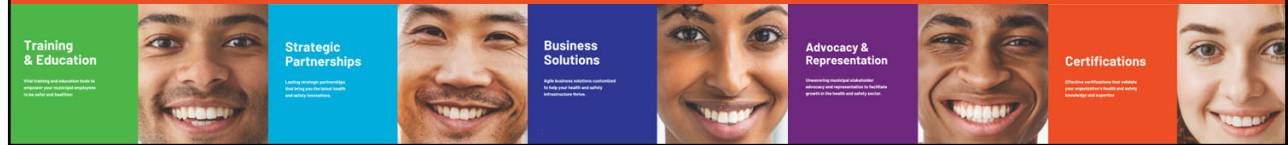




# Measuring Safety Performance

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November 29, 2022



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## How has TRIR been used?

$$\text{TRIR} = \frac{\text{Number of Recordable Incidents} \times 200,000}{\text{Number of Worker-Hours}}$$

- Measure, track, and report 'safety performance'
- Benchmark against peers
- Compare business units
- ***Pre-qualify and select contractors***
- ***Performance evaluations and incentives***



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## Assumptions that we make

- The observed TRIR is the one and only outcome that the safety system could produce.
- When TRIR goes up or down over a period of time, that is due to good or bad safety management.
- Those with lower TRIR have better safety management.
- Past TRIR predicts future TRIR.



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### Company A

Has a recordable incident in the first 1,000 worker-hours that they are in business. At this point, their TRIR is 200 per 200,000 worker-hours.

- *Is this possible?*
- *Is this meaningful?*
- *What would we expect from this business in the future?*



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**Company B**

Has 7 recordable incidents over 980,000 worker-hours in a given year. They report their yearly TRIR as 1.4 per 200,000 worker-hours.

**Company C**

Has 24 recordable incidents over 6,000,000 worker-hours in a given year. They report their yearly TRIR as 0.8 per 200,000 worker-hours.

- *Is company C better than Company B?*
- *Would we expect their performance to be different in the future?*
- *Should we select one over the other?*






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## Searching for hard facts


Given the way it is used, ***to what extent is TRIR a statistically valid metric?***


1. To what extent is TRIR stable/random?
2. Is TRIR predictive?
3. How many worker hours do we need before TRIR becomes meaningful?
4. How do we correctly interpret TRIR?
5. How do we compare two injury records?


  
Dr. Matthew Hallowell

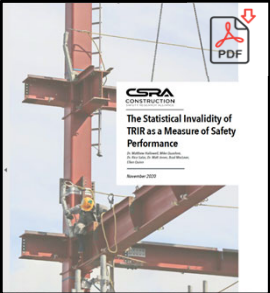
  
Dr. Rico Salas


  
Brad MacLean

  
Mike Quashue

  
Dr. Matt Jones

  
Ellen Quinn





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## Initial Analysis

- Generalized Linear Modeling

$$Y_i = \beta_0 + \beta_1 X_i + \epsilon_i$$

Labels for the equation:
 

- Dependent Variable:  $Y_i$
- Population Y intercept:  $\beta_0$
- Population Slope Coefficient:  $\beta_1$
- Independent Variable:  $X_i$
- Random Error term:  $\epsilon_i$
- Linear component:  $\beta_0 + \beta_1 X_i$
- Random Error component:  $\epsilon_i$

- Monte Carlo Simulations



17 YEARS OF



DATA &

TRILLION  
WORKER HOURS

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## What did we find?

- TRIR is not predictive of future TRIR
- TRIR is not predictive of fatalities
- TRIR is approximately 98% random

17 YEARS OF



DATA &

TRILLION  
WORKER HOURS

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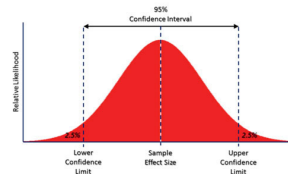
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## What does that mean?

Statistically, TRIR is almost the same as spinning a roulette wheel

- Each worker hour is like a spin of a wheel
- Each worker hour is independent
- The chance of an incident in any one worker-hour is low
- The outcome of one worker hour has no bearing on the next
- You don't have negative or partial incidents



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***TRIR should not be reported as a single, precise number.***

***TRIR must be reported as a range within a confidence interval.***

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Precision	TRIR	Worker-Hours
0.5	0.20	3,197,046
0.5	0.40	5,357,737
0.5	0.60	7,682,889
0.5	0.80	10,068,588
0.5	1.00	12,481,762
0.5	1.25	15,517,884
0.5	1.50	18,566,029
0.5	1.75	21,621,176
0.5	2.00	24,680,748
0.5	3.00	36,941,358

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Precision	TRIR	Worker-Hours
0.1	0.20	62,409,083
0.1	0.40	123,404,751
0.1	0.60	184,709,031
0.1	0.80	246,092,232
0.1	1.00	307,507,116
0.1	1.25	384,297,072
0.1	1.50	461,099,608
0.1	1.75	537,909,256
0.1	2.00	614,723,280
0.1	3.00	922,000,301






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**TRIR**

	0.1	0.2	0.5	1.0	1.5	2.0	3.0
<b>100K</b>	0.00 - 7.68	0.00 - 7.68	0.00 - 7.68	0.00 - 7.68	0.00 - 7.68	0.35 - 11.33	0.35 - 11.33
<b>250K</b>	0.00 - 3.07	0.00 - 3.07	0.00 - 3.07	0.14 - 4.53	0.14 - 4.53	0.44 - 5.83	0.82 - 7.06
<b>500K</b>	0.00 - 1.54	0.00 - 1.54	0.07 - 2.27	0.22 - 3.02	0.41 - 3.53	0.85 - 4.68	1.36 - 5.78
<b>1M</b>	0.00 - 0.77	0.04 - 1.13	0.11 - 1.41	0.43 - 2.34	0.68 - 2.89	1.09 - 3.68	1.82 - 4.95
<b>2.5M</b>	0.01 - 0.45	0.04 - 0.58	0.22 - 1.05	0.55 - 1.68	0.91 - 2.28	1.35 - 2.95	2.15 - 4.08
<b>5M</b>	0.02 - 0.29	0.09 - 0.47	0.27 - 0.84	0.68 - 1.48	1.07 - 2.04	1.52 - 2.64	2.39 - 3.76
<b>10M</b>	0.04 - 0.23	0.11 - 0.37	0.34 - 0.74	0.76 - 1.32	1.20 - 1.88	1.64 - 2.43	2.56 - 3.52

**WORKER-HOURS**



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## Lets Revisit the Cases

**Company A**

Has a recordable incident in the first 1,000 worker-hours that they are in business.

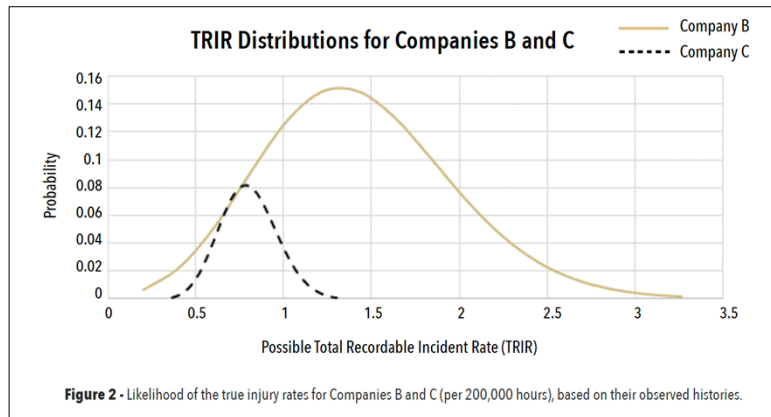
TRIR range: 35.31 to 1,125.51 per 200,000 worker-hours.

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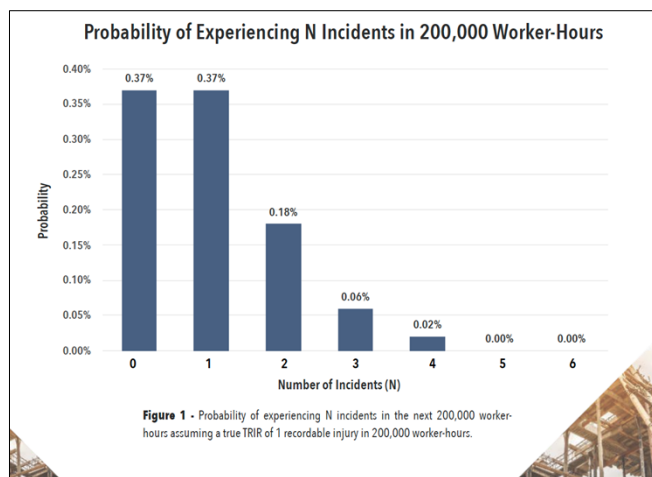
**Company B – 7 recordables over 980,000 w-h. (1.43)**  
**Company C – 24 recordables over 6 million w-h (0.80)**



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**Past → 1 injury in 200,000 w-h**

**Future →**



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## Key Findings

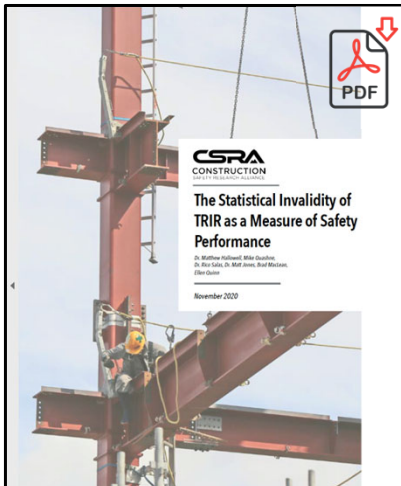
### TRIR

- is almost entirely random
- cannot be represented as a single number
- is not precise and should not be communicated to several decimal points
- is predictive only over very long time periods (100+ months)
- does not predict fatalities

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## What Does This Mean?



- TRIR should not be used to compare companies, business units, or projects
- TRIR should not be used for performance evaluations or incentives
- TRIR should be reported as a range, not a number
- TRIR is not a proxy for fatalities

***• New approaches to safety measurement are needed!***

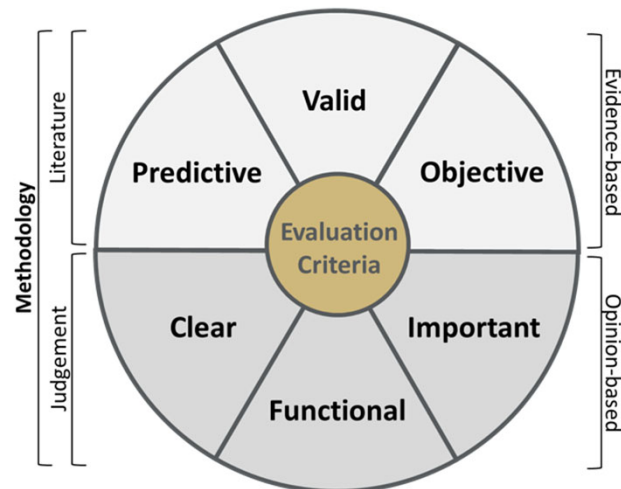
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## Attributes of a good metric



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# TRIR

- Consistently and clearly defined by the industry (*clear*)
- Based on counts over time (*objective*)
- Directly reflects a consequential outcome (*important*)
- Evidence that it is not predictive (*predictive*)
- Incidents are too rare to be statistically meaningful (*valid*)
- Not useful for preventing future incidents (*functional*)

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# Safety Leading Indicators

- Empirically linked to future performance (*predictive*)
- Can be generated with desired frequency and volume (*valid*)
- Based on counts over time (*objective*)
- Does not include quality (*important*)
- Requires significant resources (*functional*)
- Inconsistently applied across companies (*clear*)

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## Safety Climate

- Empirically linked to future performance (*predictive*)
- Can be generated with desired frequency and volume (*valid*)
- Based on counts over time (*objective*)
- Based on opinion and satisfaction (*objective*)
- Requires significant resources (*functional*)
- Inconsistently applied across companies (*clear*)

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## Other Existing Metrics Evaluated

Near Miss Rate	First Aid Rate
Fatality Rate	DART

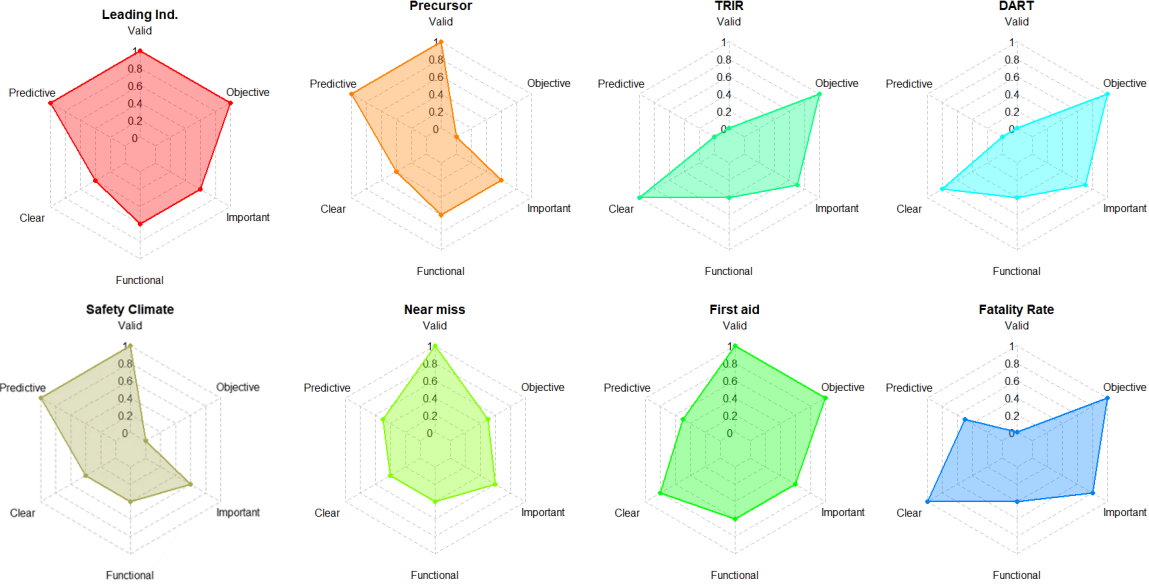
Counts of incidents with different thresholds of severity over time

**Precursor Analysis**

Trends in validated precursors observed in field safety engagements

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# Comparisons among Existing Metrics



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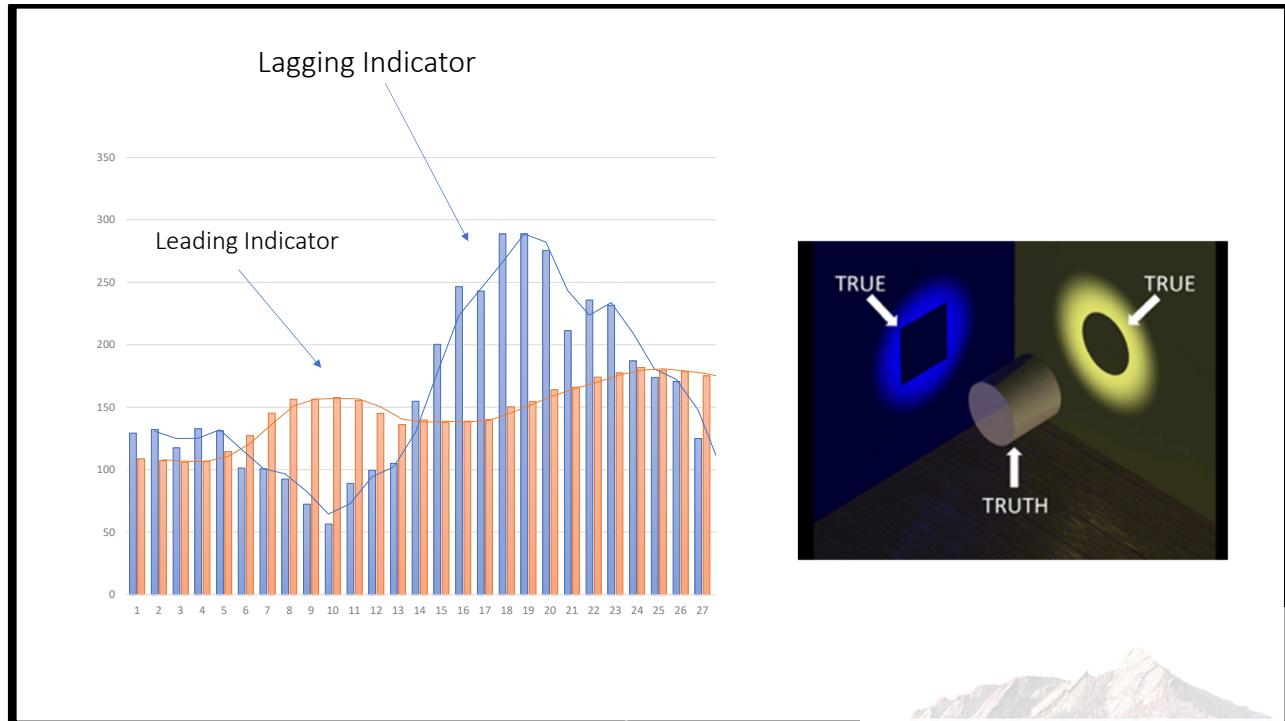
**Our metrics should tell a story about the progress we are making toward our vision**



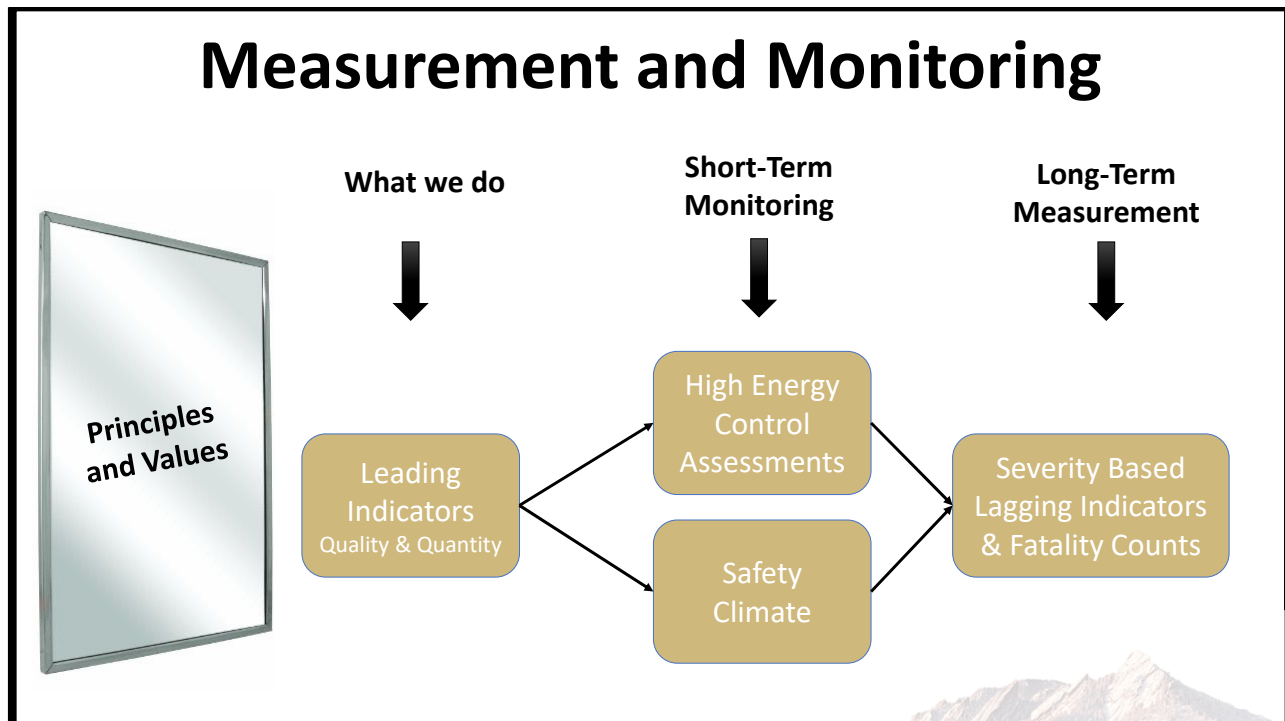
**A number by itself does not tell a story, it motivates reaction.**



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## Key Recommendation

*To counterbalance TRIR, we must standardize our alternative metrics.*



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## Key Recommendation

*We must take an active role in promoting new metrics, and we must work together as a community.*



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