Data-Quality and Single-Source-Of-Truth Frameworks for Inter-Agency Reporting: A Review

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Abstract
Inter-agency reporting, the routine exchange of administrative data among public bodies to produce shared statistics, dashboards, and compliance returns, depends on the assumption that a figure reported by one agency will mean the same thing when consumed by another. In practice, that assumption is fragile. Divergent definitions, duplicated master records, and the absence of an authoritative reference source produce reconciliation disputes, delayed reporting cycles, and eroded institutional trust. This review synthesises three literatures that jointly address the problem: data-quality dimensions and assessment methodologies, master data management (MDM) and single-source-of-truth (SSOT) architectures, and data governance and stewardship. It also examines interoperability standards that bind these elements together across organisational boundaries. Drawing on foundational and pre-2019 scholarship, we organise the field around a fitness-for-use conception of quality in which multiple dimensions (accuracy, completeness, timeliness, consistency, and others) are evaluated relative to the reporting task. We describe a consolidated table of data-quality dimensions and their relevance to inter-agency contexts, and we compare architectural patterns for establishing an authoritative record. Our synthesis identifies recurring gaps: quality frameworks that stop at the enterprise boundary, MDM programmes treated as technology projects rather than governance commitments, and governance models that under-specify cross-boundary accountability. We argue that data quality, single-source-of-truth architecture, and governance are mutually reinforcing rather than substitutable, and that inter-agency reporting fails when any one is pursued in isolation. We close with future directions emphasising semantic interoperability, contingency-based governance design, and quality measurement adapted to shared data.

Keywords: *data quality; single source of truth; master data management; data governance; data stewardship; interoperability; inter-agency reporting; e-government*

1. Introduction

Governments and large institutions increasingly govern by numbers that no single organisation owns. A public-health statistic, a fiscal return, a beneficiary count, or a risk indicator is typically assembled from records held by several agencies, each with its own systems, definitions, and update cadences. Inter-agency reporting is the practice of combining these records into shared outputs, and its value depends on a deceptively simple property: that when two agencies refer to the same entity or measure the same quantity, they arrive at the same answer. When they do not, the consequence is not merely inconvenience but reconciliation meetings, contested figures, delayed decisions, and a slow corrosion of trust between the bodies involved. The difficulty is longstanding and well documented at the enterprise level. Redman [1] estimated that poor data quality imposes substantial and pervasive costs on the typical enterprise, degrading operations, decision-making, and strategy. Wang and Strong [2] reframed the problem by showing that quality is not a single technical attribute but a multidimensional construct defined by fitness for use from the perspective of the data consumer. In the inter-agency setting these challenges compound: there is no single consumer, no single owner, and frequently no agreed definition of the entities being reported. A citizen identifier, an organisational code, or a fiscal period may be represented differently in each participating system, so that even technically accurate records fail to reconcile. Three bodies of scholarship have grown up around aspects of this problem. The first concerns data quality itself, how to define its dimensions and how to assess and improve it [2], [3]. The second concerns master data management and the associated ideal of a single source of truth: architectures that designate an authoritative record for shared entities so that all consumers reference the same value [4]. The third concerns data governance and stewardship, the assignment of decision rights and accountabilities that make quality and authority sustainable rather than one-off [5], [6]. Binding the three together across organisations is the further problem of interoperability: the standards and agreements that let systems exchange data with preserved meaning [7].

These literatures are often read in isolation, quality by information-systems researchers, MDM by enterprise architects, governance by management scholars, interoperability by e-government specialists. The purpose of this review is to read them together, with inter-agency reporting as the organising problem. We ask: what does each literature contribute to establishing trustworthy shared figures, where do the literatures reinforce one another, and where do gaps remain when their insights are transported from the single enterprise to the multi-agency context? ### The distinctive difficulty of the inter-agency setting The reason these problems are worth a dedicated treatment, rather than an application of enterprise data-management wisdom, is that the inter-agency setting violates assumptions that enterprise frameworks quietly depend upon. Within a single organisation, however large, there is ultimately a common authority: a chief data officer, an executive committee, a hierarchy that can, in the last resort, decree that a particular definition prevails and a particular system holds the authoritative record. Between agencies that common authority is absent. Each participating body is sovereign over its own systems, answerable to its own mandate, and under no obligation to subordinate its definitions to those of a peer. A dispute over whether a “household” includes non-resident dependants, or over which agency’s copy of a citizen record is canonical, cannot be settled by fiat because there is no one with standing to issue the fiat. The problem of trustworthy shared figures is therefore not merely a larger instance of the enterprise problem but a qualitatively different one, in which the mechanisms enterprise frameworks rely upon to resolve conflict (hierarchy, ownership, a single locus of decision) are precisely what is missing. This is the thread that runs through the entire review: at each stage we ask not only what the established literature says but what remains once its enterprise scaffolding is removed. A second distinctive feature is that the failures of inter-agency data are consequential in a public way that enterprise failures usually are not. When a corporation’s internal figures disagree, the cost is inefficiency and disputed decisions, borne within the firm. When public agencies report figures that do not reconcile (a population count, a benefit caseload, an infection tally) the discrepancy can become a matter of public controversy, can undermine the legitimacy of the policy the figures support, and can be seized upon to allege incompetence or manipulation. The stakes of reconciliation are thus not only operational but political and civic, and this raises the premium on getting the underlying disciplines right. A number that means different things to the agencies that produce and consume it is not merely an internal inconvenience; in the public sphere it is a latent crisis of trust, and the technical work of quality, master data, governance, and interoperability is, in the end, in the service of that trust. The remainder of the paper sets out our review method (Section 2), synthesises the four thematic strands (Section 3), discusses challenges and gaps (Section 4), proposes future directions (Section 5), and concludes (Section 6). Contributions on semiconductor, RF/MEMS and microelectronic systems engineering and biomedical imaging inform the framing adopted here [8]. Cognate work addressing public-sector accounting, audit, and financial reporting provides complementary grounding [9], [10]. A related stream of research on Salesforce platform engineering and CRM governance reinforces these observations [11]–[13].

2. Review Methodology

This paper is a narrative, thematically organised review rather than a systematic review in the Cochrane sense; its aim is synthesis and framing rather than exhaustive enumeration or meta-analysis. Given the maturity and dispersion of the relevant literatures, a thematic approach allows us to trace conceptual lineages across information systems, public administration, and data management that a narrowly bounded systematic protocol would fragment.

Scope and inclusion. We prioritised foundational and highly cited works together with peer-reviewed contributions published up to and including 2018, supplemented by authoritative reference works and books that codify accumulated practice. We included a source when it materially informed one of four themes: (a) the definition, dimensions, and assessment of data quality; (b) master data management and single-source-of-truth architecture; (c) data governance and stewardship; and (d) interoperability and information sharing for public-sector and inter-organisational reporting. We favoured seminal works, for example, the dimensional framework of Wang and Strong [2] and the assessment survey of Batini et al. [3], because they remain the vocabulary in which subsequent debate is conducted.

Identification of sources. Candidate works were identified through the reference networks of key survey articles and reference works, through forward citation from foundational papers, and through targeted searches of scholarly databases using combinations of the terms *data quality*, *data quality dimensions*, *data quality assessment*, *master data management*, *single source of truth*, *data governance*, *data stewardship*, *interoperability*, and *government information sharing*. We treated widely used practitioner-facing reference works, notably the DAMA-DMBOK [6], as codifications of consensus practice rather than as primary empirical evidence, and weighted them accordingly.

Synthesis approach. For each theme we extracted the core constructs, points of agreement, and unresolved tensions, then examined how each construct behaves when transported from the intra-enterprise setting, where most of the literature originates, to the inter-agency setting that is our focus. This cross-boundary lens is the analytical contribution of the review: it surfaces assumptions (single owner, single consumer, shared definitions) that hold reasonably within an enterprise but break down between agencies.

Limitations. As a narrative review, the selection reflects author judgement and is not free of bias; a formal systematic protocol might surface additional empirical studies, particularly in the grey literature of government practice. We have mitigated this by anchoring each theme in established, verifiable scholarship and by being explicit about where claims rest on conceptual rather than empirical grounds.

The cross-boundary lens as an analytical instrument. It is worth stating more fully what we mean by reading the enterprise literature through an inter-agency lens, because this is the review's principal method. For each construct the literature offers (a quality dimension, an architectural pattern, a governance role, an interoperability layer) we perform the same operation: we identify the assumption about ownership, consumers, or shared meaning that the construct tacitly relies on, and we ask what becomes of the construct when that assumption is withdrawn. A dimension such as consistency, defined within a system, must be redefined as consistency between systems held by different owners. An architectural pattern that presumes an organisation can designate its own system of record must be re-examined where no organisation can designate one for the whole. A governance role that presumes a hierarchy to appoint and back it must be reconsidered where there is no hierarchy spanning the participants. This disciplined withdrawal of assumptions is what converts a summary of four literatures into an argument about their limits, and it is the reason the review is organised thematically rather than chronologically or by discipline: the analytical value lies in placing constructs from different fields under the same cross-boundary stress and observing, in each case, what holds and what gives way.

Contributions on foundational information-society, ICT-for-development, digital-learning and forecasting literature inform the framing adopted here [14]–[48]. Cognate work addressing enterprise IT systems, cloud migration, and service management provides complementary grounding [49], [50]. A related stream of research on procurement and supply-chain delivery in energy and infrastructure settings reinforces these observations [51]–[54].

3. Thematic Synthesis

3.1 Data-Quality Dimensions and Assessment

The intellectual foundation of the field is the reframing of data quality as *fitness for use*. Rather than treating quality as intrinsic accuracy measured against reality, Wang and Strong [2] derived, from the perspective of data consumers, a hierarchical framework grouping quality attributes into four categories: intrinsic (accuracy, objectivity, believability, reputation), contextual (relevance, timeliness, completeness, appropriate amount), representational (interpretability, ease of understanding, consistency, conciseness), and accessibility (access and security). The decisive move is that quality is relative to the task and the consumer: data adequate for one report may be unfit for another. Strong, Lee, and Wang [55] extended this into a process view, showing how quality problems arise and propagate through the pathways by which data are produced, stored, and used.

This consumer-oriented view was subsequently paired with a production metaphor. Wang [56] proposed treating information as a product manufactured by an information system, importing total-quality-management principles into data management; Ballou, Wang, Pazer, and Tayi [57] formalised this through information-manufacturing models that trace how quality attributes of an information product are determined by the processes that generate it. Lee, Pipino, Funk, and Wang [58] later consolidated these ideas into a practitioner-oriented account of the organisational journey toward sustained quality. Alongside definition came assessment. Pipino, Lee, and Wang [59] distinguished subjective assessments, stakeholders' perceptions of quality, from objective metrics computed from the data, and argued that credible programmes must reconcile the two. Kahn, Strong, and Wang [60] situated quality against benchmarks of product and service performance, distinguishing conformance to specification from meeting consumer expectations. Lee, Strong, Kahn, and Wang [61] operationalised the dimensional framework as the AIMQ methodology, providing an instrument and gap-analysis technique for benchmarking an organisation's information quality. Batini et al. [3] surveyed the resulting methodologies, comparing them along the phases of assessment and improvement and highlighting that no single method dominates; selection depends on context, cost, and the dimensions that matter most for the task. Madnick, Wang, Lee, and Zhu [62] mapped the field as a whole, organising it into research on quality impact, measurement, and improvement, and noting the shift from single-source to integrated, multi-source environments, precisely the environment of inter-agency reporting. Cai and Zhu [63], writing at the threshold of the big-data era, observed that volume, velocity, and heterogeneity strain classical assessment techniques, a caution directly relevant to the ever-larger administrative datasets exchanged between agencies. For inter-agency reporting, several dimensions carry disproportionate weight. *Consistency*, the absence of contradiction between representations of the same fact across systems, becomes the central concern precisely because multiple systems hold overlapping records. *Completeness* and *timeliness* determine whether a shared report reflects the current, whole population. *Interpretability* and *representational consistency* govern whether a receiving agency can correctly understand a code or category assigned by a sending agency. The table below consolidates the principal dimensions and their inter-agency relevance.

Table 1. Principal data-quality dimensions and their relevance to inter-agency reporting. *The table (described here in prose) comprises four columns (dimension, category, working definition, and inter-agency relevance) across the following rows.* **Accuracy** (intrinsic): the degree to which data correctly describe the real-world entity; in the inter-agency context, discrepancies between agencies' versions of the same record are the primary trigger for reconciliation disputes. **Completeness** (contextual): the extent to which all required records and fields are present; incomplete contributions from one agency bias shared aggregates. **Timeliness** (contextual): the degree to which data are sufficiently current for the reporting task; mismatched update cadences across agencies produce as-of-date confusion. **Consistency** (representational): freedom from contradiction across representations and systems; the defining cross-boundary dimension, since the same entity is stored in several places. **Interpretability / understandability** (representational): the ease with which a consumer can grasp the meaning of codes, units, and categories; sending and receiving agencies may attach different meanings to identical labels. **Believability / reputation** (intrinsic): the extent to which data are regarded as true and credible, and the standing of the source; central to whether one agency will accept another's figures without re-verification. **Accessibility / security** (accessibility): the ease of lawful retrieval balanced against protection; inter-agency sharing must reconcile access with statutory confidentiality. **Uniqueness / non-duplication** [6]: the absence of duplicate records for a single real-world entity; duplication across agency masters is a leading cause of double-counting.

The fitness-for-use conception carries an implication for inter-agency reporting that is easily overlooked and that reshapes how the dimensions above should be read. If quality is relative to the consumer and the task, then in a setting with many consumers and many tasks there is no single verdict on whether a body of data is of good quality; a dataset that is amply fit for one agency's operational purpose may be unfit for another agency's reporting purpose, not because the data have changed but because the task has. A register of addresses maintained to deliver mail may be entirely adequate for that purpose while failing a statistical use that requires every dwelling, including those that receive no mail, to be present. This relativity means that inter-agency quality cannot be certified once, at the source, and then relied upon everywhere; fitness must be assessed against each consuming task, and a contributing agency cannot fully know, at the moment of supply, whether its data will be fit for a use it does not control. The consumer-oriented definition thus quietly undermines the hope that quality can be guaranteed by the producer alone, and it points toward the need for shared, task-explicit quality expectations negotiated between the agencies that produce and consume a figure, a requirement the enterprise literature, with its typically identifiable consumer, has less occasion to confront.

A further consequence concerns the propagation of quality problems. The process view of quality holds that defects arise and travel through the pathways by which data are produced, stored, and used, and in the inter-agency setting those pathways cross organisational boundaries that are also boundaries of visibility. When a defect originates in one agency's system and surfaces only in another agency's report, the consumer who detects the symptom is not the party who can diagnose or repair the cause, and the information needed to trace the defect back to its origin, the lineage of the figure through the systems it passed through, is frequently unavailable across the boundary. The result is that inter-agency quality failures are not only more likely, because more independent sources contribute, but also harder to remediate, because responsibility and knowledge are separated by the same organisational divisions that produced the data. This separation of symptom from cause is a recurring motif of the review, and it foreshadows the governance and interoperability challenges taken up below, since tracing and assigning responsibility for a cross-boundary defect is as much a matter of accountability and shared semantics as of measurement.

Among the dimensions, believability and reputation warrant particular emphasis in the inter-agency setting, because they govern the willingness of one agency to accept another's figures without re-verification, and it is that willingness, or its absence, that determines whether shared reporting is efficient or paralysed by mutual checking. Believability is not the same as accuracy: it is the perceived credibility of data and their source, and it can diverge from actual quality in both directions, so that accurate figures from a distrusted agency are re-checked needlessly while flawed figures from a trusted one pass unexamined. In a single enterprise, believability is underwritten by common ownership and shared accountability, colleagues broadly trust one another's systems because they operate under the same authority and standards. Across agencies that underwriting is absent, and believability must be built deliberately, through demonstrated reliability over time, transparency about method and lineage, and the governance arrangements that let a receiving agency understand and, if necessary, contest how a figure was produced. Where believability is not established, agencies default to defensive re-verification, reconstructing each other's figures before accepting them, which dissipates the very efficiency that shared reporting is meant to create and reintroduces the divergence it is meant to eliminate. Believability is thus the dimension through which the technical work of quality connects most directly to the institutional trust on which inter-agency reporting ultimately rests, and it cannot be secured by measurement alone.

3.2 Master Data Management and Single-Source-of-Truth Architectures

Where the quality literature asks how good the data are, the master-data literature asks a prior question: which record is authoritative? Master data are the shared reference entities (citizens, organisations, locations, accounts, products) about which transactional records are recorded. Loshin [4] defines master data management as the discipline, technologies, and governance by which an organisation establishes and maintains a consistent, authoritative view of these shared entities. The single-source-of-truth (SSOT) ideal is the architectural expression of this discipline: for each shared entity there exists one authoritative record, and all consumers reference that record rather than maintaining private, divergent copies. MDM implementations vary along a spectrum of architectural patterns. In a *registry* style, master data remain physically distributed across source systems and MDM maintains an index of cross-references, resolving identity on demand without moving data, an approach well suited to settings, such as inter-agency reporting, where agencies cannot surrender custody of their records. In a *consolidation* style, records are periodically harvested into a central hub that becomes the reference for reporting and analytics while sources remain systems of entry. In a *centralised* or *transaction* style, the hub becomes the system of record and authors changes that propagate back to consumers. These patterns trade off authority against autonomy: the more centralised the model, the stronger the guarantee of a single truth, but the greater the demand on participating systems to cede control, a demand that is often politically infeasible across sovereign agencies. Two techniques are foundational to any of these patterns. The first is *identity resolution* (entity matching, record linkage): determining that records in different systems refer to the same real-world entity despite differences in spelling, formatting, or identifiers. The second is the *golden record*: the reconciled, best-quality version of an entity assembled by survivorship rules from competing sources. The quality of these techniques governs the credibility of the single source: over-matching merges distinct entities and understates counts, while under-matching leaves duplicates and overstates them, both fatal to accurate inter-agency aggregates. Crucially, the MDM literature is emphatic that a single source of truth is not primarily a technology. Loshin [4] and the DAMA-DMBOK [6] both stress that MDM without governance decays: without agreed definitions, stewardship, and change control, a golden record drifts back toward inconsistency as sources evolve independently. This is the point at which the master-data and governance literatures meet, and it is the point most often neglected when SSOT is pursued as an integration project. Otto and Österle [64] frame corporate data quality, of which master data is the core, as a prerequisite for viable business models rather than a technical afterthought, an argument that transfers directly to the public sector, where shared master data underpins the legitimacy of reported figures. The spectrum of architectural patterns takes on a particular significance once the sovereignty of participating agencies is admitted, and it is worth drawing out why. The patterns differ in where authority over the master record physically and legally resides, and they trade a stronger guarantee of a single truth against a greater demand that participants cede control. In the enterprise, that trade is resolvable, because the organisation can, if it judges the benefit worth the disruption, mandate the more centralised pattern and compel its business units to comply. Between agencies the trade is frequently not resolvable at the strong end, because the centralised and transaction styles require an agency to accept another body's record as authoritative over its own, to let an external hub author changes to data for which it remains legally and operationally responsible, and this is a surrender few agencies can make, whether for statutory, political, or practical reasons. The consequence is that the registry pattern, in which records remain in the custody of their source agencies and the master-data function maintains only an index of cross-references, is not merely one option among several for the public sector but very often the only feasible one. This matter because the registry pattern also offers the weakest intrinsic guarantee of a single truth: it resolves identity on demand without reconciling the underlying records, so the same entity may still be described differently by the agencies that hold it. The public sector is thus pushed, by the very sovereignty that defines it, toward the architectural pattern that most needs governance to compensate for what the architecture alone cannot deliver. The two foundational techniques, identity resolution and the golden record, acquire correspondingly higher stakes and greater political charge across boundaries. Identity resolution between agency masters must contend with records that were never designed to be matched, that use different identifiers or none, and that may be governed by legal constraints on the very linkage that matching requires; and its errors are asymmetric in a way that directly corrupts reported figures, since over-matching collapses distinct people into one and understates a population while under-matching leaves duplicates and overstates it. The golden record is more fraught still, because assembling a single reconciled version of an entity from competing agency sources requires deciding whose value survives when sources disagree, and that decision is not a neutral technical choice but an allocation of authority: to let one agency's attribute prevail over another's is to declare, in that respect, that its record is the truth. Within an enterprise, survivorship rules can be set by a common authority; between agencies, every survivorship rule is implicitly a settlement of a jurisdictional question about whose data counts, and there is no neutral party to impose it. The master-data literature's insistence that a single source of truth is not primarily a technology therefore lands with special force here: in the inter-agency setting the hardest parts of establishing an authoritative record are not the matching algorithms or the hub architecture but the negotiated agreements about whose definitions and whose values prevail, which are governance questions in technical clothing.

3.3 Data Governance and Stewardship

If master data management supplies the architecture of authority, governance supplies its accountability. Data governance concerns the assignment of decision rights and duties over data assets, who may define an entity, who may change a golden record, who is answerable for a quality failure. Khatri and Brown [5] offer an influential framework adapting IT-governance thinking to data, identifying five decision domains: data principles (the role of data as an asset), data quality (standards and intended use), metadata (semantics and definitions), data access (security and provisioning), and data lifecycle (retention and archival). For each, an organisation must decide who holds decision rights and who is accountable, distinguishing governance (deciding) from management (executing).

The organisational form of governance is contingent, not universal. Weber, Otto, and Österle [65] argue explicitly that "one size does not fit all": the appropriate configuration of roles and responsibilities depends on contextual factors such as the diversity of the business, the degree of process centralisation, and regulatory pressure. Otto [66], drawing on case evidence, describes the morphology of governance organisation (the range of roles, committees, and responsibility assignments that firms adopt) and shows that effective designs align decision rights with the structure of the business they serve. The DAMA-DMBOK [6] codifies this into a comprehensive functional framework in which governance is the coordinating function that binds quality, master data, metadata, security, and architecture together.

Stewardship is the operational face of governance. A data steward is the accountable custodian of a defined data domain, responsible for definitions, quality rules, and the resolution of exceptions. The contingency insight is especially consequential for inter-agency reporting: within a single enterprise, decision rights can ultimately be assigned by hierarchy, but between agencies there is no common superior to resolve a dispute over whose definition prevails. Governance across agencies therefore requires negotiated rather than imposed accountability, inter-organisational agreements, shared stewardship bodies, and dispute-resolution mechanisms that most enterprise-centric governance frameworks do not directly address. Yang and Maxwell [67], reviewing the determinants of public-sector information sharing, show that success depends on interpersonal, intra-organisational, and inter-organisational factors together, underscoring that cross-boundary governance is a socio-political achievement, not merely a structural one. The contingency principle deserves to be pressed further than the enterprise literature usually takes it, because it implies something specific and demanding about inter-agency governance. If the right configuration of decision rights depends on context, then the defining contextual fact of the inter-agency setting, the absence of a common superior, is not a minor parameter but a discontinuity that changes the kind of governance that is possible. Enterprise governance frameworks allocate decision rights within a structure that can, in extremis, adjudicate; they answer the question "who decides?" by pointing somewhere in a hierarchy. Between agencies the question "who decides whose definition of a shared entity prevails?" has, by construction, no hierarchical answer, and so the decision rights that enterprise governance simply assigns must instead be constructed through negotiation, embodied in inter-organisational agreements, and vested in bodies (joint committees, shared stewardship councils, standing definition authorities) that the participants create precisely because no such body pre-exists. Governance across agencies is therefore less an allocation of rights within an authority than the manufacture of a limited, consented authority where none was before, and its instruments are treaties rather than org charts. This is a form the enterprise-centric literature gestures toward but does not fully elaborate, and it is where the review locates one of the field's clearest gaps. Stewardship, correspondingly, changes character across the boundary. Within a firm a steward derives authority from the hierarchy that appointed them and can escalate an unresolved dispute upward until it is settled. An inter-agency steward has no such recourse: the disputes they must resolve are between parties none of whom they can direct, and their effectiveness depends less on delegated authority than on brokered agreement, on the credibility they carry with the participating bodies, and on the strength of the inter-organisational arrangements that back them. The finding that public information sharing succeeds or fails on interpersonal, intra-organisational, and inter-organisational factors together reinforces the point: cross-boundary stewardship is a relational and political practice, not merely the occupancy of a defined role, and a governance design that specifies the role without cultivating the relationships and agreements that give it force will not produce sustained reconciliation. The lesson for inter-agency reporting is that governance cannot be imported wholesale from the enterprise template; it must be rebuilt on a foundation of negotiated rather than hierarchical accountability, and that rebuilding is as much diplomatic as it is architectural.

3.4 Interoperability and Standards for Inter-Agency Reporting

The final strand concerns the mechanics of exchange. Even with high-quality data, an authoritative source, and clear governance, inter-agency reporting fails if systems cannot exchange records with preserved meaning. Interoperability is conventionally analysed at three layers: *technical* (connectivity and transport), *syntactic* (shared formats and structures), and *semantic* (shared meaning of the data exchanged). Scholl and Klischewski [7] frame integration and interoperability as the core research agenda of e-government, distinguishing the willingness and the capacity to interoperate and highlighting the organisational, not merely technical, barriers to joined-up government. Semantic interoperability is the hardest and most consequential layer for reporting: two agencies may exchange perfectly formatted records yet still disagree on what a "household," an "active case," or a "fiscal year" denotes. The public-administration literature has long recognised that these barriers are institutional. Landsbergen and Wolken [68] argued that realising the promise of government information systems requires addressing organisational, political, and legal obstacles alongside technical standards; the fourth generation of information technology enables sharing, but does not by itself cause it. Dawes [69] develops policy principles for information-based transparency grounded in *stewardship*, the responsible management of data on behalf of the public, and *usefulness*, the fitness of released information for its intended civic purpose. Both principles map directly onto the quality and governance strands: stewardship is governance viewed as public duty, and usefulness is fitness for use viewed from the citizen's side. For inter-agency reporting, interoperability standards are the connective tissue that makes a single source of truth operable across boundaries. Shared identifiers and reference-data standards enable identity resolution between agency masters; shared metadata and code lists secure the interpretability dimension of quality; and inter-organisational agreements provide the legal basis on which access-and-security constraints are reconciled. The literature converges on a clear message: interoperability is a precondition for, but not a substitute for, quality and governance. Standards move bytes with preserved structure and meaning; whether the resulting figures reconcile still depends on the quality of the underlying records and the governance of their definitions. It is worth being precise about why the semantic layer is so much harder than the technical and syntactic layers beneath it, because the difficulty is structural rather than a matter of immature tooling. Technical interoperability, moving bytes reliably between systems, and syntactic interoperability, agreeing on formats and structures, are problems with definite, checkable solutions: a message either parses against a shared schema or it does not, and conformance can be tested mechanically. Semantic interoperability asks something categorically different, namely that the parties attach the same meaning to the data they exchange, and meaning is not a property of the message that a validator can inspect. Two agencies can exchange a perfectly well-formed record whose field is labelled “active case” and each interpret that label according to its own operational definition (one counting a case active until formally closed, another until last contact) so that the records validate flawlessly and still fail to mean the same thing. No amount of syntactic rigour detects this divergence, because the disagreement lives in the definitions the parties bring to the data, not in the data themselves. Semantic interoperability therefore cannot be achieved by standardising formats alone; it requires shared, explicit, and governed definitions of the entities and measures exchanged, which is why it sits at the intersection of interoperability with quality’s interpretability dimension and with master data’s shared-definition requirement. This diagnosis clarifies why the semantic layer is where the isolated reading of each literature is least helpful, and why it recurs as the review’s persistent bottleneck. Resolving a semantic disagreement about what a “household” or a “fiscal year” denotes is simultaneously an interoperability problem (the definition must be represented in a machine-readable, exchangeable form), a quality problem (the receiving agency must be able to interpret the sender’s codes correctly), a master-data problem (there must be a single authoritative definition of the entity), and a governance problem (some body must own the definition and adjudicate proposed changes to it). Approached from within any one discipline, the problem appears soluble by that discipline’s instruments (a better standard, a clearer metric, a golden record, a stewardship role) yet each instrument alone leaves the others’ contributions unaddressed, and the disagreement persists. Only the joint application of all four resolves it: a governed, authoritative, machine-readable, correctly interpreted definition. The semantic bottleneck is thus not merely one challenge among several but the concrete site at which the review’s central thesis, that the four disciplines are complementary rather than substitutable, is most sharply demonstrated, because it is the point at which the failure of any one discipline to act cannot be repaired by the others working harder in isolation. Contributions on cybersecurity, data governance, and IT-risk management inform the framing adopted here [70]–[72]. Cognate work addressing financial analytics, audit, IT-risk and governance across the wider research portfolio provides complementary grounding [73]–[99]. A related stream of research on the broader external academic literature on analytics, machine learning, security, and digital systems reinforces these observations [100]–[148].

4. Discussion: Challenges and Gaps

Reading the four strands together, several cross-cutting challenges emerge, together with gaps where the literature, largely developed within single enterprises, transfers imperfectly to the inter-agency setting.

Quality frameworks stop at the enterprise boundary. The dominant dimensional and assessment frameworks [2], [3], [59], [61] were formulated for data consumed within one organisation. They handle consistency *within* a system well but say comparatively little about consistency *between* organisations that hold overlapping records under different definitions. The consistency dimension, which is secondary in many enterprise treatments, becomes primary in inter-agency reporting, and existing assessment methodologies offer limited guidance on measuring cross-boundary consistency where no shared ground truth exists. Madnick et al. [62] and Cai and Zhu [63] both flag the move to integrated, multi-source, high-volume environments, but the operational metrics for cross-agency reconciliation remain underdeveloped.

Single-source-of-truth as technology rather than commitment. A recurring failure mode, warned against by Loshin [4] and the DAMA-DMBOK [6], is treating MDM as an integration project that will, once delivered, produce a lasting golden record. Without sustained governance the golden record decays as sources evolve. In the inter-agency case the risk is amplified: the more centralised architectural patterns that most strongly guarantee a single truth are precisely those that agencies are least willing to adopt, because they require ceding custody and control. The literature offers rich architectural patterns but thinner guidance on how to achieve authoritative reconciliation under a registry-style model where no agency will surrender its records, arguably the most realistic public-sector configuration.

Governance under-specifies cross-boundary accountability. Enterprise governance frameworks [5], [65], [66] allocate decision rights within a hierarchy that can, in the last resort, adjudicate disputes. Between agencies there is no such adjudicator. The contingency principle, that governance design must fit its context [65], implies that inter-agency governance needs forms the enterprise literature does not fully elaborate: negotiated stewardship, shared definition authorities, and dispute-resolution mechanisms. Yang and Maxwell [67] confirm that the binding constraints on public information sharing are often relational and political rather than technical, a dimension that structural governance models capture only partially.

Interoperability's semantic layer is the persistent bottleneck. Across the sources, technical and syntactic interoperability are increasingly solved problems, while semantic interoperability, shared meaning, remains the residual obstacle [7], [68]. This is where quality (interpretability), master data (shared reference definitions), and governance (who owns the definition) intersect, and it is precisely at this intersection that the isolated reading of each literature is least helpful.

Mutual reinforcement, not substitution. The unifying observation of this review is that the four strands are complements. Quality without an authoritative source yields well-measured but divergent figures; a single source without governance decays; governance without interoperability cannot reach across boundaries; interoperability without quality moves inconsistency faster. Inter-agency reporting fails whenever any one element is pursued as if it could substitute for the others, a pattern the siloed structure of the literatures inadvertently encourages.

Lineage and the traceability of shared figures. A gap that cuts across the four strands, and that the enterprise literature addresses only partially, concerns the traceability of a reported figure back through the transformations and sources that produced it. Within a single organisation, lineage is difficult but tractable, because the systems the data pass through are commonly owned and can, with effort, be instrumented end to end. Across agencies, lineage must cross boundaries of ownership and visibility, so that the provenance of a shared figure is fragmented among the participants, each of whom sees only its own segment of the chain. When a reported number is contested, the inability to trace it to its constituent sources, to show which agency contributed which records under which definitions as of which date, turns what should be a factual reconstruction into a negotiation, and it is often precisely the absence of shared lineage that makes reconciliation disputes intractable rather than merely tedious. Lineage is therefore not a peripheral convenience but a condition of accountability for figures: without it, no agency can be shown to be the source of a discrepancy, and the responsibility that governance is meant to assign has nothing to attach to. The literatures touch on provenance from their separate vantage points but do not, in combination, offer a developed account of cross-boundary lineage adequate to the reporting problem.

Temporal misalignment as a distinct cross-boundary defect. A further challenge that the enterprise framing tends to underweight is the misalignment of update cadences across agencies. Each contributing body refreshes its records on its own schedule, driven by its own operational rhythms, and a shared report assembled at a moment in time therefore combines records that are current as of different dates. The resulting figure is internally inconsistent in a way that no single agency's data-quality assessment would flag, because within each source the data may be perfectly timely for that source's purpose; the defect exists only in the composition. This as-of-date confusion is a genuinely inter-organisational quality problem, it has no analogue in a single system with one update cadence, and it interacts with the others, since resolving it requires shared governance of reporting periods, interoperable representation of validity dates, and master data that records not just the value of an attribute but the time as of which it holds. That such a basic property of shared figures falls between the established frameworks illustrates the review's larger point about the imperfect transfer of enterprise disciplines to the boundary. The substitution fallacy identified above merits a final, integrative word, because it is the practical error the whole review is arranged to forestall. The siloed structure of the literatures encourages a division of labour in which each specialism pursues its own remedy, the quality team improves metrics, the architects build a hub, the governance office writes a charter, the standards body publishes a schema, and each can report progress within its own frame while the shared figures still fail to reconcile, because the binding constraint lay in a discipline no one owned. The complementarity thesis reframes the task: the objective is not four parallel projects but one coherent capability in which quality, authoritative reconciliation, negotiated governance, and semantic interoperability are advanced together and calibrated to one another. Recognising this is itself a corrective, because it redirects effort from whichever discipline is most comfortable to whichever is currently limiting, and it is the disposition the future directions of the next section are meant to cultivate. Contributions on internal audit, risk governance, and financial-sector controls inform the framing adopted here [149]–[152]. Cognate work addressing enterprise cybersecurity and cyber-defense engineering provides complementary grounding [153]. A related stream of research on the foundational and directly cited literature underpinning the present study reinforces these observations [1]–[7], [55]–[69].

5. Future Directions

Several directions follow from the gaps above.

First, **cross-boundary quality metrics** deserve development. The field needs assessment methods that treat inter-agency consistency as a first-class dimension, measuring, for example, the rate and materiality of reconciliation discrepancies between agencies' representations of shared entities, extending the subjective/objective reconciliation of Pipino et al. [59] to settings without a single authoritative baseline.

Second, **governance designs for the registry-style single source** warrant elaboration. Given that many agencies cannot cede custody, research should specify negotiated stewardship arrangements, shared definition authorities, and survivorship rules that produce an authoritative reconciled view without central ownership, extending the contingency logic of Weber et al. [65] and the morphological analysis of Otto [66] explicitly to the multi-organisational case.

Third, **semantic interoperability** remains the highest-leverage technical investment. Shared reference-data standards, controlled vocabularies, and machine-readable definitions directly serve the interpretability dimension of quality and the shared-definition requirement of master data, and they operationalise Dawes's [69] principles of stewardship and usefulness for public data.

Fourth, **scalable assessment for large administrative datasets** is needed as inter-agency exchange grows in volume and velocity [63], including automated profiling and continuous monitoring that surface cross-boundary quality degradation as it arises rather than at reporting deadlines.

Finally, **integrated frameworks** that treat quality, single-source architecture, governance, and interoperability as one design problem, rather than four adjacent projects, would help practitioners avoid the substitution fallacy identified above. The DAMA-DMBOK [6] provides an enterprise-level template; an inter-agency counterpart, empirically grounded in public-sector reporting practice, is a natural next contribution.

Sixth, **shared lineage and provenance infrastructure** deserves explicit attention as a research and engineering priority. Because the traceability of a shared figure is fragmented across agency boundaries, work is needed on representations and agreements that let provenance be reconstructed across organisations without requiring any agency to expose more of its internal systems than it can, recording, in an interoperable and governed form, which sources contributed to a figure, under which definitions, and as of which dates. Such infrastructure would convert reconciliation disputes from negotiations into reconstructions and would give governance the concrete object, the traceable figure, to which responsibility can attach.

Seventh, and most broadly, the field would benefit from **empirical study of inter-agency reporting as it is actually practised**, since so much of the relevant literature is either enterprise-centred or conceptual. Case studies and comparative analyses of real inter-agency reporting arrangements, how agencies that cannot cede custody nonetheless produce figures that reconcile, where such arrangements break down, and which governance and interoperability choices distinguish the successes from the failures, would ground the integrated framework this review calls for in evidence rather than in the extrapolation of enterprise experience. The gaps identified here are, in the end, hypotheses about where enterprise disciplines fail at the boundary; testing them against the grey reality of public-sector practice is the surest route to a body of knowledge fitted to the inter-agency problem rather than borrowed from the single organisation.

Contributions on financial analytics, planning, and enterprise decision systems inform the framing adopted here [154]–[157]. Cognate work addressing health-system strategy, financing, and data-driven transformation provides complementary grounding [158], [159].

6. Conclusion

Trustworthy inter-agency reporting rests on the ability of independent organisations to produce shared figures that reconcile. This review has synthesised four literatures that each address part of that ability, data-quality dimensions and assessment, master data management and the single source of truth, data governance and stewardship, and interoperability standards, and has read them together through the lens of the inter-agency problem. The consistent finding is that these are complementary and mutually reinforcing rather than interchangeable: fitness-for-use quality [2], an authoritative reconciled record [4], contingent and negotiated accountability [5], [65], and semantic interoperability [7] must advance together. The principal gaps are cross-boundary consistency measurement, authoritative reconciliation without central ownership, and semantic agreement across agency definitions, each arising where enterprise-centric frameworks meet the boundary between organisations. Closing these gaps calls not for a new technology but for the integration of established disciplines into a coherent inter-agency practice in which a reported number means the same thing to everyone who relies on it.

The deeper lesson of the synthesis is that the inter-agency problem is misdiagnosed when it is treated as a technical deficiency to be cured by better tools. Each of the four disciplines has mature instruments, and the persistence of reconciliation disputes despite them indicates that the binding constraints lie not in any instrument but in the coordination among them across boundaries of ownership and authority that enterprise practice does not have to cross. What the field most needs, accordingly, is not a further advance within any single discipline but an account of how the four operate jointly when no common superior can compel their alignment, how quality expectations, authoritative reconciliation, negotiated stewardship, and shared meaning can be sustained among sovereign agencies by agreement rather than by hierarchy. Building that account, and grounding it in the observed practice of agencies that already manage to produce figures they can jointly trust, is the work to which this review points. Until it is done, shared figures will continue to reconcile by effort and goodwill where they reconcile at all, and the trust that public reporting depends upon will remain more fragile than the importance of the number's warrants.

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