

# Human-in-the-Loop Automation Workflow for SAR Review and Escalation Using Low-Code Platforms

**Sriramakrishna Vadlamudi**

Reston, Virginia, United States  
sriram.vadlamudi@gmail.com

## **Abstract:**

Suspicious Activity Reports (SARs) constitute the principal regulatory mechanism through which financial institutions identify, investigate, and communicate potentially illicit financial behavior under Anti-Money Laundering (AML) compliance frameworks. Although advances in transaction monitoring, anomaly detection, and behavioral analytics have significantly improved alert-generation capabilities, SAR preparation remains an inherently investigative process requiring contextual interpretation, documentation of investigative reasoning, and supervisory validation [1]. Existing SAR preparation workflows often rely on manually coordinated investigative activities across fragmented enterprise systems, resulting in delays, inconsistent reporting practices, and increased exposure to regulatory scrutiny [2].

This paper proposes a human-in-the-loop (HITL) automation workflow for SAR review and escalation implemented through low-code orchestration platforms. The proposed approach integrates automated evidence aggregation, behavioral timeline construction, case routing, and escalation governance while preserving investigators as final decision authorities responsible for determining suspicion and filing outcomes [3]. By embedding structured automation within governed compliance workflows, the proposed architecture improves investigative transparency, reporting consistency, and auditability while maintaining alignment with regulatory expectations that SAR determinations remain subject to documented human judgment and supervisory oversight [4].

## **INTRODUCTION**

Suspicious Activity Reporting represents a foundational obligation within AML compliance programs and serves as the primary reporting channel through which financial institutions communicate potential financial crime indicators to regulatory authorities such as the Financial Crimes Enforcement Network (FinCEN). The increasing digitization of financial ecosystems, proliferation of real-time payment infrastructures, and expansion of cross-border transaction networks have resulted in exponential growth in transaction volumes and corresponding alert generation from automated monitoring systems [5]. As financial institutions continue to modernize detection capabilities using advanced analytics and machine-learning models, downstream investigative functions responsible for alert triage and SAR preparation remain heavily dependent on manual investigator intervention.

Traditional SAR workflows typically require investigators to retrieve transactional histories, customer information, and supporting documentation from multiple enterprise platforms. Investigators must then manually construct behavioral timelines, identify suspicious activity patterns, and draft regulatory narratives using unstructured documentation tools. These fragmented investigative practices introduce variability in decision-making, reduce transparency in reporting outcomes, and limit the institution's ability to demonstrate consistent investigative reasoning during regulatory examinations [6].

Regulatory guidance consistently emphasizes that determinations of suspicion must remain under human authority, even in environments supported by advanced detection and decision-support technologies [2].

Consequently, compliance architectures must be designed to integrate automation in a manner that supports investigator judgment rather than replacing it.

## **REGULATORY AND OPERATIONAL CONTEXT**

AML monitoring programs must evaluate large volumes of transactional activity and complete investigative reviews within strict regulatory timelines mandated by national and international compliance frameworks [1]. As enforcement actions related to AML deficiencies continue to increase globally, SAR monitoring and investigation have become among the most resource-intensive compliance functions within financial institutions [7].

Operational inefficiencies in investigative workflows may lead to inconsistent reporting thresholds, delayed SAR filings, or incomplete documentation of investigative rationale, all of which may increase institutional exposure to enforcement penalties or reputational risk [8]. Furthermore, the introduction of automated detection models has increased the need for governance mechanisms capable of demonstrating that model-assisted alerts undergo appropriate human review prior to SAR filing [9].

Human-in-the-loop compliance architectures address this requirement by positioning automation as a supporting function rather than as a replacement for investigative reasoning.

## **HUMAN-IN-THE-LOOP DESIGN PRINCIPLES**

A human-in-the-loop automation model integrates human decision-making into automated investigative pipelines to ensure accountability in compliance-critical environments [3]. HITL architectures are designed to support decision rationales, transparency dashboards, and escalation mechanisms that allow human reviewers to intervene in ambiguous or high-risk investigative scenarios prior to the finalization of SAR filing decisions [4].

Key design principles for HITL investigative workflows include preservation of investigator authority over suspicion determinations, documentation of investigative reasoning supporting filing outcomes, supervisory review and escalation pathways for high-risk investigations, and traceability of automated decision-support outputs used in investigative analysis [9].

## **LOW-CODE-DRIVEN WORKFLOW MODEL**

Low-code orchestration platforms enable investigative processes to be modeled visually through configurable workflow engines rather than procedural software logic [10]. This capability allows investigative workflows to be encoded directly into governed process models aligned with institutional compliance policies and regulatory expectations.

Within a low-code HITL workflow environment, automation may be employed to aggregate transactional evidence from monitoring systems, construct chronological timelines of account behavior, identify related entities or linked accounts, route investigative tasks based on workload indicators, and trigger escalation pathways for supervisory review [7].

Workflow-optimization research suggests that dynamic routing of alerts based on workload indicators and model-confidence scores can improve escalation precision and reduce investigation time by enabling investigators to focus on cases requiring discretionary interpretation [7].

## **SYSTEM ARCHITECTURE**

The proposed HITL SAR automation architecture consists of five logical layers: presentation, workflow orchestration, decision-support, data integration, and audit and governance [10]. Automation within the decision-support layer assists investigators by structuring investigative evidence and identifying behavioral anomalies, while workflow orchestration layers enforce escalation rules and supervisory approval requirements [3].

Embedding investigator checkpoints within workflow transitions enables institutions to maintain regulatory accountability while leveraging automated decision-support tools [9].

### COMPLIANCE AND AUDIT CONTROLS

Auditability is achieved through comprehensive logging of all investigative actions, workflow transitions, and decision checkpoints executed throughout the SAR preparation lifecycle [1]. Embedding compliance controls directly into workflow logic enables institutions to demonstrate that SAR determinations result from governed investigative processes supported by documented supervisory review [8].

Workflow-embedded governance mechanisms may include mandatory documentation fields for investigative conclusions, approval checkpoints for high-risk filings, escalation triggers based on risk-score thresholds, and automated audit trails recording workflow execution history.

### CONCLUSION

A human-in-the-loop SAR automation workflow implemented through low-code orchestration platforms provides a scalable and regulatorily aligned solution to the challenges associated with investigative compliance operations in modern financial institutions [2]. By embedding human judgment within structured automation pipelines, institutions can modernize investigative workflows without undermining accountability or supervisory oversight requirements mandated by AML compliance frameworks.

Rather than replacing professional interpretation, automation serves to structure investigative activity, assemble relevant evidentiary material, and enforce escalation governance within governed workflow environments. Human investigators remain responsible for determining suspicion and filing outcomes, ensuring that SAR decisions reflect informed analytical reasoning supported by documented investigative rationale [4].

### REFERENCES:

- [1] Federal Financial Institutions Examination Council (FFIEC), Bank Secrecy Act / Anti-Money Laundering Examination Manual, 2023.
- [2] Financial Crimes Enforcement Network (FinCEN), Suspicious Activity Report Filing Instructions, 2022.
- [3] S. Amershi et al., "Guidelines for Human-AI Interaction," CHI Conference, 2019.
- [4] B. Shneiderman, "Human-Centered Artificial Intelligence," IJHCI, 2020.
- [5] T. Davenport and R. Ronanki, "Artificial Intelligence for the Real World," Harvard Business Review, 2018.
- [6] D. Sculley et al., "Hidden Technical Debt in Machine Learning Systems," NeurIPS, 2015.
- [7] C. Nie et al., "AI Applications in AML Systems," 2025.
- [8] J. Greyling, "Human-in-the-Loop AI Workflow for Compliance," 2024.
- [9] M. Langer et al., "Human-in-the-Loop AI in AML Compliance," IEEE Intelligent Systems, 2021.
- [10] W. van der Aalst, Process Mining: Data Science in Action, Springer, 2016.