# The Construction Safety Threat Assessment and Reporting (C-STAR) Framework: A Severity-Based Risk Scoring Model Using OSHA Severe Injury Reports

Christopher J. Rabe[1]

[1]Department of Interdisciplinary Engineering the University of Alabama at Birmingham Birmingham, Alabama, United States

Publication Date: 2026/02/11

**Abstract:**

- ***Background:***

**OSHA's Severe Injury Reporting (SIR) program captures high-severity construction outcomes such as in-patient hospitalization and amputation. However, prevention prioritization commonly relies on incident counts that do not simultaneously represent injury severity, persistence of hazard mechanisms, and access-context conditions related to enforcement and training resources.**

- ***Methods:***

**This paper presents the Construction Safety Threat Assessment and Reporting (C-STAR) framework—an interpretable severity-based scoring model that converts each SIR record into an incident-level Severe Incident Safety Score (SISS) by summing three factors: OSHA Regulatory Compliance context (ORC), Hazard Incident Severity (HIS), and Hazard Recurrence Probability (HRP). Incident scores are further aggregated to compute a regional-level Regional Safety Risk Score (RSRS) for comparative profiling.**

- ***Results:***

**C-STAR defines transparent subfactor rules and fixed score ranges, producing interpretable outputs suitable for ranking, tiering, and sensitivity testing by varying scoring assumptions using secondary data only.**

- ***Conclusions:***

**C-STAR provides a replicable decision-support approach for translating severe injury surveillance into structured risk scoring for prioritization and planning. GIS-based visualization is an optional downstream application of these GIS-ready outputs rather than a required component of the framework.**

***Keywords:*** *C-STAR; Severe Injury Reports; Construction Safety; Risk Scoring; Focus Four; Recurrence; ORC; HIS; HRP; SISS; RSRS.*

**How to Cite:** Christopher J. Rabe (2026) The Construction Safety Threat Assessment and Reporting (C-STAR) Framework: A Severity-Based Risk Scoring Model Using OSHA Severe Injury Reports. *International Journal of Innovative Science and Research Technology*, 11(2), 273-280. https://doi.org/10.38124/ijisrt/26feb010

## I. INTRODUCTION

Construction remains among the highest-risk sectors for severe occupational harm, with high-consequence incidents producing substantial human and economic costs across the United States. Despite advances in safety management, serious injury outcomes persist and continue to cluster around recurring hazard mechanisms. In practice, prevention strategies frequently emphasize the Focus Four hazards—falls, struck-by events, caught-in/between incidents, and electrocutions—because these mechanisms are consistently associated with catastrophic outcomes and remain central targets of construction safety interventions. [1]

A persistent challenge, however, is that severe injury surveillance is increasingly available while prioritization often remains count-based. Incident counts are useful for describing volume, but they can unintentionally treat severe

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26feb010

events as equivalent even when meaningful differences exist in outcome severity, recurrence of hazard mechanisms, and contextual access conditions that influence prevention capacity. As a result, decision makers may struggle to translate severe injury surveillance into structured, comparable signals for planning and prioritization. [2]

OSHA's Severe Injury Reporting (SIR) program provides incident-level records for specified high-severity outcomes such as in-patient hospitalizations and amputations. These reports provide a valuable opportunity to examine severe harm patterns beyond minor injury datasets. Yet, without a standardized scoring structure, SIR records may be reviewed as narrative lists or summarized only by totals, limiting their usefulness for comparative profiling across locations, time windows, and hazard categories. [3]

➢ *Need for Severity-Based Decision Support*

A severity-based scoring approach can improve interpretability by jointly representing: (1) severity of the outcome, (2) persistence of high-consequence hazard mechanisms within defined contexts, and (3) access-context indicators that approximate enforcement and training reach. Importantly, C-STAR is designed as a decision-support framework rather than a causal model; it is intended to organize surveillance signals into interpretable scores that can be compared and communicated. [4]

➢ *Purpose of the Present Study*

This paper introduces the Construction Safety Threat Assessment and Reporting (C-STAR) framework, an interpretable severity-based risk scoring model designed for secondary analysis of OSHA SIR data. The paper defines the scoring architecture and the subfactors that compose the three core factors—OSHA Regulatory Compliance context (ORC), Hazard Incident Severity (HIS), and Hazard Recurrence Probability (HRP)—and explains how these factors generate two outputs: the incident-level Severe Incident Safety Score (SISS) and the aggregated Regional Safety Risk Score (RSRS).

## II. FRAMEWORK OVERVIEW

The Construction Safety Threat Assessment and Reporting (C-STAR) framework is a severity-based, rule-driven scoring model that converts OSHA Severe Injury Reporting (SIR) records into standardized, interpretable risk metrics for comparative profiling and prioritization. C-STAR is designed specifically for secondary analysis and emphasizes transparency through an additive scoring structure with explicit factor ranges, ordinal subfactor scales, and clearly documented calculation rules. This structure is intended to support interpretability, replicability, and sensitivity testing by allowing analysts to vary scoring assumptions (e.g., access proxies or classification thresholds) without requiring primary data collection. [5]

➢ *Core Scoring Relationship*

C-STAR computes an incident-level score by summing three factors:

- Factor 1: OSHA Regulatory Compliance context (ORC), score range 3–9
- Factor 2: Hazard Incident Severity (HIS), score range 2–5
- Factor 3: Hazard Recurrence Probability (HRP), score range 1–10

Together, these factors produce an incident-level SISS score range of 6–24

➢ *Two Primary Outputs*

- Incident-level output: SISS, computed for each SIR record.
- Regional output: RSRS, computed by aggregating SISS values within a defined reporting geography (e.g., region) to support ranking and tiering.

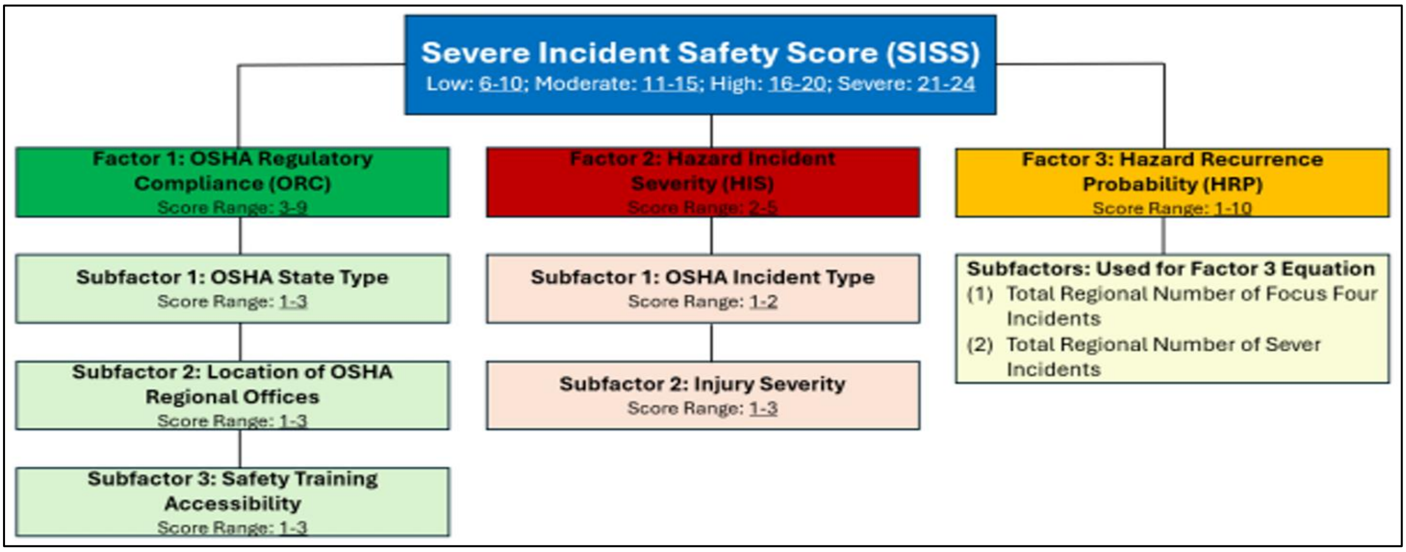


Fig 1 C-STAR Scoring Architecture and Subfactor Structure Used to Compute SISS (ORC + HIS + HRP) and Interpret Score Tiers.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26feb010

## III. FACTOR EQUATIONS AND SUBFACTOR RULES

➤ *Factor 1: OSHA Regulatory Compliance context (ORC)*

ORC represents an access-context indicator designed to reflect conditions related to regulatory environment and practical access to enforcement and training resources. ORC is computed as the sum of three ordinal subfactors, each scored on a 1–3 scale: [6]

- Subfactor 1: OSHA State Type (1–3)
- Subfactor 2: Location of OSHA Regional Offices (1–3)
- Subfactor 3: Safety Training Accessibility (1–3)

➤ *The ORC Factor is Calculated as:*

- ORC = OSHA State Type + Location of OSHA Regional Office + Safety Training Accessibility
- ORC score range: 3–9

**Equation for Factor 1: OSHA Regulatory Compliance (ORC)**
OSHA State Type + Location of OSHA Regional Office + Safety Training Accessibility = <u>OSHA Regulatory Compliance (ORC)</u>

<u>Example:</u>
OSHA State Type (3) + OSHA Regional Office is within 10 miles (1) + Safety Training Accessibility is 14% (2) = <u>6 ORC Score</u>

Fig 2 ORC Equation and Worked Example for Factor 1 (Score Range 3–9).

Table 1 C-STAR Factors, Scoring Intent, and Score Ranges.

| Factor | Scoring intent | Subfactor structure | Score range |
|---|---|---|---|
| ORC | Access-context indicator (regulatory and training reach) | 3 ordinal subfactors (1–3 each) | 3–9 |
| HIS | Severity differentiation (mechanism + outcome severity) | 2 ordinal subfactors (1–2; 1–3) | 2–5 |
| HRP | Hazard mechanism recurrence tendency within an analytic unit | Ratio-based recurrence scaled to 1–10 | 1–10 |
| SISS | Incident-level composite score | ORC + HIS + HRP | 6–24 |
| RSRS | Regional composite score | Mean of SISS within geography | 6–24 |

Table 2 ORC Subfactors, Scoring Intent, and Ordinal Scoring Scale (1–3)

| ORC subfactor | Scoring intent | Score = 1 (Lower access) | Score = 2 (Moderate access) | Score = 3 (Higher access) |
|---|---|---|---|---|
| **Subfactor 1: OSHA State Type** | Represent differences in regulatory oversight structure that may influence enforcement reach and compliance support. | Federal OSHA state (no approved State Plan). | Approved State Plan present. | State Plan with stronger program maturity / greater implementation capacity (long-established). |
| **Subfactor 2: Location / Proximity to OSHA Offices** | Approximate geographic access to enforcement and compliance assistance resources. | High travel burden to nearest OSHA office (farthest tier). | Moderate travel burden (middle tier). | Low travel burden (closest tier). |
| **Subfactor 3: Safety Training Accessibility** | Approximate access to OSHA-authorized outreach training capacity within the reporting area. | Limited trainer availability (few or none). | Moderate trainer availability. | High trainer availability (multiple trainers / strong presence). |

➤ *Factor 2: Hazard Incident Severity (HIS)*

HIS differentiates severe incidents based on the hazard mechanism category and the injury outcome severity category. HIS is computed as the sum of two ordinal subfactors: [7]

- *Subfactor 1:* OSHA Incident Type (1–2) *(e.g., Focus Four vs non–Focus Four)*
- *Subfactor 2:* Injury Severity (1–3) *(e.g., hospitalization, amputation, loss of eye—aligned to your rubric)*

➤ *The HIS Factor is Calculated as:*

- HIS = OSHA Incident Type + Injury Severity
- HIS score range: 2–5

**Equation for Factor 2: Hazard Incident Severity (HIS)**
OSHA Incident Type + Injury Severity = <u>Hazard Incident Severity (HIS) Score</u>

<u>Example:</u>
Focus Four Hazard (2) + Amputation (3) = <u>5 ORC Score</u>

Fig 3 HIS Equation and Worked Example for Factor 2 (Score Range 2–5).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26feb010

Table 3 HIS Subfactors and Scoring Categories (Incident Type 1–2; Injury Severity 1–3).

| HIS subfactor | Category | Score |
|---|---|---|
| *Subfactor 1 (SF1): OSHA Incident Type* | Non–Focus Four hazard | 1 |
| | Focus Four hazard | 2 |
| *Subfactor 2 (SF2): Injury Severity* | None or on-site first aid | 1 |
| | Hospitalization | 2 |
| | Amputation | 3 |

➢ *Factor 3: Hazard Recurrence Probability (HRP)*

HRP represents the persistence of Focus Four hazard mechanisms within a defined reporting geography. Unlike ORC and HIS (incident-level ordinal sums), HRP is calculated using a recurrence proportion scaled to a 1–10 range using a normalization multiplier. [8]

➢ *HRP Uses Two Regional Quantities:*

- Total regional number of Focus Four incidents
- Total regional number of severe incidents

➢ *The HRP Factor is Calculated as:*

- HRP = (Total Regional Focus Four Incidents ÷ Total Regional Severe Incidents) × 10
- HRP score range: 1–10

Because HRP is derived from a ratio, HRP may yield a decimal value (e.g., 5.8). For reporting consistency, HRP may be reported to one decimal place (recommended), with the same convention applied throughout SISS and RSRS reporting.

**Equation for Factor 3: Hazard Recurrence Probability (HRP)**

$$\frac{\text{Total Regional Number of Focus four Incidents}}{\text{Total Regional Number of Severe Incidents}} \times 10 = \text{Hazard Recurrence Probability (HRP) Score}$$

Example:

$$\frac{\text{50 Focus Four Regional Incidents}}{\text{80 Total Regional Incidents}} \times 10 = \text{5.8 HRP Score}$$

Fig 4 HRP Equation and Worked Example for Factor 3 (Score Range 1–10).

Table 4 HRP Inputs, Calculation Steps, and Reporting Rules.

| Component | Definition / input | How it is used | Example value |
|---|---|---|---|
| *Input 1: Total regional Focus Four incidents* | Count of severe incidents in the region classified as Focus Four hazards (falls, struck-by, caught-in/between, electrocutions). | Used as the numerator in the HRP ratio. | 50 |
| *Input 2: Total regional severe incidents* | Total count of OSHA severe incidents in the same region (all hazard types) for the analysis period. | Used as the denominator in the HRP ratio. | 80 |
| *Scaling multiplier* | Constant multiplier used to normalize the recurrence proportion to a 1–10 scale. | Multiply the ratio by 10 to produce the HRP score range. | 10 |

➢ *Core Outputs*

- *Incident-Level Output: Severe Incident Safety Score (SISS)*

The Severe Incident Safety Score (SISS) is the primary incident-level output of the C-STAR framework. SISS is calculated for each OSHA severe injury record and is designed to provide a consistent, interpretable index that combines (1) regulatory and training access-context conditions, (2) incident severity, and (3) the recurrence tendency of Focus Four hazards within the reporting geography. By using an additive structure, the model preserves transparency and enables direct inspection of how each factor contributes to the final score. [5]

SISS is the incident-level index produced for each OSHA severe injury record. It is computed as a direct sum of the three factors:

- ✓ SISS = ORC + HIS + HRP
- ✓ SISS score range: 6–24

Because HRP is calculated as a proportional measure scaled to a 1–10 metric, HRP values may produce decimals. When HRP yields a decimal, SISS may also be reported to one decimal place (e.g., 16.8). Reporting SISS in this manner preserves the proportional contribution of hazard recurrence while maintaining the interpretability of the final score.

SISS values can be grouped into ordinal severity tiers to support practical interpretation and comparative profiling. These tiers are intended to function as decision-support categories for planning and prioritization rather than as clinical or causal classifications.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26feb010

**Equation for Severe Incident Safety Score (SISS)**
Factor 1: OSHA Regulatory Compliance (ORC) + Factor 2: Hazard Incident Severity (HIS) + Factor 3: Hazard Recurrence Probability (HRP) = Severe Incident Safety Score (SISS)

Example:
6 ORC Score + 5 HIS Score + 5.8 HRP Score = 16.8 SISS

Fig 5 SISS Equation and Worked Example (ORC + HIS + HRP → SISS).

Table 5 SISS Risk Level Thresholds and Interpretation (Low–Severe).

| Numerical index | SISS: risk level | SISS: score range | Interpretation |
|---|---|---|---|
| **1** | **Low** | **6–10.9** | Incidents reflect lower composite risk, indicating more favorable compliance context, lower incident severity, and lower recurrence contribution. |
| **2** | **Moderate** | **11–15.9** | Incidents reflect moderate composite risk, typically indicating higher severity and/or recurrence contribution relative to Low cases. |
| **3** | **High** | **16–20.9** | Incidents reflect high composite risk, indicating elevated severity and/or stronger recurrence contribution, with less favorable access-context conditions in some cases. |
| **4** | **Severe** | **21–24** | Incidents reflect the highest composite risk, indicating persistent high severity and strong recurrence contribution, often requiring urgent prevention attention and targeted intervention. |

➢ *Regional Output: Regional Safety Risk Score (RSRS)*

The Regional Safety Risk Score (RSRS) is the primary aggregated output of the C-STAR framework. RSRS summarizes incident-level severity-based risk within a defined reporting geography by averaging Severe Incident Safety Score (SISS) values across all severe incidents recorded in that region. This approach supports standardized comparison across regions by emphasizing severity-weighted risk patterns rather than relying only on incident counts. [9]

- *RSRS is Calculated as:*

✓ *RSRS = average (SISS) for incidents within a region*

*When statewide benchmarking is needed, an overall state RSRS value may be calculated by averaging RSRS values across regions. RSRS supports ranking, tiering, and comparative profiling by highlighting where severe incidents collectively reflect higher composite risk, including severity and recurrence tendencies, within the framework's scoring structure.*

**Equation for Regional Safety Risk Score (RSRS)** = Total Average of Severe Incident Safety Scores for each region
**Overall State RSRS value is calculated by averaging the RSRS scores for each region.

Fig 6 RSRS Aggregation Concept (Regional Average of SISS Values).

## IV. DATA SOURCE AND MODEL INPUTS

C-STAR is designed for secondary analysis and can be implemented using publicly available or requested OSHA Severe Injury Reporting (SIR) records. The SIR program captures high-consequence outcomes and provides a consistent foundation for severity-based scoring because reports are triggered by specified severe events, rather than by minor injuries or near misses. For C-STAR implementation, the minimum required inputs include the severe outcome category and sufficient incident detail (structured fields and/or narrative text) to support hazard mechanism coding. Because SIR records may vary in completeness, analysts should explicitly document the outcome categories included (e.g., in-patient hospitalization and amputation) and describe any standardized rules used to address missing values, narrative ambiguity, repeated entries, or inconsistent text descriptions across reports. Clear documentation at the input stage is essential because C-STAR is rule-driven and interpretable; the credibility of the resulting scores depends on transparent data handling decisions. [10]

➢ *Hazard Mechanism Classification*

C-STAR uses hazard mechanism classification to compute Hazard Incident Severity (HIS) and Hazard Recurrence Probability (HRP). Classification typically relies on a combination of (1) structured SIR fields (when available) and (2) short narrative descriptions. A practical and replicable approach begins with a two-tier classification structure: [7]

- *Tier 1 (Primary Classification):*

✓ Focus Four hazards (falls, struck-by, caught-in/between, electrocutions)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26feb010

- ✓ Non–Focus Four hazards (all other mechanisms)

- *Tier 2 (Optional Refinement when Detail Allows):*

- ✓ Mechanism-specific categories (e.g., fall-from-elevation vs. same-level fall; struck-by falling object vs. vehicle; caught-in machinery vs. caught-between objects)

This two-tier method preserves comparability across records while allowing additional detail where narratives support it. Because classification affects both severity interpretation (HIS) and recurrence estimates (HRP), implementations should report the coding rubric used, identify decision rules for ambiguous narratives, and provide a small set of example classifications as a transparency check. Where multiple coders are used, it is recommended that the process include a short reconciliation step to reduce misclassification and improve consistency.

➢ *Analytic Unit and Time Window*

The regional output, Regional Safety Risk Score (RSRS), depends on the selected analytic unit, which defines how incident scores are grouped for comparison. Common units include counties, multi-county regions, or OSHA reporting geographies. The analytic unit selection should reflect the intended decision-use case (e.g., local prioritization vs. regional planning) and should be explicitly stated because it influences RSRS interpretation. [9]

Similarly, HRP depends on the chosen analysis time window, because recurrence is a time-dependent property. Short windows may emphasize immediate clustering, while longer windows may capture persistent hazard patterns. For this reason, C-STAR implementations should report the HRP recurrence window and, when feasible, examine sensitivity by comparing results across at least two time windows (e.g., a shorter and a longer period). These design choices do not change the framework structure, but they can change recurrence strength and therefore shift both SISS and RSRS distributions. Transparent reporting of analytic unit and time window supports replicability and strengthens interpretation of regional comparisons.

## V. OUTPUTS AND REPORTING

➢ *Severe Incident Safety Score (SISS)*

The Severe Incident Safety Score (SISS) is the incident-level composite index computed for each OSHA Severe Injury Reporting (SIR) record. SISS integrates three conceptually distinct components—regulatory and training access-context (ORC), incident severity differentiation (HIS), and recurrence tendency of Focus Four mechanisms within the selected analytic unit (HRP). SISS is reported as a direct sum and retains a fixed interpretive range. [5]

SISS reporting should include: (1) the final SISS value, (2) the component factor scores (ORC, HIS, HRP), and (3) the assigned risk tier based on the established thresholds (Low, Moderate, High, Severe). When HRP produces a decimal, SISS may be reported to one decimal place to preserve the proportional contribution of recurrence while maintaining interpretability and consistency across records. SISS is intended for decision-support profiling and comparative interpretation; it is not a causal estimator and should not be interpreted as a probabilistic prediction of injury occurrence.

➢ *Regional Safety Risk Score (RSRS)*

The Regional Safety Risk Score (RSRS) is the primary aggregated output and summarizes severity-weighted risk within a defined reporting geography by averaging SISS values across incidents in that unit. RSRS supports comparative profiling across regions by reflecting the combined influence of severity differentiation and recurrence, rather than relying only on incident counts. For reporting clarity, RSRS should be presented alongside the incident count (n) in each analytic unit to contextualize stability and interpretive confidence.

In comparative reporting, RSRS can be used to rank analytic units and assign tier categories using the same interpretive logic applied to SISS. Where incident volumes vary substantially across units, reporting may include basic distribution summaries (e.g., range or standard deviation of SISS) to support interpretation of whether elevated RSRS reflects broadly elevated incident-level risk or concentration among a smaller subset of high-severity incidents.

➢ *Optional Downstream Visualization*

GIS-based visualization may be applied as a downstream reporting approach to communicate RSRS patterns spatially (e.g., choropleth mapping or hotspot overlays). However, GIS is not required for C-STAR implementation and does not alter the scoring structure; it functions only as an optional presentation method for summarizing and communicating C-STAR outputs. [11]

## VI. DISCUSSION

C-STAR was developed to address a common limitation in severe injury surveillance: severe cases are often summarized using incident counts that do not differentiate between levels of outcome severity, the persistence of high-consequence hazard mechanisms, or contextual indicators that may influence prevention reach. OSHA's Severe Injury Reporting (SIR) program provides a structured source of high-severity outcomes, but translating those records into a consistent prioritization signal requires a standardized approach that remains transparent to end users. C-STAR responds to this need through an interpretable, rule-based scoring structure that converts each severe injury record into a Severe Incident Safety Score (SISS) and supports aggregation into a Regional Safety Risk Score (RSRS) for comparative profiling.

A key strength of C-STAR is its additive architecture. By expressing SISS as the direct sum of OSHA Regulatory Compliance context (ORC), Hazard Incident Severity (HIS), and Hazard Recurrence Probability (HRP), the framework preserves "auditability"—the ability to inspect how each factor contributes to the final score. This design supports stakeholder review, facilitates communication across

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26feb010

technical and non-technical audiences, and enables rapid scenario testing without requiring complex model refitting. Interpretable scoring is particularly valuable in construction safety contexts where decisions often require justification across multiple stakeholders, including management, regulators, and training providers.

The three-factor structure also supports multidimensional interpretation. HIS differentiates records by combining a mechanism classification (e.g., Focus Four versus non–Focus Four) with an outcome severity category (hospitalization versus amputation). This preserves meaningful variation within a dataset that is already restricted to severe outcomes, avoiding the assumption that all severe reports represent equivalent harm. HRP further extends interpretation by emphasizing recurrence, which can be informative when similar severe mechanisms repeatedly occur within a reporting geography or analytic unit. This recurrence component provides a mechanism for highlighting sustained hazard patterns that may warrant targeted prevention attention. [12]

ORC provides a structured way to represent access-context indicators relevant to enforcement and training reach. ORC is not intended to measure employer compliance behavior directly; rather, it summarizes contextual proxies using transparent, ordinal rules. This distinction matters because enforcement and outreach access may shape the feasibility and intensity of prevention support across locations. Within C-STAR, ORC is implemented as a rule-driven factor that can be adapted as better access indicators become available, while keeping the overall framework intact.

C-STAR also supports sensitivity testing as a built-in methodological feature. Analysts can assess stability of rankings and score tiers by varying (1) the analytic unit definition for RSRS, (2) the time window used to compute recurrence for HRP, or (3) the proxy rules used for ORC scoring. This flexibility allows users to explore how methodological assumptions influence the decision signal, which strengthens interpretability and reduces the likelihood that results are treated as fixed truths when they are, in part, dependent on definitional choices.

Finally, while C-STAR does not require GIS, its outputs are compatible with optional downstream visualization. Because RSRS summarizes severity-weighted risk within a defined geography, it can be mapped for communication, resource allocation planning, and prioritization discussions. In this workflow, GIS functions as a reporting layer applied after scoring rather than as a required component of the framework.

## VII. LIMITATIONS

Several limitations should be considered when interpreting C-STAR outputs. First, the framework depends on the completeness and consistency of OSHA severe injury reporting records. Although SIR is designed to capture high-severity outcomes, reporting practices and narrative quality may vary across employers and contexts, which can affect hazard mechanism classification and downstream scoring. [10]

Second, C-STAR requires hazard mechanism coding to calculate HIS and HRP. When classification relies on brief narratives or incomplete structured fields, misclassification can occur—particularly for incidents with limited descriptive detail or overlapping mechanisms. If multiple coders are used, differences in interpretation can introduce variability. To reduce this risk, implementations should document a coding rubric, provide examples for ambiguous cases, and apply consistent decision rules.

Third, ORC is an access-context indicator, not a direct measure of compliance performance or regulatory effectiveness. ORC is intended to represent contextual proxies related to enforcement and training reach, but these proxies do not capture the full complexity of compliance behaviors, organizational safety culture, or site-level controls. As a result, ORC should be interpreted as a structured context score rather than a causal explanation of why incidents occur.

Fourth, HRP is sensitive to analytic design choices, including the definition of the reporting geography and the selection of recurrence windows. Short windows may emphasize acute clustering, whereas longer windows may capture persistent patterns. Because HRP can influence SISS and RSRS distributions, implementations should explicitly report these choices and, when feasible, include sensitivity checks that show whether prioritization results are robust across reasonable alternatives.

Finally, C-STAR is designed as decision support rather than causal inference. The scoring system organizes surveillance signals into interpretable indices for prioritization and communication, but it does not estimate causal effects of training, enforcement, or interventions. Future research may evaluate how C-STAR outputs align with independent indicators of safety performance and whether score patterns are predictive of future severe incident occurrence.

## VIII. CONCLUSION

This paper presented the Construction Safety Threat Assessment and Reporting (C-STAR) framework, a severity-based, rule-driven scoring model designed for secondary analysis of OSHA Severe Injury Reporting data. C-STAR translates severe injury surveillance into standardized, interpretable metrics by combining three factors—OSHA Regulatory Compliance context (ORC), Hazard Incident Severity (HIS), and Hazard Recurrence Probability (HRP)—to compute the incident-level Severe Incident Safety Score (SISS). Incident scores can then be aggregated to produce the Regional Safety Risk Score (RSRS), supporting comparative profiling, ranking, and tiering across defined reporting geographies. [5]

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26feb010

C-STAR's primary contribution is its transparency. The additive structure and explicit subfactor rules allow end users to trace how each component contributes to final scores, enabling stakeholder review and sensitivity testing under alternative analytic assumptions. While GIS visualization is optional, C-STAR outputs are compatible with downstream mapping and reporting approaches that may support planning and communication.

Overall, C-STAR offers a replicable decision-support method for organizing severe injury surveillance into structured severity-based risk scoring. Future work may refine subfactor definitions, strengthen hazard mechanism coding procedures, and evaluate stability of score distributions under alternative recurrence windows and access-context proxies.

## REFERENCES

[1]. Texas Department of Insurance, Division of Workers' Compensation, "OSHA's 'Fatal Four' – The leading causes of death in the construction industry," 2024.

[2]. J. Jeong and J. Jeong, "Comparative analysis of degree of risk between the frequency aspect and probability aspect using integrated uncertainty method considering work type and accident type in construction industry," Applied Sciences, vol. 12, no. 3, p. 1131, 2022.

[3]. A. Alsharef, A. Albert, I. Awolusi, and E. Jaselskis, "Severe injuries among construction workers: Insights from OSHA's new severe injury reporting program," Safety Science, vol. 163, p. 106126, 2023.

[4]. W. B. Gray and J. Mendeloff, "Preventing construction deaths: The role of public policies," Regulation & Governance, vol. 17, no. 3, pp. 726–754, 2023.

[5]. C. L. Anderson, M. D. Aguiar, D. Truong, M. A. Friend, J. K. Williams, and M. T. Dickson, "Development of a risk indicator score card for a large, flight training department," Safety Science, vol. 131, p. 104899, 2020.

[6]. F. Salguero-Caparrós, M. D. C. Pardo-Ferreira, M. Martínez-Rojas, and J. C. Rubio-Romero, "Management of legal compliance in occupational health and safety: A literature review," Safety Science, vol. 121, pp. 111–118, 2020.

[7]. M. Reilly, "Evaluation of the characteristics of injured workers and employer compliance with OSHA's reporting requirement for work-related amputations," American Journal of Industrial Medicine, vol. 67, no. 2, pp. 154–168, 2024.

[8]. M. R. R. Shaon, S. Zhao, K. Wang, and E. Jackson, "Developing a data-driven network screening procedure for systemic safety approach," Transportation Research Record, vol. 2678, no. 3, pp. 348–364, 2024.

[9]. S. K. Aksha, L. M. Resler, L. Juran, and L. W. Carstensen Jr, "A geospatial analysis of multi-hazard risk in Dharan, Nepal," Geomatics, Natural Hazards and Risk, vol. 11, no. 1, pp. 88–111, 2020.

[10]. S. E. Wuellner and D. K. Bonauto, "Exploring the relationship between employer recordkeeping and underreporting in the BLS Survey of Occupational Injuries and Illnesses," American Journal of Industrial Medicine, vol. 57, no. 10, pp. 1133–1143, 2014.

[11]. L. Fenais, P. Koutsourelakis, and E. Markou, "Enhancing decision-making in construction safety using GIS-based visualization," Automation in Construction, vol. 104, pp. 123–132, 2019.

[12]. M. S. Johnson, D. I. Levine, and M. W. Toffel, "Improving regulatory effectiveness through better targeting: Evidence from OSHA," American Economic Journal: Applied Economics, vol. 15, no. 4, pp. 30–67, 2023.