

From Fragmented Metrics to Intelligent Enterprise Governance: The Zuber Universal Quality Measures Framework (ZUQMF)

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ABSTRACT

Purpose: To develop the Zuber Universal Quality Measures Framework (ZUQMF), an enterprise governance architecture connecting healthcare indicator specifications with multidimensional accountability, analytical interpretation, and organizational action.

Methodology: A conceptual framework-development approach combines purposive integration of quality, strategic performance, patient safety, person-centered governance, and digital health literature with analytical specification. The analysis defines core constructs, maps governance requirements, specifies Indicator Identity attributes, and formulates propositions for prospective evaluation. No primary institutional or patient-level data are analyzed.

Results/Analysis: The conceptual outputs comprise four core components: Indicator Identity, governance integration, analytics, and enterprise dashboards. A linked model separates measure definitions, specification versions, local implementations, and observations. A source-to-design matrix and comparison with existing approaches explain the proposed requirements. A comprehensive specification covers selection, sampling, coding, enterprise mappings, benchmarking, causal analysis, action strength, and graphical interpretation. Rules address zero denominators, missing evidence, critical exceptions, and double counting. A worked hypothetical example demonstrates calculation and action traceability. Empirical feasibility, organizational benefit, and predictive performance remain to be evaluated.

Originality/Value: The proposed contribution is the integration of a persistent Indicator Identity with explicit governance relationships and a closed decision cycle. ZUQMF offers a testable architecture for reusing measures across organizational perspectives while preserving their meaning and provenance. Comparative evaluation is required to establish its additional value beyond existing registries and governance systems.

Type of Paper: Conceptual framework-development paper.

Keywords: Zuber Universal Quality Measures Framework; Indicator Identity; healthcare quality indicators; enterprise governance; KPI governance; patient safety; digital health; predictive analytics.

1. INTRODUCTION :

Healthcare performance measurement serves several purposes: assessing care quality, detecting harm, allocating resources, evaluating strategy, and demonstrating accountability. These purposes overlap, but they are not interchangeable. Donabedian's structure-process-outcome model provides a foundation for examining care quality [2], while the Triple Aim brings together experience of care, population health, and cost [1]. Strategic performance systems connect organizational objectives with financial and nonfinancial measures [3–6,9]. Together, these traditions establish that performance is multidimensional and that interpretation depends on the purpose of measurement.

An organization may nevertheless possess many indicators without having a coherent measurement system. Different departments can use similar names for measures with different denominators; one measure can appear in several dashboards; and accountability for interpretation may be separated from responsibility for corrective action. These are plausible governance problems rather than evidence that all healthcare systems are fragmented. The relevant research question is how an enterprise architecture

can make the meaning, provenance, ownership, and intended use of each measure explicit across organizational boundaries.

Digitalization intensifies this question. Connecting data sources improves access, but technical connectivity alone does not establish semantic equivalence or clarify who should respond to a signal. WHO's earlier digital health strategy [8] and its updated 2020–2027 strategy [31] emphasize the organizational as well as technological foundations of digital health. ZUQMF is therefore proposed as a governance architecture, not simply as a dashboard or software product.

This paper develops the Zuber Universal Quality Measures Framework (ZUQMF) around “Indicator Identity”: a persistent, version-controlled specification linking a measure to its calculation, governance context, evidence, and decision pathway. The intended contribution is an integration of established measurement principles into an explicit enterprise operating architecture. The contribution concerns the explicit relationships among these established elements and the operational rules governing their reuse across organizational settings.

2. BACKGROUND AND RATIONALE :

2.1 Measurement and governance as related constructs:

A measure is an operational representation of a defined attribute; an indicator is a measure interpreted as a signal about a condition or performance domain; and a KPI is an indicator selected because of its relevance to a strategic or operational priority. Governance concerns the assignment of authority, accountability, review, and action. ZUQMF connects these constructs by specifying how a numerical result becomes an accountable decision input.

This distinction matters because an adverse outcome, a reporting rate, and a compliance percentage carry different meanings. An increase in incident reporting may reflect more harm, greater reporting openness, or both. A process-compliance measure can improve while an outcome remains unchanged because of case mix, statistical uncertainty, or an incomplete causal pathway. A governance architecture should preserve these distinctions rather than interpret every increase as improvement or every decline as deterioration. Reason's systems approach provides a foundation for examining organizational conditions rather than attributing every safety signal to individual failure [7].

2.2 Scope and intended applicability:

The framework is intended for hospitals, ambulatory services, and multisite healthcare enterprises. Its unit of design is the governed indicator; its unit of implementation is the organizational measurement system. Clinical, patient safety, operational, patient experience, financial, compliance, population health, workforce, and digital domains are included as organizational contexts. Predictive analytics is treated as a cross-cutting capability rather than an additional clinical outcome domain.

“Universal” denotes a common specification architecture that can accommodate different indicator types. It does not imply that all organizations should use identical measures, targets, or weights. Local service scope, regulatory requirements, patient populations, and information systems remain important. Population indicators cannot automatically be treated as hospital performance indicators, and an accreditation requirement cannot be reduced to a KPI when it requires direct observation or qualitative evidence.

3. REVIEW OF LITERATURE :

3.1 Foundational quality and strategic performance models:

Donabedian's model clarifies the relationships among resources, care processes, and outcomes [2]. The Triple Aim broadens the discussion to population-level performance [1]. These frameworks provide organizing concepts rather than complete technical specifications for enterprise indicator management. Their value should therefore be distinguished from the particular governance functions proposed here. The Balanced Scorecard links financial performance, customers, internal processes, and organizational learning to strategy [3–5]. Healthcare applications demonstrate how this approach can be adapted to hospital systems [6,9]. ZUQMF complements these approaches by retaining the technical identity of indicators while allowing them to contribute to several strategic perspectives. The integration achieved depends on implementation choices, including provenance, version control, shared definitions, and action ownership. An independent scoping review documents variation in healthcare Balanced Scorecard development and implementation, supporting attention to these contextual choices [35].

3.2 Patient safety and clinical governance:

Systems-based safety thinking directs attention to the conditions that shape clinical work [7]. The author's person-centered clinical governance standards [11] and proposed Safety-III framework [10] offer related perspectives on governance and predictive safety. They inform the conceptual design but do not provide empirical validation of ZUQMF.

Specific clinical studies also show why contextual metadata matter. The endoscopy recall case study using FMEA concerns a defined procedural risk [15]; the hand-hygiene literature review concerns cultural and religious dimensions of implementation [14]; and the COVID-19 standards paper concerns governance during an infectious disease emergency [12]. Their relevance here lies in the diversity of safety contexts that an enterprise registry must describe, rather than in a common effect estimate that could be transferred to ZUQMF.

3.3 Patient experience and accreditation:

Patient experience, satisfaction, and patient-reported outcomes should be represented separately. Experience describes interactions with care; satisfaction incorporates expectations; and outcomes describe health status or functioning. The author's patient-centric experience framework [13], hemodialysis accreditation case study [17], and Khan's accreditation literature review [18] provide contextual literature for linking experience measures with governance. Their findings should be interpreted within their study designs and clinical settings.

The post-accreditation continuous compliance framework proposes a transition from periodic preparation to ongoing oversight [21]. Its relevance to ZUQMF is the need to connect monitoring with evidence, accountable action, and reassessment. A measure of action closure must distinguish administrative closure from independently verified resolution and sustained compliance.

3.4 Resource use and population context:

Enterprise quality governance extends beyond clinical dashboards. Electricity consumption and value engineering [16], laboratory and blood-bank performance [22], and Saudi demographic, economic, and health-resource indicators [23–25] illustrate different measurement levels and units. These publications provide contextual antecedents. They support the need to specify population, organizational level, units, and period; their historical findings should not be presented as contemporary benchmarks.

The author's Cost of Quality Intelligence Framework [19] and Balanced Scorecard Intelligence Framework [20] are particularly relevant to financial and strategic interpretation. The former distinguishes monetary quality costs from a performance-intelligence index; the latter links normalized KPIs to strategic perspectives. ZUQMF can provide metadata and governance connections for such models without treating financial amounts and dimensionless scores as equivalent quantities.

3.5 Technical specifications and responsible analytics:

AHRQ's quality indicator resources illustrate the importance of explicit numerators, denominators, exclusions, and technical specifications [30]. Composite-indicator methodology additionally requires careful choices about normalization, weighting, aggregation, and sensitivity [27]. AI applications require separate ethical and technical oversight: WHO addresses accountability and human rights in health AI [28], while TRIPOD+AI supports transparent reporting of clinical prediction model development and evaluation [29].

3.6 Comparison with existing specification and governance approaches:

Existing approaches already address important elements of the proposed architecture. CMS describes a measure lifecycle that includes specification, implementation, maintenance, and testing [34]. HL7 FHIR separates a Measure definition from a Measure Report containing calculated results [32,33]. These approaches are close comparators for technical specification and information exchange. Balanced Scorecards address strategic interpretation [3–6,9,35], while implementation frameworks examine the contextual determinants of adoption [36].

Table 1 compares their principal purposes with the proposed ZUQMF contribution. The comparison is purposive and feature-based; it is not an exhaustive survey or an empirical ranking. A function outside an approach's primary scope may still be supported by a local implementation. The table therefore

identifies complementary roles rather than assuming that existing systems cannot provide governance integration.

Table 1: Comparison of principal purposes and proposed ZUQMF relationships

Approach	Principal purpose	ZUQMF relationship
CMS measure lifecycle [34]	Measure specification, testing, implementation, and maintenance.	Adopt technical specification discipline; add explicit local ownership, observation-to-action links, and enterprise reuse rules.
FHIR Measure and Measure Report [32,33]	Separate a measure definition from its calculated report and support structured exchange.	Retain definition–result separation; add local implementation and governance mapping records. Exchange requires a separate profile.
Balanced Scorecard [3–6,9,35]	Link financial and nonfinancial performance to organizational strategy.	Connect each strategic view to governed definitions and observations; preserve action history and critical exceptions.
Composite-indicator guidance [27]	Normalization, weights, aggregation, and robustness.	Apply only when a separately specified composite is justified; retain disaggregated measures and exception visibility.
CFIR [36]	Contextual determinants affecting implementation.	Use determinants to assess adoption conditions; distinguish them from indicator definitions and outcome evidence.
Author’s related frameworks [10,11,19–21]	Predictive safety, person-centered governance, financial intelligence, strategy, and continuous compliance.	Provide contextual domain links; assess ZUQMF separately rather than transferring validation claims.

3.7 Research gap and contribution:

The research problem is the explicit connection between a reusable measure definition and the local responsibilities, mappings, observations, and actions that make it useful for enterprise governance. ZUQMF proposes a linked model in which technical definitions remain stable, local implementations remain distinguishable, and observations retain their provenance. A many-to-many mapping supports several governance purposes without duplicating the underlying observation. The contribution is this specified combination and its testable mechanisms, rather than the invention of measure metadata or an exchange standard.

The null alternative is that a conventional measure registry with accountable review provides equivalent benefits. Subsequent comparative evaluation should test whether the proposed mapping, exception, and reassessment relationships improve interpretation and action beyond that simpler approach.

4. OBJECTIVES AND RESEARCH QUESTIONS :

The primary objective is to develop a conceptual enterprise architecture through which healthcare indicators retain consistent meaning while contributing to multiple governance purposes. Secondary objectives are to specify its core constructs, define an operational Indicator Identity, describe safeguards for calculation and interpretation, and establish testable propositions and a staged evaluation plan.

The paper addresses four questions. RQ1: Which attributes are required to connect an indicator’s technical definition with its governance use? RQ2: How can one indicator support several organizational perspectives without duplication or loss of context? RQ3: Which safeguards are necessary for trustworthy aggregation and predictive use? RQ4: How can feasibility, measurement consistency, and organizational effects be evaluated empirically?

5. RESEARCH METHODOLOGY :

5.1 Study design and evidentiary status:

This is a conceptual framework-development study using purposive literature integration and analytical specification. It combines theory synthesis with model construction, approaches discussed in conceptual research methodology [26]. The outputs are analytical specifications and testable propositions, with no patient-level dataset or institutional outcome analysis.

5.2 Evidence base and selection logic:

Sources were selected purposively for their capacity to address the framework's design questions. Foundational quality and strategic measurement publications [1–9] define the organizing concepts. Related clinical, accreditation, experience, resource-use, and population publications [10–25] supply application contexts. Methodological guidance [26–31] supports conceptual design and analytical safeguards. Specification, exchange, performance-management, implementation, improvement, enterprise risk, and coding sources [32–42] provide comparators, operational requirements, and boundary conditions.

The source set is not an exhaustive database review, and no screening denominator or formal risk-of-bias assessment is claimed. Foundational and methodological sources are used for conceptual or technical principles; individual clinical studies are used for contextual illustrations rather than pooled outcome estimates. Selection may favor the author's research program, making independent comparison important. Every retained self-citation has an identified contextual or conceptual role.

5.3 Analytical development sequence:

The present specification is organized through five analytical steps. First, quality assessment, strategic measurement, safety, person-centered governance, and digital health concepts are mapped. Second, their relevance is compared across five questions: what is measured, how it is specified, who is accountable, how it is interpreted, and what action follows. Third, recurring requirements are translated into Indicator Identity fields and organizational domains. Fourth, the fields are connected to governance, analytics, and dashboard layers. Fifth, logical consistency is examined through identity-change rules and an explicitly hypothetical worked example. Table 2 records the source-to-design relationships used in this analysis.

Internal examination asks whether each field has an identifiable purpose, whether numerical and categorical information remain distinguishable, whether responsibility can be assigned, and whether one indicator can be reused without counting the same observation twice. These checks concern logical consistency; empirical measurement and organizational evaluation are reserved for subsequent studies.

Table 2: Source to design traceability matrix

Source group	Conceptual requirement	Design decision
Quality assessment [1,2]	Performance has distinct constructs and levels.	Preserve measure type, population, purpose, and units; maintain a multi-domain taxonomy.
Strategy and scorecards [3–6,9,20,35]	Measures contribute to organizational priorities.	Store many-to-many strategic mappings without duplicating observed records.
Safety and clinical governance [7,10–12,14,15]	Interpretation requires care context and accountability.	Store owners, review pathways, exception states, and traceable evidence.
Experience and accreditation [13,17,18,21]	Experience, compliance, and sustained resolution differ.	Separate constructs; link actions to reassessment rather than treating closure as effectiveness.
Resources and population context [16,19,22–25]	Measures differ in units and organizational level.	Separate monetary amounts, normalized scores, clinical measures, and population indicators.

Source group	Conceptual requirement	Design decision
Calculation and aggregation [27,30,34]	Specifications and aggregation choices shape interpretation.	Document eligibility, denominator states, and normalization, weights, coverage, and sensitivity requirements.
Digital health and AI [8,28,29,31]	Technology needs organizational oversight and evaluation.	Keep AI optional; require model-specific evaluation, human review, and traceability.
Definition and reporting resources [32,33]	Definition and calculated result are different entities.	Use explicit relationships among definition, version, implementation, observation, and action.
Conceptual and implementation methods [26,36]	Design logic and implementation context require explanation.	Publish source-to-design links, boundary conditions, and testable propositions.
Improvement methods [37–39]	Signals require causal assessment, accountable change, and time-series evaluation.	Link deviations, investigations, action strength, implementation evidence, and effectiveness checks.
Selection and enterprise mapping [19,20,40,41]	Measure selection and governance need explicit quality, risk, cost, and strategy relationships.	Record selection rationale and separate ERM, Cost of Quality, and Balanced Scorecard mappings.
Clinical classification [42]	Code-defined populations depend on coding-system release and validated eligibility logic.	Store versioned ICD/procedure lists and assess comparability after updates.

5.4 Reproducibility and limitations of the synthesis:

Tables 1–11 present the comparator analysis, source-to-design matrix, logical entities, indicator specification, domains, worked example, action hierarchy, implementation-sheet structures, and testable propositions. The collection and improvement records are presented in Section 7.10. The source-to-design matrix provides the analytical audit trail for this conceptual synthesis. A later empirical study should publish its field-definition manual, analysis code, and amendment log where confidentiality permits. Because the present synthesis is author-led and purposive, selection bias and confirmation bias remain plausible. Independent reviewers and competing-framework comparisons are needed to assess whether the proposed architecture adds value beyond an existing enterprise data dictionary and governance program.

6. THE ZUBER UNIVERSAL QUALITY MEASURES FRAMEWORK (ZUQMF) :

6.1 Definition and conceptual mechanism:

ZUQMF is defined as an enterprise governance architecture that connects version-controlled indicator specifications with organizational domains, accountable review, analytical interpretation, and documented action. The proposed mechanism is that consistent definitions improve interpretability; shared governance mappings reduce avoidable duplication; and explicit action pathways make signals usable. These mechanisms are conditional on data quality, leadership engagement, analytical competence, and operational capacity.

The architecture has four core components: Indicator Identity, the governance integration layer, the analytics layer, and the enterprise dashboard layer. Data quality, privacy, security, and version control are cross-cutting controls. AI is an optional analytical capability, not a prerequisite for implementing the registry or governance cycle.

6.2 Indicator Identity:

Indicator Identity is a persistent reference to a measure's defined construct, associated with an approved specification version. A label such as "mortality rate" is insufficient because different eligible populations and counting rules describe different measures. The proposed identity has four linked entities: measure definition, specification version, local implementation, and observation. These are separated so that local ownership and monthly results do not alter the underlying definition.

Table 3: Proposed logical entities and identity rules

Entity	Identifier and attributes	Relationship or change rule
Measure definition	measure_id; construct; intended purpose.	One stable identity for a meaningfully defined measure; substantially different constructs receive separate IDs.
Specification version	measure_id + version; calculation; population; exclusions; units; effective date.	One definition can have several versions. Semantic changes require a new version and comparability assessment.
Local implementation	implementation_id; specification reference; site; owner; source mapping; schedule.	One specification can have many implementations. Local metadata changes do not rewrite the definition.
Observation	observation_id; implementation; period; numerator; denominator; result; quality status; provenance.	One implementation has many observations. Revised results supersede earlier observations through an audit trail.
Governance and action links	mapping_id or action_id; related entities; forum; trigger; status; reassessment.	Many-to-many governance mappings reuse observations; actions retain their own completion and effectiveness evidence.

An editorial correction or metadata change that leaves calculation semantics unchanged can receive a documented patch version. A change to eligibility, calculation logic, or coding semantics requires a new specification version and assessment of comparability. A substantially different construct, such as replacing inpatient mortality with 30-day mortality, requires a new measure identity. A new site or local owner creates or amends an implementation record; a new reporting period creates an observation. Local deviations from calculation semantics must be registered as variants and cannot silently share a comparable result series.

These rules are consistent with separating definition from result, as illustrated by FHIR [32, 33], but ZUQMF adds its own proposed relationships for enterprise governance. Table 4 groups the fields for compact presentation; implementation and observation attributes are stored in their respective linked records rather than overwritten in the definition.

Table 4: Comprehensive Indicator Identity and linked-record specification

Attribute group	Required specification
Indicator number and identity	Permanent enterprise indicator number; approved title; construct; specification version; effective date; amendment history; local implementation ID.
Rationale	Evidence-based reason for measurement; problem addressed; intended decision; anticipated patient or organizational benefit; supporting references.

Attribute group	Required specification
Management type	Primary type and justified secondary tags: clinical, operational, strategic, risk management, patient experience, patient safety, or other approved categories.
Measurement classification	Separate structure, process, outcome, and balancing classifications from management type and mathematical form.
Selection methodology	STEEEP dimensions; high-risk, high-cost, high-volume, and problem-prone justification; mandatory obligations; feasibility; selection decision, evidence, approver, and review date [40].
Area monitored	Hospital, service, department, unit, pathway, population, and reporting level; boundaries and applicability.
Numerator definition	Eligible event or achieved requirement; counting unit; numerator inclusion criteria and numerator exclusion criteria recorded separately; repeated-event and deduplication rules.
Denominator definition	Eligible population or exposure; denominator inclusion criteria and denominator exclusion criteria recorded separately; eligibility window; relationship to numerator; zero and unknown states.
Mathematical type and units	Count, proportion/percentage, exposure-based rate, ratio, continuous variable, duration in days/hours, or percentile statistic; exact equation, multiplier, aggregation, and unit.
Time specification	Measurement and reporting periods; data collection frequency; review frequency; reporting lag; deadline; direction of desirable performance.
Data collection methodology	Census or sampling; prospective or retrospective; manual abstraction or automated extraction; eligibility identification; measurement procedure; missing-data and verification rules.
Data collection tools	Versioned electronic form or collection sheet; instrument, query, device, or survey; calibration or instrument validation where relevant; record and attachment links.
Sample size and coverage	Eligible population size; planned and achieved sample; selection method; sample-size justification; coverage/response rate; exclusions; precision, minimum count, and suppression rules.
Clinical coding	ICD classification, release, national modification where used, code lists, inclusion/exclusion logic, and coding validation; procedure coding system, version, code lists, and mapping provenance [42].
Target	Approved organizational target; comparison operator; direction or acceptable range; source, rationale, effective date, validity period, and approving authority.
Internal benchmark	Within-organization peer or historical comparator; eligible population, period, unit, method, value, source, and comparability assessment.
National benchmark	Country and national source; comparator population and reporting period; value and uncertainty; definition, coding, case-mix, and coverage compatibility.
International benchmark	Country/network and international source; period, population, and value; comparability and currency assessment; authorization for use.

Attribute group	Required specification
Performance classification	Basic: organizational target met; Silver: comparable national benchmark met; Platinum: comparable international benchmark met. Retain separate attainment flags, status reasons, approval, and classification date.
ERM classification	Primary/secondary ASHRM domains; linked risk-register ID; likelihood and impact definitions; inherent/residual scores; Low, Moderate, High, or Extreme category using approved local thresholds [41].
Cost of Quality	Prevention, appraisal, internal failure, and external failure mapping; mapped cost record; currency, valuation basis, period, allocation and deduplication rules, or justified non-applicability [19].
Balanced Scorecard	Financial, customer/patient, internal process, and learning/growth perspectives; strategic objective and owner; approved mapping rationale and score use [3–6,9,20].
Observation and quality	Period-specific raw counts/values; calculated result; completeness, validity, exclusions, uncertainty, source provenance, correction history, and verification approval.
Non-compliance reasons	Structured reason code plus narrative; affected cases, observed deviation, evidence, validation status, data limitation versus process failure, and linked investigation.
Root causes and contributing factors	Investigation trigger; timeline; team; process map; evidence; causal statements; contributing factors and failed controls; review approval; proportionate RCA2 linkage [37].
Improvement action plan	Linked cause; specific change; owner; due date; resources; implementation evidence; process/outcome/balancing measures; follow-up dates; verified effectiveness and recurrence review.
Action hierarchy	Stronger, intermediate, or weaker action; mechanism; classification justification; feasibility, residual risk, sustainability, and accountable approval [38].
Graphical presentation	Time-series results; denominator/coverage; prior-year baseline and method; organizational target and valid benchmark lines; change annotations; slope/direction and favorability; run/SPC method [39].
Governance and accountability	Primary and secondary organizational domains; verified standards mappings; measure owner, data steward, review forum, escalation owner, action team, and review history.
Privacy and optional prediction	Access, retention, confidentiality and audit rules; where prediction is used: model version, outcome, horizon, evaluation, monitoring, and human oversight.

6.2.1 Required schema and applicability:

Every ZUQMF indicator must expose all field groups in Table 4, linked to the appropriate definition, implementation, observation, or action entity. The field schema is mandatory; its values depend on the measure. Required-field presence, specification completeness, and period-level data availability are distinct quality attributes. A populated value, a documented unavailable/pending status with a remediation owner, or an approved not-applicable explanation is required. Blank fields cannot imply compliance. Numerators and denominators are mandatory for rates and proportions but not for a median duration or another stand-alone continuous statistic. ICD and procedure codes apply to code-defined

clinical populations; they need not be invented for a facilities indicator. Targets and benchmark fields must remain visible when no valid comparator exists, with an explicit unavailable status. A performance gap may trigger an investigation; an indicator without a gap retains a reviewed “no verified deviation in this period” status rather than a fabricated root cause or action.

Definition records store the stable construct, rationale, intended use, and evidence base. Specification versions store the mathematical type, approved calculation and eligibility rules, coding requirements, amendment rationale, and effective dates. Local implementation records store area, ownership, collection tools, selection rationale, applicable strategic/risk/cost mappings, local targets, and authorized comparators. Observation records store period-specific counts or values, achieved sample, coverage, uncertainty, quality flags, attainment, and chart interpretation. Investigation and action records store verified deviations, causes, interventions, completion evidence, and effectiveness review. Each field has one authoritative location; views may reference it without creating an independently editable copy.

A registry is review-ready when the definition and local implementation are approved, critical calculation and eligibility fields are complete, the collection tool has passed verification, and responsible owners are assigned. A period result is releasable only after its eligibility, calculation, quality, and reviewer checks pass. An unavailable or pending entry satisfies visibility requirements but does not count as a completed field or validated observation. A not-applicable status requires a rationale and approval; its frequency should be audited to detect inappropriate exemptions.

Management type, mathematical type, measurement level, strategic mapping, and ERM mapping are separate classification axes. Risk management and strategic management are decision uses that can span the nine organizational domains. Days are a unit of duration, whereas a percentile is a specified distribution statistic; neither is synonymous with a percentage. A percentile record specifies the selected quantile, population, algorithm, sample size, and whether it represents a value threshold or a percentile rank.

6.2.2 Indicator selection and collection design:

Selection begins with the clinical or organizational decision, the eligible population, and the evidence supporting the construct. The six quality dimensions are safe, timely, effective, efficient, equitable, and patient-centered (STEEEP) [40]. Each selected indicator records its relevant dimensions and supporting rationale. Priority is then justified by high risk, high cost, high volume, recurrent or problem-prone performance, mandatory requirements, strategic relevance, and data feasibility. These are selection criteria, not a validated additive score. If an organization introduces scoring, it must publish the criteria, weights, review process, and sensitivity assessment. The approval record identifies the selecting committee, owner, evidence, and planned review date.

Collection specifications distinguish the eligible census from the achieved sample. Census collection is preferred where complete electronic capture is feasible; sampled audits state the sampling frame, random/systematic/stratified method where used, timing, exclusions, nonresponse, and representativeness limitations. Planned sample size is justified by the intended precision or detection objective and expected event frequency, with clustering and finite population considered where relevant. Convenience samples must be labelled and cannot support unrestricted population inference. No universal minimum sample size is prescribed. Data collection tools include controlled electronic sheets, validated surveys, source-system queries, device outputs, and abstraction guides. Field definitions, allowed values, user permissions, pilot testing, reviewer training, and reproducibility checks accompany each tool.

ICD and procedure code lists must specify their coding system, release, national modification, eligibility logic, code-set ownership, and validation process. WHO maintains ICD classifications [42]; the operational release is the one authorized for the relevant jurisdiction and source system. Procedure codes use the locally authorized classification with its version and licensing constraints. A code-set update requires a comparability review; crosswalks do not establish equivalence without assessment. Section 7.10 provides reusable collection and review-sheet structures.

6.2.3 ERM, Cost of Quality, and Balanced Scorecard mappings:

ERM mappings use the eight ASHRM domains: operational, clinical/patient safety, strategic, financial, human capital, legal/regulatory, technology, and hazard [41]. Each mapping states the risk relationship,

risk-register link, controls, accountable owner, and review date. Risk likelihood, impact, inherent risk, and residual risk are distinct from the KPI result. A 5×5 matrix may calculate likelihood $\times$ impact using approved scales; Low, Moderate, High, and Extreme thresholds are controlled local policy values, not inferred from a percentage or benchmark tier.

Cost-of-Quality mapping identifies prevention, appraisal, internal failure, or external failure, and records the monetary cost separately from the indicator score [19]. Internal failure concerns defects corrected before delivery to the patient/customer; external failure concerns failures after delivery. The organizational costing policy resolves ambiguous timing. Currency, accounting period, resource quantities, valuation assumptions, allocation method, and overlapping costs must be documented. A mapped clinical indicator need not itself be monetary. Balanced Scorecard mapping identifies financial, customer/patient, internal-process, and learning/growth perspectives, the strategic objective, and the accountable owner [3–6,9,20]. Multiple mappings reuse one observation and cannot duplicate its count or monetary cost.

6.3 Governance integration layer:

This layer maps each indicator to a primary accountable owner, contributing teams, review forum, organizational level, and decision pathway. Clinical teams interpret clinical meaning; data stewards oversee provenance and calculation; and the designated governance forum authorizes action and monitors follow-through. Responsibilities may overlap, but final accountability should be explicit.

The proposed cycle comprises specification approval, data acquisition, verification, interpretation, escalation, corrective action, and reassessment. A dashboard result without a review owner is incomplete as a governance instrument. Similarly, an action marked complete without evidence of its effect should remain distinguishable from a sustained improvement. This architecture is compatible with continuous compliance concepts [21] without claiming to reproduce any accreditation body's full assessment methodology.

6.4 Domain taxonomy and multiple mappings:

The nine domains are a pragmatic organizational taxonomy synthesized from the source-to-design relationships in Table 2, not an empirically established factor structure. The taxonomy separates organizational subject matter from analytical capabilities. Each measure receives a primary domain and may have justified secondary mappings. A medication-harm indicator can inform clinical quality, patient safety, finance, and compliance, but it remains one indicator with one governed specification. The primary domain is assigned according to the indicator's stated decision purpose; secondary mappings require a documented additional use. This assignment is independent of the management-type tags and ASHRM risk domains: an operational measure can support a strategic decision and also map to an ERM domain without changing its primary organizational domain. Clinical quality concerns effectiveness and appropriateness, whereas patient safety concerns harm and preventive controls. Operational efficiency concerns flow and capacity, whereas financial sustainability concerns monetary or environmental resource stewardship. Ambiguous assignments are adjudicated by the measure owner and governance forum and retained in the amendment log. Domain mappings should be reviewed when the measure's purpose or organizational priorities change.

Table 5: Proposed organizational domains and illustrative measures

Domain	Scope	Illustrative measure
Clinical quality	Effectiveness and appropriateness of care	Mortality or pathway adherence
Patient safety	Harm prevention and safety processes	Medication harm or traceability
Operations	Flow, capacity, and process efficiency	Turnaround time or bed utilization
Patient experience	Experience, participation, and reported outcomes	PREMs and PROMs as separate measures

Domain	Scope	Illustrative measure
Finance and sustainability	Resource stewardship and quality costs	Cost of quality or energy use
Compliance and accreditation	Conformance, evidence, and sustained resolution	Verified findings and recurrent gaps
Population health	Defined population needs and outcomes	Access or demographic context
Workforce	Capability, wellbeing, and staffing	Competency completion or workforce experience
Digital and information governance	Information reliability and technology oversight	Data completeness or system availability

6.5 Analytics layer:

The analytics layer can support descriptive summaries, time-series monitoring, benchmarking, and, where separately developed and evaluated, prediction. Choice of method depends on the indicator's distribution, exposure, frequency, and decision purpose. A monthly percentage based on a small denominator should not be interpreted with the same certainty as one based on a large denominator. Statistical uncertainty and relevant case mix should accompany comparisons.

The layer must distinguish observed measures from predicted probabilities, model outputs, and expert-assigned categories. A risk matrix is not automatically a calibrated prediction model. Natural-language processing can assist document classification, but a human reviewer must confirm evidence mappings. Digital twins and automated forecasting remain potential extensions requiring their own assumptions, verification, and evaluation.

6.6 Enterprise dashboard layer:

Dashboards provide role-appropriate views while preserving access to the underlying specification, counts, time period, data-quality status, and action history. An executive view can summarize priority domains; a departmental view should retain operational detail. Both should retrieve the same governed result rather than maintain independently calculated copies.

A high overall score should not conceal unresolved critical safety or regulatory findings. Displaying such exceptions alongside domain performance is preferable to implying that excellent financial or operational performance cancels a serious safety failure. ZUQMF therefore proposes separate exception flags, with rules approved by governance rather than presented as a universally validated threshold system.

6.7 Interoperability boundaries:

Technical interoperability concerns structured exchange; semantic interoperability concerns consistent meaning; organizational interoperability concerns responsibilities and coordinated action. ZUQMF directly specifies semantic and organizational relationships. Technical exchange requires a separate implementation profile defining resource mappings, terminology, identifier resolution, authentication, and conformance tests. FHIR Measure and Measure Report may provide exchange resources for suitable measures [32,33]; the local ownership and action records would need additional profiled resources or a separately documented interface. Technical compatibility therefore remains a requirement for separate implementation testing rather than an established property of the framework.

7. ANALYTICAL RULES AND ILLUSTRATIVE APPLICATIONS :

7.1 Calculation and missing-data rules:

For a valid proportion or exposure-based rate, $r = (N / D) \times k$, where N is the eligible event count, D is the defined population or exposure, and k is the reporting scale. The reporting window and inclusion rules must be compatible. If $D = 0$, the result is undefined for that period and must not be displayed as

zero. If D is unknown, the status is missing data. If $N = 0$ and $D > 0$, a zero result is valid. These states have materially different governance implications.

Rates should identify whether repeated events are counted and whether the denominator represents people, encounters, discharges, procedures, or exposure days. A ratio may exceed 100% when repeated events are possible; a true proportion must remain between 0% and 100% when its numerator is a subset of its denominator and both are counted consistently. Missing observations should not be replaced with favorable values, and retrospective corrections should preserve an audit trail. Calculation controls are consistent with the technical-specification approach illustrated by AHRQ [30].

7.2 Comparability and interpretation:

Comparisons require compatible populations, definitions, reporting periods, and ascertainment methods. Where case mix materially influences an outcome, an appropriate externally evaluated risk-adjustment approach may be required. For a model-based mortality comparison, observed-to-expected mortality is O/E , with expected deaths obtained by summing valid individual predicted probabilities. ZUQMF does not supply such a model or justify multiplying by an arbitrary baseline rate.

Rare events, small denominators, and changing coding practices can produce unstable apparent rankings. A dashboard should present counts and uncertainty, and use appropriate time-series or interval methods selected by an analyst. Changes after implementation cannot automatically be attributed to the framework when staffing, treatment pathways, coding, and organizational priorities also change.

7.3 Optional aggregation:

A domain index may be calculated as $S = \sum(w_i s_i)$, where each eligible normalized score s_i is on a defined 0–100 scale, $w_i \geq 0$, and the included weights sum to 1. This formula is optional and does not constitute a validated ZUQMF scoring system. Normalization must respect whether higher values are desirable, undesirable, or optimal within a range. Monetary values, event rates, percentages, and ordinal assessments cannot be combined directly.

Before aggregation, organizations should justify weights, examine correlated measures, test sensitivity, and specify handling of missing data [27]. Multi-domain mappings must not create unacknowledged double counting. If an index cannot be calculated because essential data are unavailable, the dashboard should show insufficient evidence. A critical exception should remain visible alongside the index, with its own escalation pathway. The author's financial and strategic intelligence frameworks provide related applications [19, 20]. The aggregate presented here remains an optional design extension.

7.4 Requirements for any future composite extension:

A future index protocol must publish the score transformation for each measure, target provenance, weight-elicitation procedure, treatment of overlapping measures, minimum data coverage, and override rules before evaluation. For a bounded linear score with pre-specified lower and upper anchors $L < U$, an optional higher-is-better transformation is $100 \times \text{clip}[(x - L)/(U - L), 0, 1]$; a lower-is-better transformation is $100 \times \text{clip}[(U - x)/(U - L), 0, 1]$. Here $\text{clip}(z, 0, 1)$ constrains z to the interval from 0 to 1. These transformations are design options, not universal scoring rules. They are inappropriate when the desirable value lies within an interval or the relation is nonlinear.

Weights should reflect an explicit governance purpose and undergo sensitivity analysis. An index should not silently redistribute weights when mandatory observations are missing. Critical exceptions should remain separately visible, with the applicable reporting category and escalation rule pre-specified. Until such a protocol is tested, ZUQMF can operate through disaggregated measures without a composite score.

7.5 Illustrative indicator scenarios:

The following scenarios are design illustrations, not hospital observations or study results. They show how the specification can be applied without assigning fabricated outcomes.

For inpatient mortality, Indicator Identity records the eligible discharges and deaths, exclusions, time window, responsible clinical forum, coding version, and whether results are crude or adjusted. It links an outcome signal to clinical review without implying that every death is preventable. For hand-hygiene compliance, the registry records the eligible observed opportunities, observation method, observer training, and sampling approach; implementation context can be informed by the cultural literature [14].

For patient experience, the registry records the instrument, language, sampling population, survey timing, response rate, and scoring rule. Patient-reported experience and health outcomes remain separate constructs [13, 17, 18]. For endoscopy traceability, the specification links a process measure to equipment identification, recall readiness, verification evidence, and risk ownership, drawing on the procedural context of the FMEA case study [15].

For electricity use, the unit is specified as kWh and the denominator, if used, is explicitly defined. Consumption, expenditure, service volume, and weather-related influences are distinguished rather than combined into an unexplained score [16]. Demographic and health-resource measures are retained at their appropriate population or system level [23–25]. These scenarios illustrate coverage across domains; they do not demonstrate reliability or effectiveness of the architecture.

7.6 Worked hypothetical example:

Table 6 instantiates the linked model using a locally designed process measure: timely accountable review of high-risk findings. The numbers, organization, target, reporting month, and decision rules are fictional and are introduced solely to demonstrate calculation and governance behavior. This is not a validated accreditation measure, an institutional result, or a universal benchmark.

Table 6: Worked hypothetical indicator and governance example

Record component	Illustrative specification
Definition	ID ZUQMF-DEMO-001; timely accountable review of high-risk findings; locally designed process measure; higher is better.
Specification	Version 1.0; numerator: eligible findings with documented accountable review within 7 calendar days of verified notification. Denominator: all eligible high-risk findings whose 7-day review window ends in the reporting month. Scale: 100.
Eligibility	Include unique verified findings classified high risk under the local approved method. Exclude duplicates and findings withdrawn with documented justification. Extreme-risk findings follow a separate immediate-escalation process and are not included in this illustrative cohort.
Implementation	ID DEMO-A-001; fictional Hospital A; primary domain compliance; secondary domain patient safety where relevant; accountable owner quality director; source finding register and review log; monthly reporting.
Observation	ID DEMO-A-2026-09; fictional September 2026 cohort; numerator 18; denominator 20; result $(18/20) \times 100 = 90\%$; complete data. The count reflects a census of the defined hypothetical cohort, not sampled estimates.
Local interpretation	Illustrative target 95%, chosen for demonstration only. The result prompts review of the two overdue findings; no external benchmark or accreditation threshold is implied.
Action and reassessment	Link to fictional action ACT-DEMO-01; owner investigates delay and documents response. Completion of review and sustained resolution are recorded separately. Any newly identified extreme risk triggers its own escalation regardless of the percentage.
Missing-data variants	If no eligible findings: denominator 0, result not applicable for that period. If eligibility cannot be established: missing data, result unavailable. If no timely reviews among 20 eligible findings: valid result 0%.
Version boundary	Changing the allowed review interval from 7 to 5 days creates a new specification version and a marked time-series break unless observations are recalculated. Changing the construct to sustained closure creates a new measure identity.

The example distinguishes timely review from correction and sustained resolution. A finding can meet the review deadline while its action remains open. The resulting 90% process score therefore cannot establish safe practice or completed risk mitigation. Linking the observation to an action record permits reassessment without changing the meaning of the original process measure.

7.7 Targets, benchmarks, and ZUQMF attainment categories:

Organizational targets represent approved expected performance; internal, national, and international benchmarks represent specified comparators. Each comparator records its source, period, unit, population, definition, calculation, coding, case-mix method, and uncertainty where available. Internal benchmarking may compare sites or prior periods within the organization. A national benchmark must identify the country and competent source; an international benchmark must identify its network or jurisdiction. A geographically external figure is not automatically a superior standard. Stale, incomparable, or unavailable comparators are marked unevaluable rather than treated as achieved.

For a higher-is-better measure, attainment is $x \geq \text{threshold}$; for a lower-is-better measure, attainment is $x \leq \text{threshold}$. Range measures require an approved acceptable interval and endpoint rules. The proposed ZUQMF convention assigns Basic when the organizational target is met, Silver when a comparable national benchmark is met, and Platinum when a comparable international benchmark is met. These are internal framework labels, not external certification or validated maturity levels. Separate target, national, and international attainment flags preserve the exact evidence. The highest eligible designation is displayed only after data-quality, coverage, comparability, and governance checks. Before assigning a tier, the reviewer confirms the reporting unit, desired direction, approved comparison operator, benchmark validity period, and compatible eligibility/case-mix definitions. The comparison uses the unrounded validated result; rounding is for display. Equality qualifies only where the approved operator includes equality. Missing national data do not justify an inferred Silver flag; a separately valid international comparison may support Platinum while the national comparison remains unavailable. Suppression for small counts follows a prospectively approved policy and prevents an unsupported tier. Where available thresholds are not ordered by increasing desirable performance, flags are reported independently and a tier is withheld pending governance resolution; the source, validity period, and hierarchy decision are retained in the audit record. A critical safety exception remains visible regardless of designation. Below-target, missing-data, insufficient-data, and comparator-unavailable states have explicit reasons.

7.8 Reasons of non-compliance, root causes, and action effectiveness:

Each reporting period records verified non-compliance cases and their evidence, separating process failure from incomplete or invalid measurement. Reasons use controlled codes plus narrative, responsible review, and linked observations. Initial categories may include workflow, staffing/workload, equipment, environment, communication, knowledge/skills, documentation, coding, or data-extraction issues; these are prompts for investigation, not established causes. Target failure alone does not identify a cause. The owner determines the proportionate investigation and escalates serious safety or regulatory issues promptly.

RCA2 [37] connects event analysis with corrective action. A linked investigation records the timeline, multidisciplinary review, evidence, process and control failures, causal statements, and contributory conditions. The analysis should explain the relationship between an identified condition and the deviation rather than attribute failure to an individual without examining the system. Each causal statement identifies the contributing condition, the mechanism by which it increased risk, and the observed consequence, with evidence and unresolved uncertainty. Actions are then linked to the verified causes, assigned an owner and deadline, and reassessed for effect and recurrence. "Staff failed to comply" is an observation requiring explanation; it does not establish a root cause without examining relevant workload, usability, communication, training, and control conditions. Full RCA2 is appropriate to selected events and risks; routine minor gaps may use a proportionate documented analysis.

Table 7 summarizes action strength using IHI's hierarchy [38]. Stronger actions depend less on memory, intermediate actions add support or resilience, and weaker actions rely more on individual behavior. This adaptation does not imply IHI endorsement of ZUQMF or ETQAN. An action plan records the intervention mechanism, resources, implementation evidence, and process, outcome, and balancing measures. Its states distinguish planned, in progress, implemented, under effectiveness

review, verified effective, and reopened. The owner defines the follow-up period, required coverage, recurrence criterion, and acceptable balancing results before closing the action. Completion is distinct from verified effectiveness; persistent gaps require reassessment and possible reopening. An overdue action follows its escalation pathway rather than receiving automatic closure.

Table 7: Action-strength categories and implementation requirements

Category	Examples and ZUQMF control
Stronger	Physical redesign; tested safer equipment; forcing functions; process simplification or standardization; concrete leadership support. Record the failure mechanism removed and test reliability.
Intermediate	Workload adjustment; added redundancy; software changes; fewer distractions; simulation with follow-up; cognitive aids; structured communication. Verify actual use and mitigation of the identified cause.
Weaker	Additional checks; warnings; revised policies; conventional training. Record limitations and whether a stronger feasible control is needed; training completion alone does not establish effectiveness.

7.9 Graphical presentation and interpretation of change:

Each indicator specifies its graphical method and displays its valid time series, target, compatible benchmarks, and prior-year baseline, coverage, and intervention annotations. For a proportion or exposure rate, the pooled prior-year result is $\Sigma N / \Sigma D \times k$ over comparable valid periods; an unweighted average of monthly percentages can mislead when denominators differ. If an arithmetic mean of monthly results is used, it is labelled explicitly and its equal-month weighting is justified. Continuous measures specify whether the prior-year reference is the mean, median, or percentile, with the eligible observations and units. Missing periods and specification breaks remain visible and are not bridged as if comparable.

A fitted trend line records its method, time unit, window, and slope. Positive means increasing; negative means decreasing. Favorability depends on desired direction: an increasing compliance proportion may be favorable, whereas increasing mortality may be unfavorable. An interval-target measure requires distance from its acceptable interval rather than an automatic slope label. A short or noisy series is reported as uncertain. Descriptive slope is not proof of sustained improvement. Run charts assess patterns over time [39] using a specified median and interpretation rules; statistical process control uses an appropriate chart and limits. The prior-year mean is a labelled baseline, not a run-chart median or a control limit.

The hypothetical review indicator in Table 6 may be selected as problem-prone/high-risk and mapped to timely, safe, and effective care. Collection is a monthly census of eligible findings through a controlled registry query and sheet; the achieved denominator is 20. Its type is a process proportion, its unit is percent, and the desired direction is higher. ICD/procedure codes are not applicable because eligibility is based on governance findings. A defensible ERM mapping is legal/regulatory, with a clinical/patient-safety secondary relationship where findings concern care; Balanced Scorecard mapping is internal process, and an appraisal-cost link can capture review resources separately. For this process indicator, numerator inclusion requires evidence of owner review by the seven-day deadline; late reviews are excluded from the numerator but remain in the eligible denominator. Duplicate, withdrawn, and extreme-risk cases are excluded from both counts according to the specified cohort rules. The source register and review log must be reconciled before absence of review evidence is classified as a verified late review rather than incomplete extraction. At 90% against the illustrative 95% organizational target, Basic is not attained. National/international comparators and prior-year data are unavailable in this example, so Silver, Platinum, a prior-year mean, and a trend cannot be assigned. The two delayed reviews require documented reasons and investigation before selecting actions; the example supplies no invented causes or effectiveness results.

7.10 Reusable ZUQMF collection and improvement records:

The following sheet structures operationalize the linked entities. Each implementation adapts the field names and permitted values without removing required field groups. Patient identifiers remain in an authorized restricted source; dashboards use coded references and aggregated results. Each sheet carries a version, owner, access rules, validation checks, and retention policy. Conditional fields record an approved applicability status. These are proposed implementation templates, not patient datasets. Table 8 specifies the source-level collection record for each encounter or measurement opportunity.

Table 8: Reusable encounter or opportunity data collection sheet

Field group	Required entries
Record linkage	Indicator number; specification version; implementation ID; reporting period; coded record/opportunity ID; source reference; abstractor and collection date.
Eligibility	Area; relevant dates; denominator inclusion yes/no; exclusion code and evidence; eligibility decision; applicable ICD/procedure code and coding-system release.
Measured event	Numerator inclusion yes/no; exclusion reason; event count or continuous value; unit; exposure; source evidence; duplicate check.
Quality and deviation	Missing/unknown/not applicable status and reason; verified non-compliance code and narrative; reviewer/date; correction trail; restricted investigation link.

Table 9 connects the validated period result with its comparators, graphical interpretation, and governance review.

Table 9: Period-level indicator reporting sheet

Field group	Required entries
Population and collection	Indicator/version/site/period; census or sampling method; eligible population; planned and achieved sample; response/coverage; exclusions; source-tool/query version.
Result	Numerator/denominator or statistic; formula and multiplier; result and unit; uncertainty and quality status; zero-denominator/missing status; verifier/date.
Comparator assessment	Organizational target; internal, national, international benchmarks and source dates; comparability decision; independent attainment flags; Basic/Silver/Platinum or unevaluable status.
Graph and interpretation	Prior-year baseline/method; series link; chart method; slope/time unit and direction; favorable/unfavorable/uncertain interpretation; intervention dates; exception flags.
Governance	Area, type and selection rationale; ERM/CoQ/BSC mappings; reviewed reasons of non-compliance; review decision; investigation and action links; next review date.

Table 10 links verified non-compliance to investigation, improvement actions, implementation evidence, and effectiveness reassessment.

Table 10: Non-compliance investigation and improvement record

Field group	Required entries
Trigger and analysis	Indicator observation/case links; verified deviation; severity and escalation; investigation scope/team; chronology, process map, evidence, causes and contributing factors.
Action design	Cause link; specific intervention; stronger/intermediate/weaker category and justification; owner, due date, resources, anticipated risk reduction and unintended effects.
Implementation	Status; completion evidence; training or system-test records where applicable; overdue escalation; independent verification and date.
Effectiveness	Baseline and follow-up process/outcome/balancing results; coverage; reassessment date; recurrence; residual risk; sustainment plan; approval to close or reopen.

The encounter/opportunity sheet provides the source-level audit trail; the period sheet reports validated results; and the investigation/action sheet records response and verified reassessment. Automated and manual collection should produce equivalent field meanings. A review cannot close an action solely because the task is marked complete: completion evidence, follow-up measurement, and accountable verification must be separately recorded.

8. CONCEPTUAL RESULTS AND TESTABLE PROPOSITIONS :

8.1 Outputs of the framework-development analysis:

The analysis produces a four-component architecture, a comprehensive Indicator Identity specification, a nine-domain organizational taxonomy, calculation and interpretation safeguards, a source-to-design audit trail, an explicit linked-entity model, and a prospective evaluation agenda. These are conceptual results addressing the research questions. No effect size, predictive accuracy, adoption rate, cost saving, or patient-outcome improvement is estimated.

The principal analytical implication is that governance integration depends on controlled relationships among measures rather than on the number of dashboard tiles. One indicator can support several decisions if its calculation remains stable and its mappings are explicit. Conversely, combining superficially similar indicators without reconciling their definitions can create a misleading impression of integration.

8.2 Testable propositions:

Table 11 converts the proposed mechanisms into evaluable propositions. The expected directions are hypotheses, not findings. Independent assessment and suitable comparators are necessary because an implementation team's approval of its own registry cannot establish organizational benefit.

Table 11: Testable propositions and candidate evaluation outcomes

ID	Proposition	Candidate assessment
P1	Version-controlled specifications improve calculation consistency.	Percentage of paired independent calculations agreeing within a prespecified tolerance; comparison with a simpler registry or baseline.
P2	Shared mappings reduce unnecessary duplication without losing local detail.	Count of semantically identical specifications maintained separately; staff hours per reporting cycle; audit of retained local information.

ID	Proposition	Candidate assessment
P3	Explicit ownership improves accountable response.	Median hours from verified signal to documented owner review; percentage with independently verified reassessment; comparator and observation window prespecified.
P4	Quality flags improve interpretation.	Percentage of correctly classified zero-event, zero-denominator, and missing-data cases in standardized reviewer scenarios.
P5	Visible exceptions improve recognition of unresolved critical findings.	Percentage of critical findings correctly identified and escalated; controlled scenarios with and without exception flags.
P6	Readiness moderates implementation feasibility.	Proportion of eligible measures maintained with complete required fields; maintenance time and adoption compared across pre-specified readiness strata.

9. DISCUSSION :

9.1 Theoretical contribution:

ZUQMF connects measurement specification with the organizational conditions under which a measure can inform action. Its contribution is architectural: it proposes a common identity and governance structure for indicators that retain different clinical, strategic, and statistical meanings. This complement established quality and performance theories [1–6, 9] while recognizing that existing enterprise architectures may already incorporate some or all of these features.

Indicator Identity must therefore be evaluated against a serious alternative explanation: that its benefits arise from implementing an ordinary data dictionary, accountable review, and disciplined management rather than a distinct framework. Comparative research should identify which additional mappings or decision pathways produce measurable value. The comparator table and source-to-design matrix delimit the proposed integration; its additional organizational value is an empirical question.

The comprehensive specification also provides an implementation structure for ETQAN: indicator definitions connect to collection sheets, period reports, risk and strategic mappings, investigations, actions, and reassessment records. This operational alignment does not establish empirical effectiveness. Evaluation should measure field completeness, calculation reproducibility, maintenance burden, action traceability, and user interpretation against a simpler registry.

9.2 Managerial and accreditation implications:

For executives, the architecture provides a proposed method for identifying where an indicator came from, what it means, who owns it, and what decision it supports. For quality and accreditation teams, it can connect evidence, findings, actions, and reassessment. Integration with JCI, CBAHI, NABH, or other applicable programs requires verified, edition-specific mappings from authorized standards, with an owner and review date. The proposed mappings are implementation requirements, and should be verified separately for each applicable program.

Accreditation readiness remains broader than indicator performance. Staff competence, direct observation, interviews, documentation, and reliable clinical practice cannot be replaced by dashboard scores. The continuous-compliance perspective [21] and the patient-experience literature [17,18] motivate sustained oversight, but do not justify treating a closed action as proof that care is consistently safe.

9.3 AI and digital governance:

The author's proposed Safety-III approach [10] provides a conceptual connection to predictive safety, but ZUQMF should permit useful governance before AI is introduced. Predictive tools require defined use cases, accountable users, appropriate data, and evaluation of performance across relevant groups, and mechanisms for detecting deterioration after deployment. WHO's AI guidance supports ethical

oversight [28], and clinical prediction studies should use appropriate reporting guidance such as TRIPOD+AI [29].

Automation should support rather than obscure review. Generated summaries must remain traceable to source evidence, and model recommendations should not be confused with confirmed findings. Access controls, audit logs, cybersecurity, and change management are implementation requirements proposed here. Their implementation and performance require separate verification.

9.4 Potential disadvantages and trade-offs:

Standardization can impose administrative burden, delay local innovation, and encourage excessive indicator collection. A central registry may also concentrate access risks. Overly complex mappings can make governance harder to understand, while score-based incentives may encourage selective reporting or target gaming. These concerns warrant a minimal viable registry, clear amendment procedures, and periodic retirement of low-value measures, and checks for unintended consequences. Financial sustainability and efficiency should be interpreted alongside safety, experience, and workforce effects. Reducing expenditure is not necessarily quality improvement if it shifts burden to patients or increases staff workload. Similarly, expanding prediction may increase alert fatigue unless the organization has capacity to respond. These trade-offs form part of the empirical research agenda rather than assumed benefits.

10. IMPLEMENTATION AND EMPIRICAL EVALUATION ROADMAP :

10.1 Staged implementation:

A proposed implementation begins with an inventory of existing indicators and a baseline assessment of duplicated definitions, missing ownership, and data-quality problems. A multidisciplinary group then approves the registry schema and pilots a limited set of high-priority measures. The pilot should test calculation reproducibility, version management, evidence access, and action tracking before enterprise expansion.

Subsequent stages connect departmental views to the registry, establish audit and amendment procedures, and extend coverage where feasibility is demonstrated. Predictive analytics should be introduced only for defined decisions with separate evaluation. Timing, resources, and acceptance criteria should be set locally; the paper does not prescribe an evidence-based universal deployment duration.

10.2 Content and measurement evaluation:

Independent clinicians, quality professionals, data specialists, managers, and patient representatives should assess relevance, clarity, and completeness of the proposed fields. A pre-specified consensus procedure could refine the taxonomy and document disagreements. Content validity indices may support that process but would not establish clinical effectiveness or predictive validity.

Operational testing should measure independent reproducibility of calculations, consistency of domain coding, specification completeness, and traceability to source records. Agreement statistics should match the type of data being assessed. Reliability testing must distinguish agreement in classification from stability of an outcome rate. A publicly described coding manual and amendment history would support replication across settings. Candidate readiness determinants can be assessed using the updated CFIR, with adaptation documented rather than treating CFIR as a ZUQMF outcome instrument [36].

10.3 Organizational and outcome evaluation:

A multicenter prospective evaluation should compare ZUQMF with usual governance or a simpler standardized registry. Depending on implementation feasibility, designs could include a controlled interrupted time series or a cluster-randomized rollout. Outcomes should be prespecified and include definition consistency, time to detect and resolve data defects, action completion verified independently, reporting burden, and unintended effects. Clinical outcomes may be included where a credible mechanism and adequate sample size exist.

A prospective protocol should identify one primary governance outcome and pre-specify secondary outcomes. Candidate primary measures include the proportion of active indicator implementations with an independently verified complete specification, or the proportion of releasable observations calculated consistently by independent reviewers. Specification completeness is the number of approved

applicable fields with valid entries divided by all required applicable fields; approved non-applicable fields are excluded, while unavailable or pending fields remain incomplete. Calculation concordance is the number of paired calculations meeting a prespecified tolerance divided by all eligible paired calculations; discrepancy causes are reported. Action-effectiveness verification is the number of implemented actions meeting their prespecified follow-up criteria divided by implemented actions due for reassessment. Exclusions, overdue reviews, and missing follow-up are reported separately to prevent selective denominators.

Maintenance burden should be measured as staff time per indicator/reporting cycle and compared with the comparator registry. Readiness, implementation fidelity, site resources, and case mix are recorded as potential moderators. The analysis plan defines the unit of analysis, clustering level, baseline and follow-up periods, precision or power assumptions, and treatment of missing data before recruitment. Clinical outcomes remain secondary unless a credible causal pathway and adequate design support them. Independent reviewers should be separated from framework developers where feasible.

Analysis should account for clustering, baseline differences, case mix where relevant, concurrent interventions, and missing observations. Effect estimates and uncertainty should be reported rather than relying on before-and-after percentages alone. Economic evaluation should include implementation and maintenance costs, not only assumed savings. Patient and workforce experience should assess whether improved reporting translates into useful changes in practice.

10.4 Evaluation of optional prediction tools:

Each predictive application needs a clearly defined target outcome, time horizon, predictor availability, and intended decision. Evaluation should include appropriate discrimination and calibration measures, comparison with a meaningful baseline, performance in relevant subgroups, and prospective effects on decisions. Temporal or external evaluation and monitoring for model drift are recommended design requirements. Clinical prediction reporting should follow TRIPOD+AI where applicable [29]; an enterprise governance architecture is not itself a clinical prediction model.

11. LIMITATIONS :

The framework is conceptual and has not undergone empirical evaluation in this paper. Its purposive source set does not support an exhaustive assessment of competing architectures. The author's prior publications provide substantial contextual input, creating a possibility of intellectual allegiance and selective emphasis. Independent comparison and critical review are consequently important.

The proposed taxonomy and fields may require adaptation across countries, service types, and digital maturity levels. The 30-field-group specification, domain assignments, attainment categories, and workflow rules require formal content and usability evaluation. No fixed weights, risk thresholds, or composite scoring categories have been validated. The breadth of the required schema may impose different burdens on automated and manual implementations; completeness must therefore be evaluated alongside workload and feasibility. Illustrative scenarios contain no institutional data. Benefits concerning interoperability, workload, accreditation sustainability, prediction, and outcomes remain contingent and unmeasured.

12. CONCLUSION AND RECOMMENDATIONS :

ZUQMF proposes an enterprise governance architecture in which healthcare indicators have a persistent, version-controlled identity connected to accountable interpretation and action. Its conceptual contribution is the integration of technical specifications, multiple governance mappings, analytical safeguards, and dashboard traceability. This approach offers a testable response to fragmentation without requiring that all measures be reduced to one score.

Healthcare organizations considering the framework should begin with a manageable registry, verify calculations, establish action ownership, and preserve the distinction between observed outcomes, compliance evidence, and predicted risk. Independent feasibility studies and comparative multicenter evaluations are needed before claims of improved safety, financial performance, or organizational effectiveness are warranted.

13. RESEARCH DECLARATIONS :

This paper reports literature-based conceptual analysis and explicitly hypothetical examples; no identifiable patient or institutional observations are presented. No primary dataset was generated. Ethics review requirements for subsequent empirical implementation should be determined by the relevant institution.

The author is employed by Dr. Sulaiman Al Habib Medical Services Group Company and is the developer of the named framework. Related publications by the author inform the conceptual analysis and are cited explicitly. This intellectual involvement is disclosed.

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