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Designing Key Performance and Risk Indicators (KPI/KRI) for a Five-Layer Framework of International Financial Transfers and Proposing an Automatable Management Monitoring Model

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ABSTRACT

This study designs Key Performance and Risk Indicators (KPI/KRI) for a five-layer framework of international financial transfers and proposes an automatable management monitoring model to control performance, operational risks, and compliance risks across the transfer lifecycle. It addresses how a five-layer architecture can be elevated from a conceptual level to a measurable, managerially monitorable model in banking operations.

An applied, mixed-methods (predominantly qualitative) approach was used. First, initial KPI/KRI candidates were derived from qualitative evidence (expert interviews and coding). Next, a multi-round fuzzy Delphi process refined and validated the indicators and established expert consensus. Experts evaluated indicators simultaneously in terms of "importance" and "operational implementability" to strengthen content validity and practical deployability. Indicator weights were then computed by normalizing expert scores, and indicators were organized by layer.

The study finalized 30 indicators across the five layers (3 KPIs and 3 KRIs per layer): (1) inter-institutional financial exchanges, (2) social/decentralized FX network, (3) digital wallet, (4) stable-value digital currency (conversion and settlement), and (5) connectivity and operations management. Additionally, 12 priority indicators were selected for first-page dashboard monitoring and alert-driven managerial attention. The monitoring model specifies calculation logic, monitoring frequency, control thresholds, and reporting/escalation pathways, enabling dashboard deployment and monitoring automation.

Layered KPI/KRI design combined with an automatable monitoring model upgrades the framework from a conceptual architecture to a measurable and controllable system, supporting operational decision-making through improved efficiency, transparency, traceability, and operational/compliance risk management.

Keywords: International financial transfers; Key performance and risk indicators; KPI/KRI; Five-layer model; Automatable management monitoring model; Risk management

1. Introduction

International financial transfers are a vital component of banking operations and a direct backbone for foreign trade, trade finance, and the settlement of firms' foreign-currency obligations. At the operational level, the quality of these transfers affects three key variables: execution cost (fees and process-related costs), settlement time, and operational and compliance risks. From an operational banking perspective, any volatility or disruption in these variables can increase the operational burden on units, raise the cost of correction and transaction reversals, and reduce the predictability of customers' cash flows (CPMI, 2020; FATF, 2023). Given the sensitivity of compliance requirements, the absence of a structured monitoring system can also intensify credit/reputational risk and the risk of compliance penalties.

Despite the literature's emphasis on improving cross-border payments efficiency and strengthening compliance requirements, a practical challenge remains in operational banking: how can performance and risk indicators be designed in an "architecture-driven" and "automation-ready" manner so that they not only measure the situation but also trigger alerts and corrective actions? On the one hand, a stream of studies focuses on reducing costs and settlement times and on standardizing data in cross-border payments; on the other hand, another stream emphasizes compliance controls, traceability, and operational risk management. However, the linkage between these two domains—within a layered indicator system connected to an operational management monitoring mechanism—has been less frequently articulated in an integrated manner. Accordingly, the literature review first outlines the main trends and findings in related studies and then formulates the research gap regarding the design of layered KPI/KRI and an automatable management monitoring model for the five-layer framework.

In practice, conventional international transfer mechanisms face challenges that stem from multi-stage processes, numerous control points, and substantial reliance on manual controls. This results in decision bottlenecks, a higher likelihood of human error, and difficulties in end-to-end traceability across the transfer lifecycle. Moreover, customer due diligence and anti-money laundering requirements make decisions on accepting, holding, or returning a transaction dependent on accurate data, clear rules, and continuous monitoring mechanisms. In many organizations, these decisions are still made in a non-systematic manner and often rely on individual experience, which increases the risk of inconsistent decisions and weakens accountability. In other words, the key challenge is not merely "executing a transfer," but ensuring end-to-end traceability, controllability, and standardization of control decisions throughout the transfer cycle—an objective that cannot be achieved without making the process measurable and defining valid indicators.

In response to these conditions, modern approaches in operational banking increasingly move toward making performance and risk measurable and then automating the monitoring process. In this context, Key Performance and Risk Indicators (KPI/KRI) are standard tools for translating complex operations into manageable variables—enabling managers to specify what to monitor, when to trigger an alert, and what action to take in response to deviations. However, if KPI/KRI are designed without an operational architecture and without mapping to process components, they tend to become fragmented lists and lose practical decision utility. Therefore, indicators should (1) be mapped to the process components and the architectural layers, (2) have clear operational definitions, data sources, and monitoring frequency, and (3) be linked to alert thresholds and corrective actions so that monitoring evolves from descriptive reporting to action-oriented management.

This study is grounded in a five-layer framework for international financial transfers as an operational architecture and aims to provide a "measurable and monitorable system" for this architecture. In addition to designing KPI/KRI tailored to each layer, the study proposes an automatable management monitoring model to upgrade monitoring from manual and ad hoc reporting to a data-driven, periodic, and alert-based approach. The underlying idea is that operational monitoring should be able to: (1) collect data systematically, (2) compute indicators in a standardized manner, (3) apply control thresholds, and (4) activate reporting pathways and corrective actions. Accordingly, the main research question is: How can a layered set of KPI/KRI be designed for the five-layer framework of international financial transfers such that it is both expert-validated and deployable within an

automatable (dashboard-ready) management monitoring model?

The core contribution of this research can be articulated at two levels: first, it provides a layered KPI/KRI set for the five-layer framework of international financial transfers; second, it proposes an automatable management monitoring model that integrates indicators with thresholds, alerts, and corrective actions in a coherent manner. From an implementation perspective, the outputs can serve as a basis for designing monitoring dashboards, structuring management reports, and standardizing operational decision-making. Specifically, the study delivers: (a) a final list of KPI/KRI by layer, (b) indicator weights/priorities to support managerial focus and reduce alert fatigue, and (c) monitoring logic (frequency, thresholds, reporting pathways, and corrective/escalation actions) to enable dashboard deployment.

The study employs a mixed-methods approach: indicators are first extracted from qualitative data and then refined and weighted through expert consensus to strengthen both content validity and operational feasibility (Creswell & Plano Clark, 2018). In this regard, the research objectives can be summarized as: (1) extracting initial KPI/KRI from qualitative data, (2) refining and reaching consensus via fuzzy Delphi, (3) weighting and prioritizing indicators using normalization, and (4) developing an automatable management monitoring model that specifies calculation logic, thresholds, and corrective-action pathways.

Operational Architecture: Mapping of Components to the Five Layers

To clarify the operational scope of the proposed five-layer framework and to ensure consistent interpretation of the layered KPI/KRI design, the main functional components are mapped to each layer as follows.

Layer 1 — Interbank / Inter-institutional Transactions (Financial Institutions Layer)

- Interbank communication network
- Transfer protocols / payment instructions
- Settlement hub/center
- Nostro–Vostro accounts
- Accounting management (inter-institutional posting and reconciliation)

Layer 2 — Decentralized FX Social Network (Network Layer)

- Group creation and participant coordination
- FX buyers
- FX sellers
- Layer linkage / cross-layer integration mechanisms
- Service-oriented broker/agent (service-based intermediation)
- Request tracking system (network-level request management)

Layer 3 — Digital Wallet (Customer Interface Layer)

- Integration with buyer banks (customer-to-bank initiation/interaction)
- FX-to-IRR conversion capability (customer-facing conversion initiation)
- Member-to-member exchange (peer exchange initiation/record)

Layer 4 — Stable-Value Digital Currency: Conversion & Settlement (Value Layer)

- FX wallet opening (value-account enablement for settlement)
- Crypto conversion (conversion between value representations)
- Cold wallet and common crypto-exchange services (custody/exchange access)
- Member-to-member value transfer (value transfer/settlement rail)

Layer 5 — Connectivity & Operations Management (Orchestration/Control Layer)

- Data transfer (integration and data flow management)
- Account balance management
- Service transfer / orchestration management
- Collateral management
- Customer account management under integrated accounting
- Reporting management
- Risk management
- Transaction tracking (end-to-end traceability)

2. Literature Review and Research Gap

In the operational banking literature, the efficiency of cross-border financial transfers is a function of settlement time, transaction costs, and the quality of execution controls. Specialized reports on cross-border payments indicate that multi-stage processes, multiple actors, and the lack of integrated standards in data and controls are major drivers of higher costs and longer processing times, while also reducing transparency in cross-border payments. This situation directly affects customers' liquidity planning as well as banks' operational productivity (CPMI, 2020).

From a compliance standpoint, customer due diligence and anti-money laundering standards require banks to establish, in addition to ex-ante controls, continuous monitoring mechanisms and reliable documentation for control decisions. In practice, the effectiveness of these requirements depends on clear rules, traceable control points, and timely alerting capacity; otherwise, control costs increase and compliance and reputational risks intensify (FATF, 2023).

At the same time, banking risk-management literature emphasizes that operational risks in complex financial processes mainly arise from human errors, lack of coordination across units, deficiencies in internal controls, and weaknesses in event logging and traceability. Therefore, an indicator-based monitoring system can play a significant role in early deviation detection, error reduction, and accountability enhancement—particularly when indicators are computed regularly and linked to managerial action thresholds (BCBS, 2011).

From the perspective of financial technologies, research on digital transformation in financial services shows that building data-driven infrastructures and measurable instruments is a prerequisite for automation and improved decision-making in financial processes. In this view, automation is not merely mechanization; it requires well-defined indicators, decision rules, and alert-and-corrective-action pathways (Allen et al., 2002).

In recent years, part of the literature has focused on using decentralized technologies for value transfer and enhancing traceability. These studies suggest that distributed-ledger-based networks can strengthen event recording and transaction traceability; however, translating a conceptual architecture into an operational mechanism in banking requires that performance and risk in each process component be measurable and monitorable (Böhme et al., 2015; Zohar, 2015).

In addition, in data analytics, studies on the variability of patterns over time emphasize that transactional behaviors and risk patterns may change; therefore, monitoring should be continuous and data-driven. This provides a suitable theoretical basis for designing indicators and alert thresholds as well as the logic of continuous monitoring (Gama et al., 2014; Žliobaitė, 2010). Taken together, the above literature shows that "efficiency" (cost/time), "compliance controls," and "operational risk" have largely been examined separately; however, translating these requirements into an architecture-driven indicator system that is both monitorable and automation-ready requires articulating the gap and proposing an executable model.

2-1. Research Gap

Despite numerous studies in financial transfers, risk management, and emerging technologies, the existing literature has paid less attention to how a layered set of Key Performance and Risk Indicators (KPI/KRI) can be designed for a multi-layer transfer architecture (such as a five-layer framework) in a way that is both managerially monitorable and operationally automation-ready. More precisely, the main gap can be defined at two levels:

1) The lack of layered KPI/KRI that cover "efficiency," "transparency/traceability," and "operational/compliance risks" across different components of the transfer process;
2) The lack of an automatable management monitoring model that links indicators to thresholds, alerts, and corrective actions and specifies the reporting pathway.

2-2. Positioning and Novelty of the Present Study

Focusing on operational banking, the present study addresses this gap by proposing layered KPI/KRI for the five-layer framework and designing an automatable management monitoring model—such that indicators are not merely descriptive lists but are connected to calculation logic, monitoring frequency,

and managerial action thresholds (CPMI, 2020; BCBS, 2011). Specifically, the novelty is articulated through: (1) mapping indicators to the five layers, (2) weighting and prioritizing indicators to reduce alert fatigue, and (3) linking indicators to control thresholds and corrective action/escalation pathways to enable deployment of an automatable management dashboard.

3. Method

This study is applied in terms of purpose and developmental in nature, and it employs a mixed-methods approach. In the first step, the proposed indicators were extracted from qualitative data; in the second step, they were refined and weighted through expert consensus. The logic of this approach is that KPI/KRI must be grounded in experts' experience and knowledge (content validity), while also being measurable, monitorable, and convertible into an alert mechanism (managerial deployability) (Creswell & Plano Clark, 2018). Within this framework, the methodological output is structured in sequential stages including: (i) extracting initial indicators, (ii) refining/consensus-building, (iii) weighting, and (iv) designing an automatable management monitoring model, so that the "indicator → alert → corrective action" linkage can be established at the level of banking operations.

3-1. Initial extraction of KPI/KRI from the five-layer framework

In the first stage, based on the five-layer architecture of international financial transfers and the components extracted from qualitative data (including components related to efficiency, transparency, and controllability), an initial list of Key Performance and Risk Indicators was developed. At this stage, efforts were made to ensure that each indicator has a clear operational definition, a specified data source, and the capability of periodic measurement. Each indicator was also assigned to one of the five layers to preserve the "layered" structure of the indicators (Braun & Clarke, 2006).

3-2. Refinement and consensus-building with experts

To enhance the content validity of the indicators and reach consensus regarding the necessity and function of each KPI/KRI, fuzzy Delphi was applied over multiple rounds. In each round, experts assessed the importance and operational reliability/implementability of each indicator. Based on the results across successive rounds, less important indicators were removed or merged, and selected indicators were stabilized. The aim of this stage was to reduce dispersion, eliminate overlap, and arrive at a "minimal yet sufficient" set of indicators for management monitoring at the level of banking operations (Hsu & Sandford, 2007).

In addition, the final set was validated for internal consistency and applicability across layers by mapping each indicator to its data source, measurement frequency, and responsible owner (indicator owner). This mapping confirmed that the prioritized 12 indicators are directly measurable with available operational data and can be monitored at executive level without overloading the dashboard.

3-3. Indicator weighting and final prioritization

After the indicator list was stabilized, indicator weights were calculated by normalizing expert scores to determine the relative contribution of each indicator to performance and risk assessment. In this stage, expert scores were transformed into comparable weights, and the sum of weights was controlled at the overall model level. The output of this stage is a "weight profile" of KPI/KRI that forms the basis for dashboard design, threshold definition, and prioritization of managerial alerts (Rowe & Wright, 1999).

3-4. Designing an automatable management monitoring model

In the final step, drawing on the validated KPI/KRI and the computed weights, an automatable management monitoring model was developed. This model specifies each indicator's data source, monitoring frequency, control thresholds (alert levels), and reporting/corrective-action pathway. The objective is to move monitoring from manual reporting toward a standardized, alert-driven cycle that can be implemented in a management dashboard; as a result, decision bottlenecks are reduced and operational accountability is strengthened.

To clarify the execution of the method and improve the evaluability of the study, expert

consensus-building in the fuzzy Delphi stage was conducted with the participation of 18 experts and continued for three rounds. The data collection instrument in this stage was an indicator evaluation questionnaire. Experts rated each indicator on a 1–9 scale in terms of both "importance" and "operational implementability/reliability." At the end of each round, results were aggregated; overlapping indicators were merged; and indicators that did not reach the minimum expected consensus/importance level were carried forward to the next round for revision or removal. Ultimately, the final list of indicators was stabilized after consensus was achieved (Hsu & Sandford, 2007).

Table 1-1. Summary of the consensus-building and weighting procedure for indicators

Method component	Value/Description
Research approach	Mixed-Methods
Indicator extraction stage	Extracting KPI/KRI from components and qualitative data (interviews and coding)
Indicator validation method	Fuzzy Delphi
Number of experts	18
Number of rounds	3
Expert rating scale	1 to 9 (importance and operational implementability/reliability)
Refinement rule	Merging overlapping indicators; revising/removing indicators with insufficient consensus
Weighting method	Normalization of expert scores and controlling the sum of weights
Final output	Layered KPI/KRI list + indicator weights + basis for threshold and alert design

4. Results

In this study, Key Performance and Risk Indicators (KPI/KRI) are used as measurable instruments for monitoring international financial transfer operations. KPIs are defined to assess the achievement of operational objectives and service quality (e.g., time, cost, and service level), while KRIs are defined to provide early warning signals of increasing operational and compliance risks (e.g., transaction returns, mismatches, compliance holds, and case backlogs). This distinction constitutes the basis for indicator design, categorization, and prioritization across the five layers of the model (CPMI, 2020).

To ensure that indicators are implementable and deployable, each KPI/KRI in this study satisfies four minimum requirements: (1) a clear operational definition, (2) a specified data source, (3) an identifiable monitoring frequency, and (4) the capability to be linked to alert thresholds and corrective actions. This rule prevents indicators from remaining descriptive and enables their direct use in management monitoring design and operational reporting (BCG, 2023). Within this framework, "automation readiness" refers to the ability to compute indicators periodically from recorded data and generate alerts when thresholds are breached.

4-1. Extracting and organizing KPI/KRI within the five-layer framework

Based on the qualitative stage outputs and expert refinement, the final KPI/KRI set was developed such that each indicator (1) has a clear operational definition, (2) a specified data source, and (3) the capability of periodic monitoring, and can also be assigned to one of the five layers of the model. At this stage, indicators were classified into two groups—"performance indicators" and "risk/compliance indicators"—and, for effective monitoring, an alert threshold and corrective-action logic were specified for each indicator (CPMI, 2020; BCG, 2023). The result is a layered indicator view that enables the simultaneous monitoring and comparison of performance and risk within each layer.

4-2. Mapping KPI/KRI to the five layers

To present results coherently and show the relationship between indicators and model components, Table 2 displays the proposed KPI/KRI by layer. This mapping provides the basis for management dashboard design and monitoring automation in the next section (IMF, 2023).

Table 2. Mapping final KPI/KRI to the layers of the five-layer model

Layer	Key KPIs (Performance)	Key KRIs (Risk/Compliance)
Layer 1: Inter-institutional financial exchanges	1) Average inter-institutional settlement time 2) Percentage of transactions settled within the target window 3) Average transfer fee/cost	1) Transaction return/rejection rate 2) Information/document mismatch rate 3) Percentage of compliance-driven control holds
Layer 2: Social/decentralized FX network	1) Average time to discover a route 2) Success rate of alternative routes 3) Route diversity/dispersion index	1) Route/actor concentration (concentration risk) 2) Counterparty non-performance rate 3) Behavioral risk index of network participants
Layer 3: Digital wallet	1) Average request registration/submission time 2) Successful request completion rate 3) User error rate	1) Abnormal user behavior rate 2) Failed/suspicious attempt rate 3) Rate of transactions requiring manual review
Layer 4: Stable-value digital currency / conversion and settlement	1) Average conversion/settlement time 2) Conversion completion rate within the target window 3) Average deviation of conversion rate from the reference rate	1) Conversion/settlement error rate 2) Volatility of rate deviation over short intervals 3) Liquidity risk / adequacy of settlement coverage
Layer 5: Connectivity and operations management	1) End-to-end transfer completion time 2) Service level (SLA) attainment rate 3) Average response time to alerts	1) Number of red/critical alerts 2) Recurrence rate of control events 3) Ratio of open/backlogged cases to total requests

Note: The "end-to-end" indicator can also be defined as a composite indicator so that several key KPIs—using the computed weights—are aggregated into a single composite score (PYMNTS, 2023). In this case, the composite indicator can serve as an executive summary metric on the first page of the dashboard.

4-3. Indicator card and operational specification of KPI/KRI

To automate monitoring, each indicator must have an indicator card—i.e., its definition, data source, monitoring frequency, thresholds, and corrective action must be specified—so that once a threshold is breached, the action pathway and the escalation path are clear. Table 3 presents the indicator-card template and provides examples for several key indicators (BCG, 2023; FATF, 2023).

Table 3. Indicator-card template and sample completion

Indicator	Type	Definition	Calculation method	Data source	Frequency	Thresholds	Corrective action
Average inter-institutional settlement time	KPI	Time from submission to settlement confirmation	Mean time of settled transactions	Settlement system logs	Daily / Weekly	To be determined by the bank	Refer to operations unit; identify bottlenecks
Transaction return/rejection rate	KRI	Percentage of returned/rejected transactions	# returns ÷ total transactions	Settlement/control reports	Weekly	To be determined by the bank	Root-cause analysis; revise procedure/control
Information/document mismatch rate	KRI	Percentage of documentary/information mismatches	# mismatches ÷ total cases	Reconciliation/control system	Weekly	To be determined by the bank	Fix forms; improve data validation
SLA attainment rate	KPI	Percentage of requests completed within target window	Completed within SLA ÷ total requests	Operations dashboard	Weekly	To be determined by the bank	Process/capacity corrective actions
Number of red alerts	KRI	Count of critical-level alerts	Counting red-level alerts	Alert engine	Daily	To be determined by the bank	Activate escalation path

4-4. Indicator weighting and monitoring prioritization

After finalizing the indicators, each KPI/KRI weight was calculated by normalizing expert scores in order to determine the relative contribution of each indicator to management monitoring. The output of this stage has two primary applications: (1) prioritizing indicators in the dashboard (what should be displayed on the first page), and (2) determining alert severity and the level of escalation commensurate with the indicator's weight. To avoid unnecessary complexity, weights are controlled at both the "layer" level and the "overall model" level to maintain balance between performance and risk (IMF, 2023; Rowe & Wright, 1999). In this study, weights are reported as "priority indicators" so that the dashboard remains protected against indicator congestion and low-importance alert noise.

In the final quantitative version, the "weight table" includes the indicator name, normalized weight, rank, and importance level (high/medium/low) and will be connected in Section 5 to alert thresholds and the monitoring automation logic (CPMI, 2020).

To make the results explicit and evaluable, the fuzzy Delphi refinement stabilized the indicator set at 30 KPI/KRI measures aligned to the five-layer framework (3 KPIs + 3 KRIs per layer). During the refinement rounds, overlapping indicators were merged and low-consensus items were removed until convergence was achieved. Expert judgments were captured on two dimensions—importance and operational implementability—on a 1–9 scale; the normalized scores were then used to derive indicator weights and ranking. Based on the resulting weight profile and to avoid dashboard congestion, 12 priority indicators were selected as the first-page executive dashboard set, while the remaining indicators were retained for drill-down monitoring and periodic audits.

Table 4. Quantitative summary of the finalized results and dashboard prioritization

Item	Quantitative Output
Finalized KPI/KRI set	30 indicators (15 KPI, 15 KRI)
Layer-wise distribution	6 indicators per layer (3 KPI + 3 KRI) across 5 layers
Expert validation process	18 experts; 3 rounds; 1–9 scale (importance & implementability)
Executive dashboard prioritization	Top 12 indicators selected for the first-page dashboard
Monitoring model readiness	Each indicator mapped to data source, calculation rule, frequency, thresholds, and escalation/action pathway

5. Automatable Management Monitoring Model for KPI/KRI

The purpose of this section is to transform the KPI/KRI extracted in Section 4 into a management monitoring system that can be deployed in operational banking and can move from manual and ad hoc reporting toward periodic, alert-driven monitoring that is implementable in a dashboard. In this model, indicators are not only used to measure status; they are also linked to control thresholds and corrective actions so that monitoring outputs lead to operational decisions and actions (CPMI, 2020; Allen et al., 2002). This section explains the operational logic of the model, the weighting-based prioritization mechanism, the threshold-setting policy, and the responsibility/escalation structure in a way that enables implementation in monitoring systems and management dashboards.

5-1. Model logic: from data to managerial decision

The proposed model is based on a standard cycle: data collection → indicator calculation → comparison against an alert threshold → alert generation → corrective action → logging and reporting. The value of this cycle in operational banking is that decision-making shifts from case-by-case judgment to a rule-based and traceable process; that is, each alert is linked to a specific indicator, an analyzable cause, and a standard corrective action, and when the red threshold is breached, the escalation path is activated so that the issue is addressed at the managerial level (BCG, 2023). "Traceability" means that for each alert, an event record is logged including the timestamp, the triggered indicator, the cause/event code, and the outcome of the corrective action, enabling evaluation, auditability, and continuous improvement.

5-2. Indicator weighting and monitoring prioritization

Normalized indicator weights (computed in Section 4) are used in this section as the basis for "monitoring priority." The logic is that indicators do not have equal managerial importance; therefore, indicators with higher weights should be prioritized on the first page of the dashboard, and breaches of their thresholds should trigger higher alert severity and a higher level of escalation. This mechanism increases managerial focus, prevents accumulation of low-importance alerts and wasted response capacity, and ensures that operational resources concentrate on sensitive points in the process (IMF, 2023). In practice, indicator weights can also be used to "rank alerts" and determine escalation level (e.g., whether referral to a unit manager or a committee is required).

5-3. Green/Yellow/Red thresholds and alert policy

For each KPI/KRI, three control levels are defined: **Green** (acceptable status), **Yellow** (requires attention and review), and **Red** (requires urgent action). Threshold setting can be based on historical data, target service levels, or internal bank policy, and it can be periodically reviewed. The key point is that thresholds must be "actionable"; i.e., breaching a yellow/red threshold should activate a standard corrective action rather than merely changing the dashboard color (CPMI, 2020). To prevent alert fatigue, a "minimum duration/frequency" policy can also be applied (e.g., persistence of a yellow status across several cycles or repeated red alerts within a short window).

5-4. Reporting path, accountability, and escalation path

For management monitoring to be effective, each indicator must have an "indicator owner" and an "action owner." This means that responsibility for data quality, indicator calculation, and reporting must be specified, and when an alert occurs, the accountable unit for corrective action must also be defined. For red-level alerts, the escalation path is activated to move the issue from the expert level to the managerial level, enabling rapid decisions such as pausing a route, revising controls, or reallocating operational resources. This structure increases accountability and prevents accumulation of unresolved cases (BCBS, 2011). Escalation level can be defined based on a combination of "alert color" and "indicator weight," such that red alerts and/or high-weight indicators trigger faster escalation at a higher level.

5-5. Dashboard design and monitoring automation

The model is designed to be implementable in a management dashboard. In this dashboard, indicators are displayed by layer, and each indicator's status is visible through color coding (green/yellow/red). Indicators with higher weights are prioritized in display to maintain managerial focus on sensitive points of the process. At the red-alert level, the system automatically generates a short management report and activates the escalation path so that the issue is transferred from the expert level to the managerial level (PYMNTS, 2023). The minimum automation outputs in the dashboard include: displaying indicator status, logging alert events, automatically assigning/referring alerts to the indicator owner/action owner, and generating a short management report for red alerts.

5-6. Operational monitoring table: weight, threshold, and corrective action

To operationalize the model, indicators must simultaneously have weights, monitoring frequency, data source, control thresholds, and corrective actions so that the monitoring system is upgraded from "status display" to "action-oriented management." Table ۰ presents the proposed operational version for the 12 priority indicators and serves as the basis for configuring the dashboard and alerting rules (FATF, 2023; CPMI, 2020). In this table, "weight" determines dashboard display/response priority, and "threshold" determines alert activation and corrective action.

A descriptive review of the prioritized dashboard set (Table 5) shows that the Top-12 indicators provide balanced coverage across all five layers (Layers 1 and 5 each contribute three indicators; Layers 2–4 contribute two each) and an equal split between KPIs and KRIs (6 each). Notably, three of the four highest-weighted indicators are KRIs, suggesting that experts place a premium on early-warning risk and control integrity (e.g., returns/rejections, document mismatches, and critical alerts) alongside end-to-end throughput.

Table ۵. Final operational version (weight + thresholds + corrective action + responsibility + data source + frequency)

No.	Indicator	Type	Layer	Direction	Weight (%)	Importance	Data source	Monitoring frequency	Threshold (Green/ Yellow/ Red)	Proposed Corrective action	Action owner	Escalation path
1	End-to-end transfer completion time	KPI	5	↓ better	10.3	High	Integrated operations/case-record system + event logs	Daily	To be determined by the bank	Identify bottlenecks; reallocate resources; activate alternative route / process redesign	FX Operations + IT	Senior expert → Unit manager → Committee/CEO
2	Number of red/critical alerts	KRI	5	↓ better	10.3	High	Alert engine / control-event logs	Daily	To be determined by the bank	Activate incident management; classify root causes; define immediate actions; log report	Risk + Compliance	Senior expert → Unit manager → Committee/CEO
3	Transaction return/rejection rate	KRI	1	↓ better	9.2	High	Settlement reports / messaging system / reconciliation & control system	Weekly	To be determined by the bank	Root-cause analysis (data/compliance/route); revise stage controls; review transfer route	Reconciliation/Control + Compliance	Senior expert → Unit manager → Committee/CEO
4	Information/document mismatch rate	KRI	1	↓ better	9.2	High	Document reconciliation/control system + mismatch reports	Weekly	To be determined by the bank	Standardize input data/forms; strengthen validation; revise registration and reconciliation procedures	Reconciliation/Control + FX Operations	Senior expert → Unit manager → Committee/CEO
5	Average inter-institutional settlement time	KPI	1	↓ better	8.0	Medium	Settlement logs / send–confirm time reports	Daily/Weekly	To be determined by the bank	Analyze settlement delays; optimize coordination; use alternative route	FX Operations	Senior expert → Unit manager → Committee/CEO
6	Route/actor concentration (concentration risk)	KRI	2	↓ better	8.0	Medium	Route/agent reports + route shares of transfer volume	Weekly	To be determined by the bank	Redistribute routes/agents; set concentration caps; activate alternative routes	Risk + FX Operations	Senior expert → Unit manager → Committee/CEO
7	Rate of transactions requiring manual review	KRI	3	↓ better	8.0	Medium	Control system / manual-review queue + referral reports	Daily/Weekly	To be determined by the bank	Analyze drivers of manual referrals; revise control rules; improve data quality	Reconciliation/Control + IT	Senior expert → Unit manager → Committee/CEO
8	Average deviation of conversion rate from reference rate	KRI	4	↓ better	8.0	Medium	Conversion/settlement reports + reference rate (Policy/Market)	Daily	To be determined by the bank	Review reference-rate source / conversion rules; temporarily pause conversion under severe deviation	FX Operations + Risk	Senior expert → Unit manager → Committee/CEO
9	SLA attainment rate	KPI	5	↑ better	8.0	Medium	Operations dashboard + case time-tracking	Weekly	To be determined by the bank	Adjust capacity/resources; reprioritize based on indicator weights to return to SLA	FX Operations + IT	Senior expert → Unit manager → Committee/CEO
10	Success rate of alternative routes	KPI	2	↑ better	6.9	Medium	Route-selection reports + transfer outcome	Weekly	To be determined by the bank	Review route-selection rules; strengthen alternative-route network	FX Operations	Senior expert → Unit manager
11	Successful request completion rate	KPI	3	↑ better	6.9	Medium	Request registration system + final case status	Daily/Weekly	To be determined by the bank	Identify failure points; improve input data quality to reduce failures	FX Operations + IT	Senior expert → Unit manager
12	Average conversion/settlement time	KPI	4	↓ better	6.9	Medium	Conversion/settlement logs + time reports	Daily/Weekly	To be determined by the bank	Revise timing rules; strengthen controls over conversion/settlement steps	FX Operations	Senior expert → Unit manager

For indicators with high importance, the escalation path is defined up to the Committee/CEO level; for medium indicators, escalation is handled at the unit-manager level, and in case of persistence/repetition, referral to higher levels is triggered.

6. The Discussion and Managerial Implications (Discussion)

The results of this study indicate that adding a "measurability" layer to the five-layer framework through the design of layered KPI/KRI transforms the model from a conceptual architecture into a monitorable managerial mechanism. In banking operations, the management of financial transfers becomes efficient only when traceability, accountability, and controllability are established at the process level; otherwise, even well-designed architectures face hidden operational costs and decision delays in practice. Accordingly, the main value added of this study lies in linking indicators to weights, thresholds, and corrective actions, which enables data-driven decision-making and timely operational intervention (CPMI, 2020; Allen et al., 2002). On this basis, the study's output is not merely a "list of indicators," but rather an executable mechanism for converting monitoring into managerial action in operational banking.

From an operations management perspective, a KPI/KRI monitoring dashboard enables the bank to

observe the current status of transfers in a layered manner and, instead of reacting after a crisis occurs, to track indicator changes through green/yellow/red alert levels. In this structure, higher-weight indicators act as "focal indicators" and determine response priority; this feature directly mitigates alert fatigue, because alerts are not treated as equal and the response level is activated in proportion to indicator importance. Such an approach is essential for automatable management monitoring in high-volume transaction environments in terms of operational efficiency and cost control (IMF, 2024; BCG, 2023).

From a risk and compliance perspective, defining explicit KRIs and linking them to corrective actions and escalation paths improves the quality of control execution and makes control decisions more consistent. In many operational environments, deviations escalate when controls deviate from standard practice or when control decisions rely on individual judgment; in contrast, the proposed model—by defining thresholds and standard corrective actions—reduces repeated occurrences of similar events and strengthens accountability. This is aligned with compliance-oriented approaches, because it reinforces documentation and the traceability of corrective actions (FATF, 2023; BCBS, 2011). The practical implication is that "control" shifts from an individual-centric mode to a rule-based and auditable mode.

From a technology and implementation perspective, a substantial portion of the proposed framework's value depends on "data quality" and "data-flow coherence." Although a data source is proposed for each indicator in this study, real-world implementation may face fragmented, heterogeneous, or incomplete data, which weakens indicator computation and automated monitoring. Therefore, an important managerial implication is that the bank should consolidate the minimum critical data required to compute priority indicators into a coherent data flow and standardize event logging and time-stamping rules; otherwise, the dashboard will become a descriptive report rather than a decision-support tool (BCG, 2023; Friedlmaier et al., 2018). **Operational recommendation:** first standardize the "minimum data" needed for the 12 priority indicators, and then gradually expand coverage to supplementary indicators.

From the perspective of network controllability and transfer routes, part of the KRIs in this study addresses concentration risk and behavioral risk of network actors. The literature on distributed-ledger network analysis and crypto-economics has shown that concentration of actors or routes can reduce resilience and create systemic risks; therefore, monitoring indicators such as route/actor concentration (e.g., using concentration indices) can play a preventive role in risk management. This is important for operational banking because "reliance on limited routes," under operational stress or institutional constraints, increases the probability of decision bottlenecks and recurring disruptions (Böhme et al., 2015; Zohar, 2015).

From the perspective of risk dynamics and transactional behavior, the necessity of data-driven monitoring becomes more salient when behavioral patterns change over time. The "concept drift" literature emphasizes that fixed models and rules may lose effectiveness over time; therefore, indicator definitions and thresholds should allow periodic review and recalibration. For this reason, it is recommended that implementation begin in a phased manner and that thresholds be tuned based on real operational data so that alerts become more accurate and the cost of handling false alerts is reduced (Gama et al., 2014; Žliobaitė, 2010). Consequently, thresholds should be "re-tunable" and reviewed at defined intervals (e.g., quarterly).

Finally, from the standpoint of monitoring policy design, selecting a "first-page indicator set" (Top 12) is a defensible managerial decision. As the number of indicators and monitoring frequency increase, the costs of maintenance, analysis, and response also rise; therefore, focusing on priority indicators increases executability while maintaining sufficient coverage. Supplementary indicators can be placed on the second layer of the dashboard or in periodic reports without creating an excessive operational burden on units (PYMNTS, 2023; CPMI, 2020).

7. Conclusion, Limitations, and Recommendations (Conclusion)

7-1. Conclusion

Focusing on operational banking, this study showed that to convert a multi-layer architecture for international financial transfers into a manageable mechanism, "measurability" must be systematically

embedded in the model. Designing layered KPI/KRI and linking them to weights, alert thresholds, and corrective actions brings the five-layer framework closer to operational deployment and enhances management monitoring, response prioritization, and operational accountability (CPMI, 2020). In practical terms, the five-layer model becomes effective when, for each layer, computable indicators and a response mechanism (alert/action) are defined.

The results indicate that the proposed model, in addition to controlling performance (e.g., settlement times and service-level attainment), enables monitoring of operational and compliance risks—particularly through indicators such as return rate, mismatch rate, critical alerts, and route/actor concentration. Moreover, weighting indicators provides a practical tool to reduce alert fatigue and focus management on sensitive points, thereby strengthening the basis for designing an Automatable Management Monitoring Framework (IMF, 2024). "Accordingly, the model is deployable as a dashboard-driven monitoring and response mechanism."

In conclusion, this study provides an implementable monitoring package for international financial transfers, consisting of: (1) a finalized layered KPI/KRI set (30 indicators aligned to the five-layer framework), (2) a weighting and prioritization mechanism that yields a focused first-page set of 12 executive indicators, and (3) an automatable monitoring logic that links indicator calculation rules to thresholds, alert severity, escalation pathways, and corrective actions. By combining measurable indicators with prioritization and response governance, the proposed model supports faster decision-making, stronger accountability, and more effective performance and compliance-risk supervision in complex cross-border transfer operations.

Therefore, the study's contribution is not only to propose indicators, but also to deliver a deployable monitoring governance that operationalizes performance/risk supervision through measurable data, prioritized dashboards, and actionable escalation workflows. From a managerial perspective, the prioritization pattern indicates that executive attention can be concentrated on two high-leverage control points: (i) end-to-end operational flow and incident severity in the connectivity/operations layer, and (ii) settlement and reconciliation integrity in the inter-institutional exchange layer. Technically, the model can be implemented by integrating operational event logs, reconciliation data, and alerting-system outputs into a unified data pipeline feeding a dashboard. From a governance standpoint, defining indicator owners, action owners, and escalation paths converts monitoring from periodic reporting into an actionable control loop.

7-2. Study limitations

First, a substantial portion of the indicator design is based on expert judgment; although consensus-building was performed, generalizing the results to all banks and all types of transfer operations requires caution and testing in diverse operational environments. Second, defining green/yellow/red thresholds and calibrating them ultimately depends on historical data, internal policy, and the bank's target service levels, and may differ across organizations (Hsu & Sandford, 2007). In addition, weights may vary depending on each bank's operational/risk priorities and may require recalibration during implementation.

Third, successful automatable monitoring depends on data quality and the integration of information flows. If data are fragmented, event logging is inconsistent, or time-stamps are incomplete, indicator accuracy declines and the dashboard shifts from a decision-support tool to a descriptive report. Therefore, a key prerequisite for implementation is strengthening data governance and standardizing the logging and reporting of operational events (BCG, 2023).

7-3. Practical recommendations

It is recommended that banks adopt a phased implementation approach: first, deploy the "12 priority indicators" in the management dashboard, and after a pilot period, calibrate weights and thresholds using real operational data. In addition, for each indicator, the data owner, action owner, and escalation path should be formally defined so that alerts lead to traceable corrective actions and the accumulation of open cases is prevented (CPMI, 2020).

To reduce operational costs and increase decision consistency, it is recommended to formalize standard alerting and corrective-action rules through internal procedures and to generate periodic management reports based on indicator weights. Furthermore,

compliance risk indicators (e.g., mismatch rate and return rate) should be prioritized for daily/weekly monitoring to strengthen prevention of high-risk events and reduce compliance costs (FATF, 2023).

7-4. Recommendations for future research

Future research is recommended to implement the proposed model in a real case study and evaluate its effects on indicators such as settlement time, error rate, return rate, and handling/response costs. In addition, by developing quantitative models, weighting methods can be compared using multi-criteria decision-making approaches, and sensitivity analysis of weights and thresholds can be conducted under different operational scenarios (Saaty, 1980). Specifically, comparing normalized-score weighting with methods such as AHP can help assess the stability of indicator rankings across varying conditions.

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