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Research Article

FDIC Resolution & Regulatory Submissions: Traceable, Reconciled Data Pipelines for Large Financial Institutions

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ABSTRACT

Resolution planning and high-frequency regulatory submissions have become critical supervisory expectations for systemically important financial institutions. Regulators such as the Federal Deposit Insurance Corporation (FDIC) increasingly require institutions to demonstrate not only accuracy and timeliness, but also traceability, reconciliation and audit-ready lineage across complex enterprise data environments. Traditional regulatory reporting architectures-often fragmented, manual and opaque-are insufficient to meet these expectations, leading to reconciliation breaks, delayed submissions and extensive regulator follow-up queries. This paper presents a reconciled, traceable data pipeline architecture designed to support FDIC resolution planning and recurring regulatory submissions for large financial institutions. The proposed framework integrates controlled reference data, dual-control reconciliations, deterministic aggregation logic and reproducible reporting outputs. Emphasis is placed on end-to-end lineage, from source systems through transformation layers to regulatory schedules, enabling transparent auditability and rapid regulator Q&A response. The methodology incorporates standardized ingestion patterns, metadata-driven transformations, reconciliation checkpoints at each processing stage and a rigorous testing matrix spanning unit, integration, regression and scenario testing. A governance-aligned control framework ensures segregation of duties, change management discipline and submission certification accountability. Results from an enterprise-scale implementation demonstrate measurable improvements, including reduced manual adjustments, accelerated submission timelines, improved data quality metrics and enhanced regulator confidence. The findings indicate that reconciled pipelines are foundational to sustainable compliance, particularly under increasing submission frequency and supervisory scrutiny. This paper contributes a practical, scalable model for regulatory data engineering in the context of FDIC resolution requirements.

Keywords: FDIC resolution planning, Regulatory reporting, Data lineage, Reconciliation controls, Audit-ready pipelines, Financial data governance

1. Introduction

1.1. Background

Following the world financial crisis, the regulatory authorities the world over came up with heightened resolution planning criteria to reduce the systemic risk posed by large and complex financial institutions[1,2]. The Federal Deposit Insurance Corporation (FDIC) in the United States requires the resolution plans (also known as living wills), to be submitted that show how a firm might be resolved in an orderly fashion without assistance by the taxpayers. Originally developed as more or less fixed documents, these plans have turned into very data-intensive and recurring regulatory filings that require regular operational discipline. These submissions have highly increased their range

to incorporate granular balance sheet breakdowns, liquidity measures and legal entity exposures, derivatives stands and additional vital financial and risk information. To satisfy these needs, it is important to have regular and reconciled flows of data in many domains, such as finance, risk, treasury and operational systems, each of which could have its own data structures and reporting conventions. Regulators have become more attention able to the fact that compliance is not only a question of the number of figures on the balance sheet but they also need to have transparent, traceable and reproducible reporting frameworks. This implies that the reported aggregates should be supportable, have an evident audit trail of how the data copy came to the aggregation system through transformation and submission. This in practice necessitates a complete data governance, centralized reference data management, deterministic transformation and aggregation logic and sound reconciliation processes. The regulatory emphasis on traceability and reproducibility is an expression of a wider supervisory aim, namely to make sure that firms can adequately demonstrate operational resilience and provide timely and reliable information under normal and extreme circumstances so as to enhance the stability of the financial system overall.

1.2. Needs of FDIC resolution & regulatory submissions

The large financial institutions are highly demanded in terms of operational accuracy and governance structures by the FDIC resolution planning and the regulatory submissions that accompany the planning process[3,4]. The needs can be classified in several major areas **(Figure 1)**:

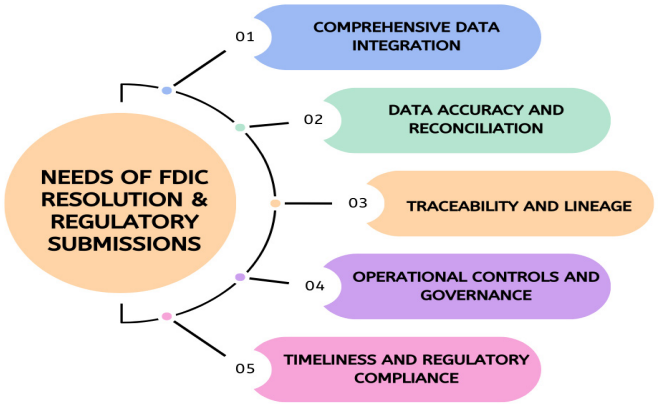

Figure 1: Needs of FDIC Resolution & Regulatory Submissions.

- **Comprehensive data integration:** Resolution plans need data of different functional area to be aggregated such as finance, risk, treasury and operations. Multiple sources with different schemas, data standards and frequencies of updates, which consist of different institutions, need to be combined in a unique reporting pipeline. This integration helps to assure that all the regulatory submission is consistent, complete and aligned with the statutory financial and risk exposures of the institution.
- **Data accuracy and reconciliation:** In order to have the confidence of the regulators, precise and reconciled data is essential. The FDIC and other oversight regulators anticipate that the reported figures, including balance sheet decompositions, liquidity positioning as well as legal entity exposures, be aligned not only within individual systems but also between and among systems. Aggregated data integrity requires multi-dimensional reconciliations, which encompass legal entities, product lines, currencies and exposures to counterparty to prompt inconsistencies capable of attracting regulatory enquiries.
- **Traceability and lineage:** The regulators are placing more importance on traceability and explainability of the reported data. All the figures supplied in a resolution plan should be identifiable to source systems, documented transformations, aggregation rules and reference data mappings. Such a degree of data lineage can guarantee submissions can be reproduced, can be reviewed by an audit or other supervisors and makes all reported metrics more defensible at a glance.
- **Operational controls and governance:** It also needs powerful governance structures to contain the confusion and danger of repeated submissions. The key requirements that institutions should introduce are the controlled reference data hubs, approval workflows, version control and effective-dated change management. Concerted balances, regularized verification process, on-format testing cycle are needed in order to ensure consistency, less manual intervention and measurement of the operational risk.
- **Timeliness and regulatory compliance:** The submission of high-frequency regulatory submissions requires timelines. The institutions should have in place procedures that enable points of data freeze, sign-offs of reconciliation, management certification and submission in a timely manner. It is imperative to meet these deadlines and be able to achieve the accuracy and completeness of the data so as to be able to retain regulatory trust and show preparedness to operate under the possible resolution scenarios. Taken together these requirements point to the fact that FDIC resolutions and regulatory submissions cannot be viewed as mere reporting activities, but in order to facilitate transparency, reproducibility and quick regulatory reaction a well-developed, integrated and auditable data infrastructure is necessary.

1.3. Regulatory submissions: Traceable, reconciled data pipelines for large financial institutions

Regulatory submissions in relation to large financial institutions have become extremely complicated activities, which demand more than mere data reporting[5,6]. More and more certainly, regulators like the FDIC and other supervisory agencies are demanding not only numerical accuracy but also traceability in all reported metrics in addition to reproducibility and reconciliation. This has brought about a need to come up with traceable, reconciled data pipelines that could combine information across diverse functional areas such as finance, risk, treasury and operations. These pipelines are the foundation of regulatory reporting in which institutions are able to generate quality and defendable data, both with consistency and efficiency. Traceable data pipes are end to end, meaning that each figure that is reported can be tracked to the underlying systems, transformations and aggregation logic. It involves comprehensive lineage of transactional data, reference data and calculation procedures so that regulators need not have to question reported measures since they can self-test and recreate them. Traceability minimizes chances of errors, enhances auditability and enables quick response to supervisory questions especially in the context of resolution planning where real time and correct reporting is crucial. The reconciliation in the given pipelines is complementary since it ensures the data

survey evenness among various aspects including legal entities, product lines, currencies and counterparty IEs. Multi-layered, automated reconciliations (source-to-ingestion, ingestion-to-transformation and aggregation-to-output) are effective to identify discrepancies at an early stage as well as avoiding the spread of errors. This will reduce the state of man-hands, operational risk and expediture and the submission cycles, making institutions able to meet the arm-twisting regulation time frames without quality of data being compromised. Also, the strong governance and control systems, such as centralized reference data control, aggregation logic versions and formal approval processes, strengthen the pipeline integrity. Through the integration of traceability, reconciliation and controls into the architecture, the financial institutions, which are large, can make sure that the regulatory submissions made by them are not solely accurate but they are also auditable, repeatable and in line with the changing supervisory expectations. Such pipelines can be used to ensure that regulatory reporting is resilient and proactive rather than reactive and the report includes both compliance and operational efficiency.

2. Literature Survey

2.1. Regulatory reporting architectures

The regulatory reporting environment has changed dramatically and the sphere of report-oriented and siloed process to support and interpret data-driven architectures[7-9]. Principles supporting effective risk data aggregation and risk reporting (BCBS 239) by the Basel Committee on Banking Supervision are foundational directions that state essential requirements in regards to the accuracy, completeness, timeliness and flexibilities of the data. These doctrines have had a potent power in shaping patterns of thinking in supervisory and industry designs. These requirements are however extensively addressed in the literature at a conception level which has little to say on how companies can practically implement them in complex legacy systems. White papers on industry and publications by vendors often recommend centralized regulatory data lakes or enterprise reporting systems, whereas in fact the reconciliation, control and governance provisions on which such resolution planning and supervisory scrutiny will depend.

2.2. Data lineage and auditability

Data lineage and auditability Studies on data lineage and auditability are mainly concerned with metadata management, provenance tracing and technical traceability of data pipelines. In financial services, though, lineage has an extra regulatory aspect: financial institutions are expected to be able to justify, defend and recreate any given reported figure of business and regulatory substance. Supervisory expectations are larger than system-to-system traceability with clarity of data ownership, logic of transformation and compliance to required regulatory definitions. Current lineage models often focus on the technical processes at the expense of resolving the gap between the raw data, business semantics and regulatory interpretation, making them ineffective with regulatory reporting and examination needs.

2.3. Reconciliation frameworks

Literature on reconciliation also focuses on the fact that it is the financial control processes that include the reconciliation of sub-ledger balances against the general ledger to enhance accounting integrity. These strategies are quite established in the reporting of financials, but they are not adequate in terms of regulatory resolutions filings, which must be reconciled on various levels, including legal entities, product, currency and counterparty hierarchies. The resolution-related data also should be in a position to reconcile with risk, finance and treasury areas and this is usually on a tight time schedule. The literature does not have sufficient advice on how to expand the reconciliation frameworks past accounting constructs in order to facilitate regulatory submissions where heterogeneous data source and supervisory viewpoints are aggregated.

2.4. Gaps identified

A weakness in the literature on regulatory architecture, data lineage and data reconciliation, is the lack of a holistic, end-to-end framework, integrating governance, controls, lineage, reconciliation, plus testing into a single reporting pipeline on regulations. The current research and industry trends would look at these factors singly, thus coming up with piecemeal solutions that can never pass the scrutiny of the supervisor. It is interesting to note that scholarly or practitioner literature is scarce that describes operationally proven architectures that are explicitly aligned with expectation of resolution authority, e.g., the expectations of the FDIC. The paper aims to fill this gap with a set of proposed, unified, regulator-friendly architecture that is based on reality experience in implementation.

3. Methodology

3.1. Architectural overview

The proposed regulatory reporting pipeline will be developed as a layered architecture, which will enhance regulatory traceability, control and modularity[10-12]. The levels have their own functions as well as help in end-to-end data lineage, reconciliation and governance. This isolation of concerns makes it scalable, review of by supervisors is made easy and it makes it possible to have an individual part of the reporting process evolve without jeopardizing the integrity of the entire process **(Figure 2)**.

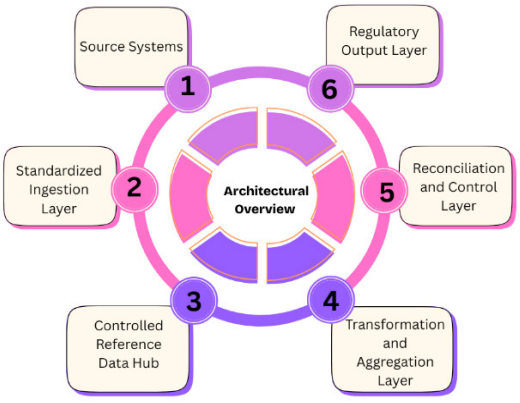

Figure 2: Architectural Overview.

- **Source systems:** At the heart of the architecture is a set of source systems that are the core finance, risk and treasury platforms to create authoritative transactional level and position level data. The data structures, definitions and the update rates are often not homogeneous in these systems because they are usually optimized to provide operational processing, as opposed to regulatory reports. The architecture views the linking of source systems as systems

of record whereby original data attributes are retained and required metadata necessary to support both traceability and auditability of the downstream reporting lifecycle are captured.

- **Standardized ingestion layer:** Standardized ingestion layer is the layer that is in charge of sourcing out data in the source systems and transforming it to a consistent and normalized format. Initial validation checks, schema conformity, completeness and simple data quality checks, are enforced in this layer, before the data is taken into the regulatory pipeline. The architecture ensures the downstream is kept simple by imposing common standards of ingestion and only allows data of the right format to pass through the system in all ways such that its technology and governance requirements have been defined in advance.
- **Controlled reference data hub:** The controlled reference data hub is a central repository of important reference data that contains legal entity hierarchy, product taxonomy, currency code, side of the counterparty and so on. This layer gives uniformity of reference data within all the processes of reporting and facilitates regulatory expectation of similar interpretations of areas of significance. Reference data are placed under strong governance, versioning and approval workflows to make changes controlled and allow cumulative reproducibility of regulatory submissions.
- **Transformation and aggregation layer:** The transformation and aggregation layer uses business rules, regulatory logic and calculation methods in order to transform normalized source data into reportable metrics. This layer facilitates intricate changes, such as currency converts, risk-weighting, aggregations on legal entity levels and much more. Every logic of transformation is recorded, parametrized and controlled to ensure transparency and allow someone to trace the reported indices into their underlying causes (regulators and internal stakeholders).
- **Reconciliation and control layer:** The reconCIlation and control layer is used to conduct organized verifications to confirm that transformed data is valid. This involves balancing regulatory aggregates to fund totals and ensuring consistency between such dimensions as legal entities and products and unexplained variances. Hidden controls, tolerance limit and exception management processes have been instituted to verify that inconsistencies are investigated, registered and addressed before submission to the regulatory authorities.
- **Regulatory output layer:** Regulatory output layer will generate final submission ready reports and data files in a format mandated by regulatory bodies. This layer can contain jurisdiction specified templates, frequency of submission and validation regulations without detriment of the underlying governed data set. Outputs are also completely audible, reproducible and maintained with evidence of lineage and control, which allows an institution to react properly to supervisory investigations and inspections.

3.2. Reference data controls

Reference information, such as legal entity structures, product hierarchies and counterparty classification, among other important dimensions[13,14], contributes to the basic role of regulatory reporting and resolution planning. The proposed architecture has the reference data being consolidated through a controlled hub which acts as the single source of authority to all the downstream regulatory processes. In centralization, an imbalance manifested by duplicate or locally managed reference datasets and disparity in the interpretation of key reporting dimensions within the finance, risk and treasury boundaries is removed. As it is a highly regulated data where the regulating body considers reference data as defining the boundaries of aggregation and the factor to report on, well-built governance and control systems are directly integrated in its lifecycle management. All documentary data items will be tightly versioned and effectively date to aid historical reproducibility of regulatory submissions. A change is given the version identifier and time that it was made and the business rationale that it was made and it is impossible to rearrange the data that was actually used as references by any previous submission that was made by the institution in history. This is essential to answer supervisor questions, remediation work and lookback analysis, especially in resolution planning, where the regulators can demand re-submission or recalculation of past numbers in previous organizational set-ups. Reference data change management is a formal work flow that involves two approvals, on both business and data governance fronts. Changes are impacted to determine downstream impacts on the logic of aggregation, its reconciliations and its regulatory output before being further advanced to production. Segregation of duties takes place through automated controls that cannot make alterations that are unauthorized and also reduce operational risk. Besides, periodic attestations and data quality checks are conducted to confirm completeness, accuracy and consistency of reference data to outside sources and internal policies. The architecture will facilitate the reproducibility of supervisory-perspective regulation reports by integrating governance, auditability and reproducibility into reference data management so that regulation reports are technically correct and defensible on a supervisory basis. These controls, directly, reinforce regulatory requirements of transparency, consistency and explainability and they constitute an important enabler of dependable, scalable and regulator-compliant reporting procedures.

3.3. Dual-control reconciliations

There are embedded dual-control reconciliations in the regulatory reporting pipeline to verify the integrity of the data it contains, its completeness and its defense to the regulatory scrutiny[15,16]. Instead of leading to a reconciliation as a single end-stage operation, the architecture deploys checks at the transition points that are critical and independent control perspectives are applied on the same stage. This method will allow identifying the problems with data early enough, reduce the spread of mistakes and leave documents by which they will be able to audit that they have checked the reported numbers throughout the entire data lifecycle.

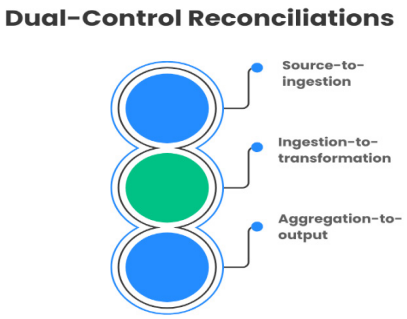

Figure 3: Dual-Control Reconciliations.

- **Source-to-ingestion reconciliation:** The reconciliation matches the data obtained by source, to ingestion ensures that all and all the data extracted in the finance, risk and treasury source systems is completely and purely mirrored in the standardized ingestion layer. Checks in this level are based on the number of records, critical financial sums and such attributes as legal entity, product and currency identifiers. The architecture will ensure that no data is lost, copied or changed in the extraction and transfer process since it reconciling the data ingested with source system control totals. Errors are recorded and examined before reduced to downstream processing and a firm basis on future transformations is established.
- **Ingestion-to-transformation reconciliation:** Ingestion-to-transformation reconciliation is used to verify the use of normalization rules and business logic when data is transferred to the transformation and aggregation layer. The element of this stage here is to determine the consistency of standardized data items following enrichment, reference data merger and preliminary calculations. The controls involve check of balance, dimensional completeness and verification of rules of transformation against approved specifications. External validation of transformations works well to ensure consistency in business and regulatory logic used in the transformation processes and periodicity of business reports.
- **Aggregation-to-output reconciliation**: Aggregation-to-output re-convergence is used to verify that the aggregated measures and regulatory reports represent the underlying transformed data correctly. This involves balancing regulatory totals to finance control figures, certifying cross-dimensional consistency (legal entity/ product roll-ups) and certifying consistency to regulatory templates. Tolerance levels and escalation protocols are used to deal with acceptable tolerances and enquiry into abnormalities. This last reconciliation levels offers a secure ensuring that the regulatory submissions are indeed complete and are accurate with a definite audit trail that links to the source and the output.

3.4. Deterministic aggregation logic

Deterministic aggregation logic is an overarching design concept of the proposed regulatory reporting architecture and acts as a guarantee that reported metrics are always based on, can be fully explained and reproduced across reporting periods[17,18]. The aggregation policies are all rule-based and parameterized and the business and regulatory logic is clearly sped out and not hard-coded in an ad hoc script or custom tunings. Such a strategy negates the use of discretionary overrides, which often introduce operational risk and raise doubts among the supervisors and executes standardized computations which are readily verifiable and effectively reproducible. The aggregation rules are deterministic in nature i.e. to a given set of rules; the same inputs should always have the same outputs. Other important parameters like hierarchies in legal entities, conversion rate of various currencies, reporting thresholds and regulatory classification mappings are externalized off code and governed by controlled configuration tables. This separation of parameters and logic increases transparency and gives the ability to make changes controlled without necessarily having to redevelop, whilst maintaining a clear audit trail of changes over time. All aggregation logic (rule definitions, dependencies order of execution, etc.) is described and reconciled with regulatory interpretations and governing internal policy. Aggregation logic is formalized in version managed repositories having formal change management and approval procedures that support auditability and supervisory review. The versions of the logic are marked to which reporting periods are applied, which makes it possible to recreate historical submissions accurately and provide remediation or re-calculation requests to regulators. Robots' tests checks confirm the results of aggregation with specified situations and balances without any risks of undesirable effects being applied in response to changes. The architecture enhances the integrity of data and regulatory defensibility by imposing deterministic and parameterized aggregation. It sees to it that the results of aggregation are clear, repeatable and to the point of business semantics and regulatory definitions. This ability is especially vital in resolution planning and stress testing, where regulators are interested in being assured that reported numbers can be brought into play on the necessary scrutiny and within limited timeframes.

3.5. Testing and validation matrix

The testing and validation system is designed in a multi-dimensional matrix, which is aimed at providing holistic assurance of the regulatory reporting pipeline. Instead of using one testing stage, the architecture uses a number of various types of tests which are aligned to various areas of risk and give the architecture correctness in both technical and regulatory sense. This stratified methodology helps in the early identification of defects, manageable change process and provide the traceable proof of rigor in testing so as to provide internal control and audit.

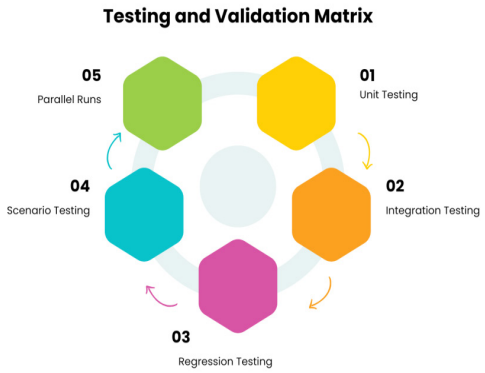

Figure 4: Testing and validation Matrix.

Unit Testing: Unit testing is a technique used to test single transformation rules and calculations and data enrichment logic. All the rules undergo testing on pre-defined scenarios of inputs and outputs to ensure to conform to the documented business and regulatory needs. Unit tests test that transformation logic is working as desired, responds to edge cases in a reasonable manner and gives consistent results given work with known conditions. This test layer enables defects to be curtailed at an early stage before they can trickle down to lower aggregation and reporting operations.

Integration Testing: The integration testing ensures that there are end-to-end data flows between various systems and architecture layers, including ingestion of data sources, transformation and reconciliation on the data to regulatory output. The aim is to verify that data interfaces, dependencies

and sequencing are as expected when interaction between components occurs within a production-like setup. Tests which verify schema compatibility, reference data joins as well as cross-domain consistency, ensure that the pipeline is made to work as a cohesive unity and not as a collection of independent modules.

Regression Testing: To achieve stability and consistency in regulatory outputs despite system enhancements, regulatory code change or infrastructure improvement, regression testing is conducted. Regression testing detects the unintentional impacts of changes by performing regression testing of previously tested cases and situation comparisons. This is especially critical in a regulatory setting where any slight deviation can attract questions of supervision or formal clarification.

Scenario Testing: Scenario testing is a method used to test behavior of the reporting pipeline under pressure or hypothetical conditions used in the resolution planning. Such tests measure how the aggregation logic and assumptions respond to highly unlikely but possible situations, e.g. entity separability or liquidity stress. Scenario testing aids in confirming the ability of the architecture to uphold the regulatory prospects of stability and futuresight test.

Parallel Runs: Parallel runs Parallel runs are operations that run the new reporting pipeline and compare the results to the legacy processes in several reporting cycles. Analysis and the explanation of differences and subsequent resolution are conducted to make integrity in the new architecture. This method offers empirical demonstration of equivalence or betterment, which contributes to controlled shift and control endorsement of new reporting system.

3.6. Submission timeline and controls

A timeline that comprises formal control gates that are meant to ensure there is accuracy, accountability and regulatory compliance is controlling the regulatory submission process[19,20]. Each of the milestones of the timeline depicts an essential validation point at which the data quality and the reconciliation state, as well as the governance approvals, are confirmed before the next step is successful. this is a formalized method of imposing a disciplined approach throughout the reporting chain and offers a distinct indicative thread of control and decision making to internal audit and oversight. When T-10 (Data Freeze) the source data is officially locked out to the reporting period. Such freeze makes it consistent by avoiding the introduction of changes which can compromise reproducibility and reconciliation. All the data added on this level are versioned and tagged to the reporting period to create a consistent baseline on the downstream processing. Any exception or post freeze-adjustments may be stringently escalated and approved and the nature of the reporting dataset is not compromised. At T-7 (Reconciliation Signoff) all embedded reconcilments throughout the pipeline, source-to-ingestion, ingestion-to-transformation and aggregation-to-output must be engaged and officially examined. Exceptional absences are enquired, clarified or clearly explained within justified boundaries of tolerance. Independent functions of control offer checks on whether figures which are reported have been reconciled to sources of authority and adhered to standard practices of internal controls. At T-3 (Management Certification) the senior management examines the final regulatory outputs, supporting documentation and control evidence. Management certification will ensure that submissions are complete, accurate and prepared as per what a regulatory expects of submissions. The action strengthens accountability on the right level of the organization and integrates the reporting outcomes provided on the governance and risk supervision functions. At T (Regulatory Submission), the final reports and data files are technically presented into the hands of the regulator via established channels. Approvals, submission artifacts and timestamps are stored to allow auditability and post-submission inquiries. All these gated controls result in a clear, repeatable and regulator-ready submission process which can stand up to supervisory review.

4. Results and Discussion

4.1. Data quality improvements

Table 1: Data Quality Improvements.

Metric	Improvement (%)
Manual Adjustments	65%
Submission Cycle Time	53%
Regulator Queries	50%

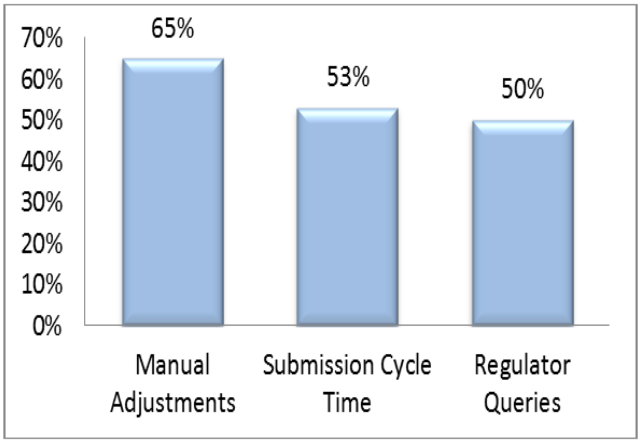

Figure 5: Graph representing Data Quality Improvements.

- **Manual adjustments (65% Improvement):** The introduction of the controlled, deterministic regulatory reporting architecture led to a huge number of manual adjustments reduced. With the capability to build standardized ingestion, controlled reference data, deterministic aggregation logic and multi-layer reconciliations, a significant number of data anomalies that had to be handled by people beforehand was removed on the fly. Robotic controls and rule-based transformations minimized the use of spread sheets and hacks and increased operational effectiveness and trust in the regulators. The fact that the number of manual adjustments decreased 65 percent indicates a better degree of data consistency, enhanced upstream data quality and greater execution of control, on a reporting cycle.
- **Submission cycle time (53% Improvement):** By almost a half, the time lag in submission cycles was selected to lessen, implying a decrease in 15 days to 7 days per reporting interval. The reason behind this was the fact that the data problems were earlier identified through embedded reconciliations, the root-cause analysis was quicker due to end-to-end lineage and less rework was required due to incorrectly fixed manually. The workflows were streamlined, control gates were already preset and the financial, risk

and survived coordination across the finance, risk and treasury functions enhanced the reporting speed. Reduced cycle times will increase the capability of the institution to meet the shorter regulatory deadlines, especially stress or resolution situations.

- **Regulator queries (50% Improvement):** Regulator questions of data accuracy, consistency and explainability reduced by half post implementation. Improved data lineage, version-controlled logic and extensive documentation have allowed quicker and more accurate responses to supervisory questions. Regulators could more easily use reported figures that have been traced to authoritative sources and fewer follow-up clarification requests would be necessary. Such a decrease suggests that transparency and defensibility of submission regulatory reports are enhanced, which reinforces supervisory trust and also reduces the currently experienced compliance levels among reporting teams.

4.2. Audit and supervisory outcomes

Audited and supervised reviews (after implementation) showed a significant level of improvement in the transparency, reliability and defensibility of the regulatory reporting process. Internal and external audit controls verified the completeness of a full, end-to-end data lineage with the ability to report figures that are traceable unambiguously back to source systems to ingestion and transformation and aggregation through to ultimate regulatory reporting. The metadata generated by the system, a version-controlled logic and a timestamped control evidence helped to fill the void of the lineage documentation and provided the ability to verify the correctness and integrity of the reported information in a manner that is independent of manual explanations or additional analyses. Better control efficacy was also observed by the auditors in the purpose of the reporting lifecycle with references to the areas of reconciliation, reference data governance and change management. Buried reconciliations and explicit authorization processes minimized the occurrence of undisclosed variance and the accurate recreation of submissions in the past was achieved through good dating and versioning. Such possibilities would help in mitigating the usual audit findings regarding data integrity, inadequacy in documentation and inability to reproducely perform audits and consequently reduce the amount of audit observations and re-mediation needs. As a supervising aspect, regulators indicated an enhanced transparency and effectiveness when it comes to examination and review. The standardization of data definitions, deterministic aggregation logic and a rigorous lineage had the important benefit of reducing the time needed to comprehend the reported numbers and examine anomalies. Supervisory enquiries might be solved faster because of the possibility to deliver uniform and well documented clarifications with auditable support. This increased transparency boosted confidence of regulators to the reporting system of the institution and ensured that requests of data had to be repeated or follow-up reviews were lengthy. All in all, the better audit and supervisory results indicate that the improved efficiency of the operations is not accidental but, on the contrary, the architecture contributes to the explainability, governance and control regulatory expectations directly. This is especially essential in the context of resolution planning, as regulators need to be extremely confident in the capability of the institution to generate correct, prompt and justifiable data when there is increased pressure and stricted deadlines.

4.3. Operational efficiency

The delivery of automated reconciliation and deterministic aggregation logic has significantly improved the productivity level of the operational aspects of the regulatory reporting pipeline. The rule-based validations and systematic reconciliation checks ensured on various levels, such as the source-to-ingestion, ingestion-to-transformation and aggregation-to-output levels, helped to decrease the number of steps that require manual work by subject-matter experts to considerably. In the past, the complicated data problems and inconsistency could easily involve intense scrutiny by finance, risk and treasury professionals, leading to a point of congestion and resulting in an operational risk associated with key-person dependency. The automatization and standardization of processes are used to make sure that the tasks are performed consistently, accurately and reproducibly and that fewer are utilized to these processes, along with enhancing their overall resilience. Deterministic logic also leads to efficiency in operative processes by eradicating discretionary overrides and ad hoc calculations. All rules of transformation and aggregation are parameterized, version-managed and well documented and the data may pass through the pipeline without any manual reconfiguration. This does not only increase the speed of the reporting cycle but also makes outputs predictable and easy to audit. The architecture will eliminate the repetitive human effort required and allow staff to work on activities associated with increased value, including the analysis of exceptions, scenario planning and regulatory engagement instead of daily data corrections or reconciliations. Combining automated controls, embedded reconciliations and deterministic logic contribute to lowering error propagation thus improving the reliability of upstream and downstream processes. Reduced errors will lead to shortening of the cycle time, average cut in regulatory inquiries and reworks, all of which can be tracked to efficient gains. Also, the standardized processes enable scalability, so that the institution can easily handle more and more volumes of data or more regulation needs without corresponding staffing growth. All these operational enhancements, in general, help the institution to make prompt, correct and justifiable regulatory submissions and reduce the risks that come with personnel dependency and manual processing. This leads to a more robust, effective and sustainable reporting system that can respond to the changing supervisory requirements and organizational expansion requirements.

5. Conclusion

The article posted will describe a detailed, reconciled and traceable data pipeline system that was dedicated to the FDIC resolution planning and high-frequency regulatory reporting. The framework handles the key issues regarding contemporary regulatory reporting, combining various levels of control, governance and automation. Centralized reference data controls provide consistency, versioning and an effective-dated reproducibility of important dimensions like the legal entity, product hierarchy and counterparty classification. Multi-stage dual-control reconciliations occurring between source-to-ingestion, ingestion-to-transformation and aggregation-to-output confirm that the data remains accurate and that anomalies are identified at an early age and supports this information with auditing evidence to promote supervisor looking-glass self-assurance. Deterministic aggregation logic is rule-based and parameterized, version-controlled and documented and removes

discretionary overrides and produces reproducible results. In addition to these controls, a formal testing and validating matrix, comprising of unit, integration, regression, scenario and parallel testing is used, to ensure every part of the pipeline is not only sound, but also reliable as well as in line with regulatory expectations. Together, these contributions form a framework which can produce audit ready, high quality regulatory information at scale and shorten operational risk, cycle time and the use of subject-matter experts.

There is next generation regulatory impact to the implementation of traceable and regularly adjusted pipelines. With an ever-growing focus on transparency, reproducibility and quick reaction to questioning on the part of supervisory authorities, strong data pipelines are turning into a key part of the infrastructure, not a superfluous improvement. The regulators are not only focusing on the accuracy of the reported metrics but also on whether the institution can be able to show full lineage including their ability to reconcile disparities and explain variances as they arise in good time. Through adopting controlled, deterministic and auditable reporting pipelines, institutions will be able to address such increased expectations, increase the number of regulator queries and enhance the trust in their reporting systems. Further, the architecture can be used to ensure scalable compliance and to meet changing reporting requirements, stress scenarios and resolution planning exercises without having to make significant rework or draw on manual processes.

This framework can be continued strategically in different ways in future research. The incompatibility of reporting standards, legal entity structure and supervisory expectations/ expectations across several regulatory regimes presents special problems in cross-jurisdictional resolution planning and the framework would be amenable to such complexities. Another frontier is real-time supervisory reporting, potentially made possible by streams of data in high frequency and automated controls that might permit near-instant reconciliation and submission of regulations. Moreover, the adoption and adaptation with the new regulatory technologies, including distributed ledgers, artificial intelligence-based anomaly detectives and technological data provenance assistants, would contribute to its transparency, predictive microeconomic efficiency and capability. Considering these possibilities, the future of work might be developed, basing on the basis of this paper, establishing regulation reporting systems that are more robust, flexible and adapted to the changing environment of the supervisory expectations.

6. References

1. Supervision B. Basel committee on banking supervision. Principles for Sound Liquidity Risk Management and Supervision, 2011.
2. FSB. Key attributes of effective resolution regimes for financial institutions, 2014.
3. Bonollo M, Neri M. Data quality in banking: Regulatory requirements and best practices. Journal of risk management in financial institutions, 2012;5: 146-161.
4. Khatri V, Brown CV. Designing data governance. Communications of the ACM, 2010;53(1): 148-152.
5. Otto B. Organizing data governance: Findings from the telecommunications industry and consequences for large service providers. Communications of the Association for Information Systems, 2011;29(1): 3.
6. Buneman P, Khanna S, Wang-Chiew T. Why and where: A characterization of data provenance. In International conference on database theory, 2001: 316-330.
7. Bovenzi JF. Inside the FDIC: Thirty years of bank failures, bailouts and regulatory battles. John Wiley & Sons, 2015.
8. Gordon M. Reconciliations: The forefront of regulatory compliance procedures. Journal of Securities Operations & Custody, 2016;8: 356-363.
9. Li J, Maiti A, Fei J. Features and scope of regulatory technologies: challenges and opportunities with industrial internet of things. Future Internet, 2023;15: 256.
10. Bhatt T, Cusack C, Dent B, et al. Project to develop an interoperable seafood traceability technology architecture: issues brief. Comprehensive Reviews in Food Science and Food Safety, 2016;15: 392-429.
11. Leuz C. Different approaches to corporate reporting regulation: How jurisdictions differ and why. Accounting and business research, 2010;40: 229-256.
12. Bowen F, Panagiotopoulos P. Regulatory roles and functions in information-based regulation: A systematic review. International Review of Administrative Sciences, 2020;86: 203-221.
13. Marchini PL andrei P, Medioli A. Related party transactions disclosure and procedures: a critical analysis in business groups. Corporate Governance: The International Journal of Business in Society, 2019;19: 1253-1273.
14. Kraakman RH, Armour J. The anatomy of corporate law: A comparative and functional approach. Oxford university press, 2017.
15. Bennett M. An industry ontology for risk data aggregation reporting. Journal of Securities Operations & Custody, 2016;8: 132-145.
16. Cai S, Gallina B, Nyström D, et al. Data aggregation processes: a survey, a taxonomy and design guidelines. Computing, 2019;101: 1397-1429.
17. Fang Z. System-of-systems architecture selection: A survey of issues, methods and opportunities. IEEE Systems Journal, 2021;16: 4768-4779.
18. Mahoney W, Gandhi RA. An integrated framework for control system simulation and regulatory compliance monitoring. International Journal of Critical Infrastructure Protection, 2011;4: 41-53.
19. Bamberger KA. Technologies of compliance: Risk and regulation in a digital age. Tex L Rev, 2009;88: 669.
20. Sparrow MK. The regulatory craft: controlling risks, solving problems and managing compliance. Bloomsbury Publishing USA, 2011.