MA - Methodology Areas | Abstract (and subsequent Paper)

OC - (26145) - ADVANCING PROCESS SAFETY EVALUATION THROUGH DYNAMIC DATA ENVELOPMENT ANALYSIS: MEASURING EFFICIENCY, LEARNING, AND RISK MITIGATION OUTCOMES

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The quantitative assessment of process safety program effectiveness in integrated oil and gas companies remains a persistent challenge, owing to the interplay of technical, human, and organizational factors influencing both incident occurrence and risk mitigation outcomes. This paper proposes a comparative and temporal approach based on Dynamic Data Envelopment Analysis (Dynamic DEA) to evaluate the relative efficiency of successive process safety management cycles. The study employs Tier 1 and Tier 2 process safety indicators, as defined by the API Recommended Practice 754 (API, 2016), encompassing three consecutive years of operational data from large integrated oil and gas corporations.

The proposed model treats as input variables associated with technical training investments, frequency of internal audits, and preventive maintenance costs, while output variables include avoided incident rates, mean residual risk, and mitigation return (Khoshnevis & Jiang, 2020).

By adopting the Dynamic DEA framework (Emrouznejad & Thanassoulis, 2010) instead of traditional static efficiency models (Charnes, Cooper & Rhodes, 1978), the method captures the temporal evolution of efficiency and identifies organizational learning effects following the implementation of new safety policies and modernization programs.

Additionally, the integration of efficiency metrics with probabilistic indicators of residual risk is proposed to enhance the operational representativeness of DEA results and to support investment prioritization decisions. Preliminary findings suggest a promising relative efficiency gain in post-implementation cycles of new mitigation programs. The approach is expected to contribute to the development of a composite process safety effectiveness indicator, potentially integrable with asset management systems compliant with ISO 55001 (ISO, 2024).

Overall, the study provides quantitative evidence that dynamic performance assessment can serve as a strategic instrument for investment decision-making and risk governance within the oil and gas industry, advancing both the analytical rigor and managerial applicability of process safety evaluation.

Palavras-chave : Process safety, Data Envelopment Analysis, dynamic performance assessment, organizational learning