporting period

w_{mt} = the weight of a medical case (w_{mt} = 500)

n_{jtr} = the number of job transfer or restricted cases during the reporting period

w_{jtr} = the weight of a job transfer or restricted case (w_{jtr} = 750)

n_{daw} = the number of days-away-from-work cases during the reporting period

w_{daw} = the weight of days-away-from-work cases (w_{daw} = 1,500)

e = the total number of worker hours amassed during the reporting period in worker hours

c = a standard scalar adjustment factor (c = 200)

By replacing the variable with the assigned weights and incorporating the scalar adjustment factor, the research team arrives at Equation 2. This equation is a simplified version of Equation 1.

Equation 2:

$$SBLI \ = \frac{100 \cdot n_{fa} + 500 \cdot \ n_{mt} \cdot + 750 \cdot n_{jtr} + 1500 \cdot n_{daw}}{e} \cdot 200$$

FIGURE 2
STANDARD TRIR TREND FOR COMPANY X

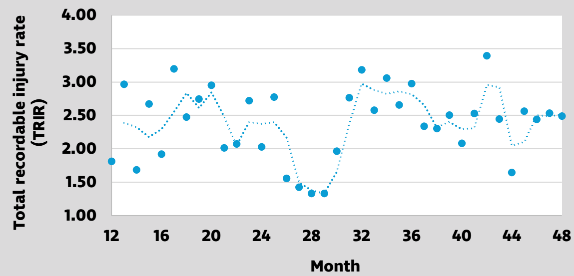


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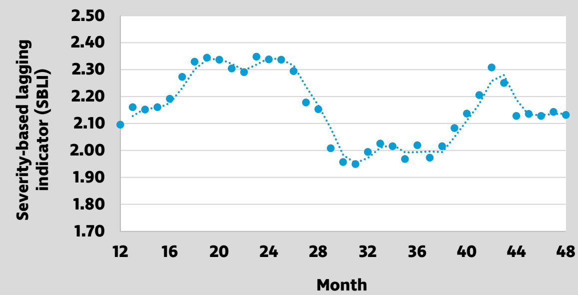
FIGURE 3
ROLLING 12-MONTH SBLI FOR COMPANY X



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Rolling Averages

Although SBLI includes first aid injuries, the total injury count in a monthly report is only marginally higher than other lagging indicators. To address this limitation, we use a rolling average so that more information is included in each monthly number. Rolling averages are often used to smooth data for a highly volatile metric such as stock prices and measures of product quality (Hunter, 1986). For example, if a 12-month rolling average is used, each month's SBLI value is averaged with the 11 months prior. The effect is a much more stable SBLI trend since short-term aberrations have limited influence. This method forces us to consider long-term trends rather than short-term aberrations.

Rolling averages are calculated by using Equation 3, which can be applied for SBLI or any other metrics that are regularly reported. Since Hallowell et al. (2021) found that most medium to large companies achieve statistical stability in approximately 1 year, a rolling 12-month average was used. Note that rolling averages for TRIR may produce trends that are similar to SBLI when first-aid injury counts are relatively low.

Equation 3:

$$Rolling\ average = \frac{\sum_{i=1}^{r} SBLI_i}{r}$$

where:
r = the rolling period in months
SBLI = the SBLI value for a given month of i

Case Example

To provide a full illustration of the SBLI method, a dataset was created for hypothetical Company X. The data for Company X was created by averaging the datasets from three randomly selected utilities represented by the team between 2018 and 2021. Table 3 (p. 23) provides a sample of the necessary data to enable SBLI computation and trending for Company X. The data includes monthly counts of injuries for each severity level and the number of worker hours amassed each month. Table 3 includes data for a 15-month period so the reader has enough information to perform the relevant computations presented in this article. For example, Table 3 includes the computed SBLI values to encourage the reader to apply Equations 2 and 3 to compute the 12-month rolling averages. Since computations of a 12-month rolling average require the SBLI data for the preceding 12 months, enough data are provided for the reader to compute the rolling average from September to December 2022 only. TRIR is included in Table 3 for reference, and it is calculated using the medical treatment, restricted duty or transfer, days away from work, and fatality cases per the OSHA definition. The entire dataset for the 3-year period amassed for Company X is not provided in the interest of brevity.

Visualizations

To visually illustrate SBLI trends and describe the potential intelligence that could be gathered through SBLI, the authors produced several graphs. First, the traditional TRIR for Company X are graphed for reference in Figure 2. As shown in Figure 1 (p. 22), this traditional approach produces a trend that is highly volatile and lacks statical trends or forecasting utility as observed by Hallowell et al. (2021). In contrast, Figure 3 illustrates 12-month rolling SBLI data based on the same dataset and the same period. The 12-month rolling SBLI provides a smoother curve that illuminates long-term trends. Note that the trends for SBLI are available for month 12 to 48 because the first 12 months of data are required to create the first observation for a rolling 12-month average. To demonstrate the rolling SBLI data in direct comparison to traditional TRIR, both graphs are provided for months 12 to 48. Although standard TRIR and a rolling average of SBLI are compared, a rolling average can also be applied to TRIR to smooth trends and decrease volatility.

Sector-Level Baseline & Reference Set

Metrics are only useful if they can be compared against a meaningful reference. Unlike TRIR and other traditional lagging indicators, no reference dataset existed for SBLI. Thus, the team members from EEI collected, reported and pooled SBLI data for a 48-month period between 2018 and 2021. This involved using a standardized template to report monthly counts of first aid, medical treatment, job restriction or transfer, days-away-from-work cases, and worker hours. The data were then

TABLE 4
DATA & METRIC COMPUTATIONS FOR THE EEI AVERAGE

Sample shown for October 2020 through December 2021 (FA = first aid; MT = medical treatment; JTR = job transfer or restricted duty; DAW = days away from work).

Year	Month	Hours	FA	MT	JTR	DAW	TRIR	SBLI	12-month rolling SBLI	Average severity	12-month average severity
2020	Oct.	1,622,099	10	5	3	5	1.50	1.55	1.94	559	638
2020	Nov.	1,401,691	8	3	3	4	1.38	1.41	1.82	567	618
2020	Dec.	1,388,573	7	3	1	6	1.51	1.73	1.73	676	608
2021	Jan.	1,393,193	8	3	3	4	1.47	1.56	1.75	584	612
2021	Feb.	1,476,108	10	3	2	4	1.33	1.47	1.75	553	613
2021	March	1,637,168	10	3	3	7	1.57	1.79	1.76	658	614
2021	April	1,606,733	9	3	2	8	1.56	1.90	1.80	710	620
2021	May	1,513,302	9	3	3	6	1.55	1.74	1.77	628	610
2021	June	1,501,293	12	4	2	7	1.69	1.94	1.78	595	609
2021	July	1,521,889	13	4	2	5	1.41	1.54	1.73	501	603
2021	Aug.	1,502,508	14	3	2	8	1.76	2.19	1.76	610	608
2021	Sept.	1,526,730	11	4	3	9	1.97	2.39	1.77	704	612
2021	Oct.	1,568,992	9	3	3	6	1.51	1.69	1.78	640	619
2021	Nov.	1,463,019	8	3	3	6	1.57	1.79	1.81	658	626
2021	Dec.	1,338,188	7	3	2	5	1.46	1.67	1.81	687	627

Note. Reprinted from "Severity-Based Lagging Indicator: Making the Best of Our Injury Data," by M.R. Hallowell & E.D. Oguz Erkal, Edison Electric Institute, 2023 (https://bit.ly/4c1u0Vz).

archived and aggregated to create the baseline referred to as the EEI average.

Data were received from 20 utility companies, which included a total of more than 1.6 billion worker hours; 11,000 first aid injuries, 4,000 medical treatment cases, 2,000 restricted duty or transfer cases, 7,000 days-away-from-work cases, and 20 fatalities. Table 4 presents a sample of the average EEI data for a 15-month period between October 2020 and December 2021. Figure 4 (p. 26) provides the rolling average for the Company X and the EEI average (reference set). As shown in Figure 4, Company X and EEI had similar trends for the first 32 months, after which time Company X had an SBLI value that was consistently higher. This comparison was shown to demonstrate how a company may use its SBLI and average severity metrics with respect to the industry average.

Average Severity: Complementary Method to Measure & Track Trends in Relative Severity

SBLI was formulated to be an alternative injury rate based on the concept that injuries should be weighted by their relative severity and aggregated into one number. However, the SBLI metric itself does not illuminate changes in the distribution of incidents across severity levels. If an organization observes a decrease in SBLI, it is not clear whether that decrease is from a relatively large reduction in low-severity incidents or a relatively small decrease in more severe injuries. For further inspection, it is worthwhile to track the average severity of the incidents that comprise SBLI. Using the same weighted sum method, Equation 4 can be used to compute average severity for a period. This equation represents average severity as the average number of joules of energy associated with an incident for the reporting period, which lends a degree of practical interpretability.

Equation 4:

$$Average\ severity = \frac{w_{fa} \cdot n_{fa} + w_{mt} \cdot n_{mt} \cdot + w_{jtr} \cdot n_{jtr} + w_{daw} \cdot n_{daw}}{(n_{fa} + n_{mt} + n_{jtr} + n_{daw})}$$

By replacing the variable with the assigned weights shown in Table 2 (p. 22), we arrive at Equation 5. The rolling average calculation methodology given in Equation 3 may also be applied to average severity.

Equation 5:

$$Average\ severity = \frac{100 \cdot n_{fa} + 500 \cdot n_{mt} \cdot + 750 \cdot n_{jtr} + 1{,}500 \cdot n_{daw}}{(n_{fa} + n_{mt} + n_{jtr} + n_{daw})}$$

Tracking average severity reveals trends in the distribution of incidents across severity categories. If the ratio of injury counts remains consistent across severity categories as originally conceived by Heinrich (1931), the average severity would remain relatively stable. However, if incidents in one severity category increase or decrease at a different rate than another, the ratios and average severity would change over time. The actual trends from EEI shown in Figure 4 (p. 26) indicate that the average severity is not stable and, therefore, the ratios of injuries across severity levels are not consistent.

Average severity allows us to inspect for differences even when the SBLI scores for two periods are similar. This is important because a company may observe different average severity scores even when the SBLI scores are the same. For example, the data in Table 5 (p. 26) show two contrasting periods. During Period A, there are a relatively high number of low-severity injuries and no high-severity injuries. During Period B, there are a few high-severity injuries and no low-severity injuries. Although the data for both periods result in a similar SBLI score, the average severity for Period B is more than 4 times greater than for Period A. Thus, average severity provides important contextual information that helps an analyst to better inspect and understand their data.

To inspect the trends in average severity, the data in Tables 3 and 4 are used to trend EEI and Company X, respectively. The rolling 12-month average severity is plotted in Figure 5 (p. 26). The average severity increased for the EEI dataset in the first 12 months recorded (from 2019

FIGURE 4
COMPARISON OF COMPANY X & EEI AVERAGE FOR A 12-MONTH ROLLING AVERAGE SBLI

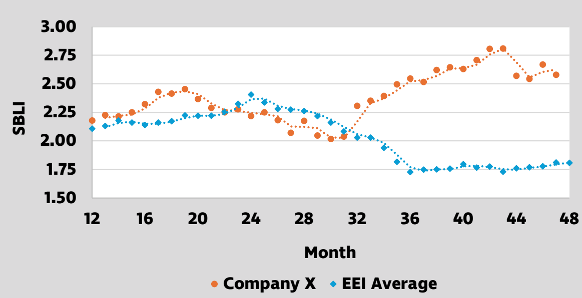

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FIGURE 5
12-MONTH ROLLING AVERAGE SEVERITY FOR COMPANY X & EEI

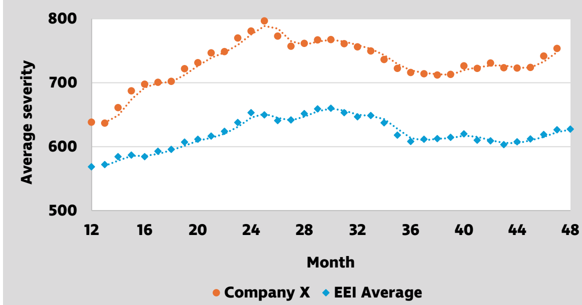

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TABLE 5
EXAMPLE DATA

Example showing data that produce similar SBLI but different average severity.

	Injury counts				Worker		Average
Period	***FA***	***MT***	***JTR***	***DAW***	**hours**	**SBLI**	**severity**
A	20	25	1	0	1,000,000	3.05	332
B	0	0	1	10	1,000,000	3.15	1,432

to 2020) and then stabilized and slightly decreased for the following 24 months (2020 to 2022). The observed trends prior to 2020 reflect the fact that the rate of less-severe injuries decreased while the rate of more-severe injuries plateaued (Hallowell, 2020). It is interesting that the average severity appears to have stabilized or decreased slightly since 2020, indicating that initiatives focused on serious injuries and fatalities may be translating to impact on long-term sector-level incident trends.

Tracking average severity is a helpful accompaniment to SBLI that provides complementary but different information using the same data and underlying computational approach.

Future State

In this first major baseline of SBLI, we learned that weighting injuries by their actual severity, rolling average over 12 months, and comparing the values against a substantial reference dataset produces more statistically stable and meaningful trends than the traditional lagging indicator approaches. In the future, SBLI may be improved by recording estimates of *actual* energy magnitude related in each injury. That is, the precise magnitude of each injury could be recorded in joules instead of categorizing incidents by severity level and applying an average weighting. This would yield an SBLI that is based on continuous data that represents the total magnitude of energy released over time. In this extension, near misses may also be included if the magnitude of energy released can be estimated. This maturation would involve moving from a binary classification of injuries (e.g., TRIR) to a categorical approach (SBLI) and eventually to a continuous monitoring of total energy release. Reaching this state would require consistent reporting and deployment of precise methods of estimating energy magnitude. In some ways, this initial version of SBLI may be seen as an imperfect beginning that paves a pathway to a more innovative metric as incident reporting continues to mature.

Limitations of SBLI

SBLI is a philosophical and statistical improvement over traditional lagging indicators, but it is still a lagging indicator that is subject to many of the same limitations as traditional metrics. For example, it is retrospective and likely to encourage reactive behavior. Additionally, as an injury rate, using SBLI to make comparisons is based on an inherent assumption that safety is simply the absence of injuries. Also, as with nearly all comparative safety metrics, SBLI is vulnerable to manipulation and underreporting (Pedersen et al., 2012). In fact, SBLI may be more vulnerable to reporting issues and case manipulation than TRIR because reporting first aid injuries is not mandated, and reporting is likely to be inconsistent. OSHA defines first aid incidents, but refinement, calibration and standardization are still required. Finally, SBLI is more complicated to describe than TRIR, perhaps making it more challenging for some to communicate or understand than traditional indicators.

Conclusion

Lagging indicators such as TRIR have been the dominant safety performance metrics for nearly 50 years. Although they are standard, objective and easy to understand, traditional lagging indicators suffer from severe philosophical and statistical limitations that render them invalid for making important business decisions. At the same time, lagging indicators are important because they describe the extent to which employees were actually injured. Thus, lagging indicators must be used in a way that is meaningful and valid and in combination with complementary metrics such as leading indicators.

SBLI is introduced to address some of the limitations of traditional lagging indicators. By weighting injuries by their relative severity, SBLI addresses the longstanding limitation of TRIR where all recordable injuries are counted as the same. Furthermore, including first aid injuries and rolling SBLI over 12 months produced more statistically stable and meaningful trends. Although SBLI addresses some weaknesses, there are trade-offs. SBLI is more complex to explain and understand, and reporting associated with first aid injuries may be inconsistent due to the lack of government-mandated reporting requirements. Thus, some may prefer traditional lagging indicators to SBLI.

The authors believe that lagging indicators will play an important role in measuring and improving safety in the future. However, lagging indicators only tell part of the story. To be effective, a selected lagging indicator should be valid and meaningful and used in concert with other metrics and monitoring variables. When used correctly, SBLI may help to illuminate the relationships between leading indicators, short-term observations and long-term outcomes. **PSJ**

Acknowledgments

The authors acknowledge the Edison Electric Institute (EEI) for supporting, coordinating and staffing this project. The authors also acknowledge the vital contributions made by professional members of the team.

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Matthew R. Hallowell is the executive director of the Construction Safety Research Alliance. He is also a President's Teaching Scholar and an endowed professor of construction engineering at the University of Colorado. Outside academia, he is the founder and executive director of Safety Function LLC, and serves as a technical advisor to the Edison Electric Institute (EEI) and Interstate Natural Gas Association of America. Hallowell is a professional member of ASSP's Rocky Mountain Chapter.

Elif Deniz Oguz Erkal is a senior associate in the construction consulting practice of Exponent. She has a Ph.D. in Construction and Engineering Management from University of Colorado Boulder specializing in safety performance measurement and predictive analytics for serious injury and fatality prevention. She focuses on data and knowledge management systems, operational implementation of predictive analytics, organizational design, and change in various industries including utilities and construction.

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