BEYOND THE 85% TRAP: DEPLOYING RISK-WEIGHTED LLM AUDITING TO ACHIEVE HIGH-RELIABILITY OPERATIONS IN ENTERPRISE CONTACT CENTRES

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Resumo: The HRO Engine shifts enterprise quality assurance from 2% manual sampling to 100% NLP-automated auditing, applying risk-weighted mathematics to calculate a real-time Team Resilience Index (Ri). Validated in a 120,000-interaction environment, the system achieved a 99.19% F1-score and elevated Ri from 36.5 to 97.8 over 12 weeks while reducing workforce attrition by 22%.

Palavras-chave: High-Reliability Organisations; Large Language Models; Performance Optimisation; Risk-Weighted Analysis; DMAIC.

INTRODUÇÃO

In modern enterprise contact centres, the prevailing mechanism for risk mitigation and quality control is the legacy Quality Assurance (QA) scorecard. This paradigm relies on manual evaluators reviewing a statistically insignificant fraction of live interactions—typically between 1% and 2% of total transaction volume—introducing two critical systemic vulnerabilities: **sampling bias** and the **aggregate score paradox**, commonly referred to as the **"85% Trap."**

By auditing only 2 out of every 100 interactions, operational leadership infers total performance from a skewed data subset. High-risk compliance infractions—such as failures to execute mandatory Identity Verification (ID&V) or truncate sensitive data—frequently occur outside this audited window. Legacy scorecards further compound this by combining disjointed behavioural dimensions into a single aggregate percentage, allowing an agent to pass at 85% while completely omitting a mandatory regulatory disclosure.

High-Reliability Organisation (HRO) theory emerged from the study of systems operating in high-hazard, zero-tolerance environments (e.g., aerospace, nuclear power generation) where operational failures result in catastrophic consequences (Rochlin et al., 1987; Weick & Sutcliffe, 2007). This paper argues that modern corporate communication networks have evolved into complex, highly regulated information-processing environments requiring a direct translation of HRO theory. By leveraging Large Language Models (LLMs) and structured mathematical modelling, an enterprise can transform a chaotic, high-volume communication pipeline into a digitally enclosed, high-reliability safety net. The primary objective is to present the **HRO Engine**—a novel operational architecture that combines 100% population auditing with risk-adjusted mathematics to achieve total compliance visibility.

MATERIAL E MÉTODOS

The HRO Engine architecture operates on two synchronised layers: algorithmic verification via the **AI Guardian Engine** and structural root-cause diagnostic loops. To eliminate LLM hallucinations, the AI Guardian functions as a binary semantic classifier constrained by strict token-boundary prompts and negative string boundaries, forcing an audit-ready, single-key JSON output (`{"verdict": 1}` for compliance or `0` for a defect), rejecting all partial credit models (Reason, 2000).

Individual process components are assigned a **Weight of Criticality (W_c)** scaled from 1 to 10 based on legal and fiduciary liability (e.g., Identity Verification = 10; Brand Greetings = 1). Systemic risk exposure is measured against total processing volume (V_{total}) and absolute defect frequency (F_c) to calculate a real-time **Team Resilience Index (R_i)**:

$$R_i = \max(0, (1 - \Sigma(W_c \cdot F_c) / V_{total}) \times 100)$$

The outer bounding parameter **max (0, …)** enforces an absolute mathematical floor of 0, preventing negative percentages from destabilising downstream business intelligence dashboards. Compromised workflows are categorised within a systematic DMAIC (Define, Measure, Analyse, Improve, Control) ledger into **System Gaps** (infrastructure/script friction), **Skill Gaps** (training deficiencies), or **Will Gaps** (behavioural divergence). Operational leadership behaviours are restructured around the **Employee Experience Mandate (EX-Mandate)**—which legally redefines compliance anomalies as organisational improvement opportunities—executed

via a targeted **30-Minute Daily Pulse** coaching cadence.

RESULTADOS E DISCUSSÃO

A mixed-methods case study was conducted within a regulated, high-volume mutual care and insurance infrastructure processing 120,000 monthly interactions. A random sample of 1,000 multi-lingual interaction transcripts was processed concurrently by the AI Guardian and a human master auditing panel, with metrics evaluated using standard confusion matrix equations balancing True Positives (TP), False Positives (FP), False Negatives (FN), and True Negatives (TN).

The AI Guardian achieved a **Precision of 99.46%**, **Recall of 98.93%**, and **F_1-score of 99.19%**, significantly exceeding traditional human inter-rater reliability benchmarks (82%–88%). Upon full activation, the population audit exposed deep systemic vulnerabilities previously hidden by the 2% manual sample, dropping the apparent 91.4% passing score to a baseline R_i of 36.5 (Table 1).

Table 1. Quality Assurance Framework Performance Matrix Comparison.

Performance & Compliance Vector	Legacy QA (2% Sample)	HRO Engine (100% Audit)
Monthly Audited Volume	2,400 contacts	120,000 contacts
Performance Score / Ri	91.4% (Passing)	Ri = 36.5 (Critical)
Identity Breaches (Wc = 10)	0 logged	3,110 defects
Financial Consents (Wc = 8)	1 logged	5,420 defects
Process Variance	±14.5% (High)	±1.8% (Precise)

The root-cause classifier revealed that **65% of compliance failures were driven by System Gaps** (software interface delays and script logic timeouts) rather than frontline negligence. This shifted the operational paradigm from punitive agent management to platform optimisation. Over a 12-week migration horizon, supervisors used automated diagnostic arrays to isolate *Skill Gaps* (32% of defects), running surgical 30-second coaching drills during their Daily Pulse routines (Caldevilla-Domínguez et al., 2025).

By Week 12, the enterprise compressed performance variance to a strict ±2% tolerance threshold, achieving a sustained R_i of **97.8**. Furthermore, voluntary workforce attrition decreased by **22%** due to the non-punitive EX-Mandate framework, proving that compliance precision and employee psychological safety can coexist symmetrically (Stavrakis, 2026).

CONCLUSÃO

The HRO Engine demonstrates that High-Reliability Organisation principles can be programmatically translated into cognitive digital workflows. By deploying structured LLM prompts governed by rigid binary outputs and translating risk vectors into an active, bounded mathematical index (R_i), enterprise customer experience platforms can achieve total compliance visibility. The framework effectively dismantles the legacy aggregate scorecard paradigm, removing administrative auditing waste and enabling leadership to pivot from passive monitoring to strategic performance engineering.

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