

## CONSTRUCTION ENGINEERING MASTERS DISSERTATION ABSTRACT

### Leading Indicators of Oil and Gas Construction Safety

World energy consumption has been projected to increase 56% over the next 25 years. A global investment of more than \$48 trillion will be required to meet this energy demand. Consequently, oil and gas companies will need to develop new reserves, and complete larger, more complicated and higher risk construction projects. Significant capital and human resources will be necessary to execute these projects, increase in joint-ventures and contracting of labor, may decentralize the management and control of safety programs and performance outcomes.

In a time of increasing societal expectations and environmental pressures, the financial and reputational consequences of major safety incidents have never been greater. Improving safety performance is paramount to the success of construction projects in the oil and gas industry. While considerable attention has been paid to developing and using new types of safety performance indicators, traditionally, contractor safety has been measured and managed through lagging indicators. Alternatively, risk mitigation measures can be measured and used to predict contractor safety performance outcomes as leading indicators.

Several research studies have been performed on the development, identification and application of safety leading indicators in the construction industry. However, literature reviews have revealed a knowledge gap in demonstrating quantitative relationships between available safety leading indicators and loss-based safety performance outcomes captured through Total Recordable Incident Rate (TRIR) and Severity Rate (SR). The identification of safety leading indicators that correlate with safety outcomes/lagging indicators would allow the oil and gas companies to identify warning signs, manage contractor risks and predict their overall safety performance, based on their contractor safety performance.

A quantitative method was developed to: (1) analyze contractor safety data to establish risk mitigation measures that can serve as predictors of contractor safety performance and (2) examine the efficacy of potential safety leading indicators with contractor safety outcomes/lagging indicators. Using Principal Factor Analysis, Statistical Modeling and Correlation, the following factors were identified with substantial to strong correlation with safety performance outcomes as predictive indicators of safety performance: Work-in-Progress Risk Management (F1), Workforce Engagement and Monitoring (F2), and Non-routine Safety Actions (F3). Applying the factors in statistical modeling, the predicted TRIR indicates strong correlation (0.7251) with actual TRIR, while the predicted SR indicates substantial to strong correlation (0.5338) with actual SR. The statistical models of TRIR and SR also suggest good fit when applied to new contractor safety data. Therefore, the predicted TRIR and SR models can be utilized by oil and gas industry as safety leading indicators.

Implementing safety leading indicators requires a shift in cultural and organizational mindsets for managing contractor safety—from reactive to proactive through the use of safety leading indicators. A method to identify safety leading indicators that can quantitatively measure safety performance outcomes through risk mitigation measures has been established. Using this approach, clients can use the results to implement adaptive risk mitigation, reduce incidents, and continuously improve contractor safety performance. This research contributes to existing body of knowledge by empirically identifying safety leading indicators, testing their efficacy, and validating the resulting



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models. This research set a foundation for establishing quantitative safety leading indicators in the construction industry in the future for other forms of project outcomes. applying controls; serious accidents with OSM are not unlikely, but inevitable.

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