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Escrow Analytics: AI Monitoring of RERA and Wafi Waterfalls

A controlled architecture for construction-progress evidence, escrow reconciliation, release entitlement and lender oversight

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ABSTRACT

Background. Milestone-linked real-estate escrow releases join legal rules, project progress, professional certification, invoices, bank balances, reserves and segregated approvals. **Objective.** This paper develops an escrow-analytics architecture for B1 real-estate finance participants operating with Dubai RERA and Saudi Wafi project waterfalls. **Approach.** The analysis reviews 50 primary, official and peer-reviewed sources available through 2 August 2026 and joins canonical ledgers, immutable evidence, computer-vision support, deterministic entitlement, exception workflow and named human authority. **Findings.** Claude and construction computer vision can support bounded extraction, comparison, imagery review, source-linked drafting and exception preparation. Approved professionals retain progress certification, accounting confirmation, payment orders, trustee review, lender consent and regulatory authority. **Implications.** Implementation should begin with one jurisdiction, one project, one request category and a shadow-mode pilot. Worked cases and operating inputs are unverified illustrative scenarios; attributed Matchpoint or client revenue, cash cost reduction, loss reduction and alpha remain USD 0 until approved observed evidence exists.

Highlights

Primary users. B1 developers, project-finance teams, account trustees, lenders and authorised monitoring professionals.

Evidence unit. An immutable project, cash, progress or decision object with source, time, permission, reviewer and refresh state.

Architecture. Permissioned sources feed canonical ledgers, deterministic reconciliation, bounded AI analysis, approved rule packs and exception-led workflow.

Decision boundary. Models support evidence work; consultants, accountants, developers, trustees, lenders and regulators retain allocated authority.

Economics. Attributed revenue, cash saving, loss reduction and alpha remain USD 0 until observed evidence is approved.

JEL Classification: G21, G28, G32, G33, G38, K22, K25, L85, M15, O33

Keywords: real-estate escrow, RERA, Wafi, construction progress, computer vision, Claude, release entitlement, account trustee, lender dashboard, off-plan development

1. INTRODUCTION

Off-plan real-estate escrow is a controlled release process. Money enters a project-specific account, evidence accumulates as construction advances, authorised parties certify or challenge that evidence, and the trustee or bank releases only the amount permitted by the applicable legal and contractual waterfall. Dubai and Saudi Arabia implement this logic through different institutional arrangements. Dubai Law No. 8 of 2007 requires a separate project escrow account, project-level records and regulated withdrawals; Dubai Land Department guidance describes progress certification and trustee verification in operational terms [1-6]. Saudi Arabia's active off-plan law and implementing regulations require a separate account, three-party payment orders, engineering and accounting reports, and defined retentions and exceptions within the Wafi framework [11-15].

The control problem is therefore larger than recognising a building element in a photograph. A release decision depends on five linked questions:

1. Which legal and contractual rule applies to this project, account, cost category and request?
2. What work was approved, completed, measured, certified and invoiced?
3. What cash has entered, left or been reserved in the escrow account?
4. Which authorised people and firms have reviewed the request, and what exceptions remain open?
5. Can a later reviewer reconstruct the decision from immutable source evidence?

This paper develops an escrow-analytics architecture for B1 real-estate finance participants, including developers, project-finance teams, account trustees, lenders and authorised monitoring professionals. The architecture joins a canonical project ledger, a milestone graph, a controlled evidence vault, computer-vision support, deterministic reconciliation, a release-entitlement engine, an exception queue and a lender dashboard. Claude is used only for bounded document and image analysis, source-linked extraction, comparison, explanation and draft preparation. Deterministic services calculate balances and thresholds. Named professionals retain certifications, payment instructions, waivers, overrides and disbursement authority.

The term **RERA waterfall** in this paper refers to the project-specific release logic operating under Dubai's escrow framework and related agreements. The term **Wafi waterfall** refers to the project-specific release logic operating under Saudi Arabia's off-plan framework and its implementing regulations. These labels are analytical shorthand; they do not replace statutory language, regulator instructions, escrow agreements or professional advice.

The paper answers four practical questions. First, what data must be joined before a milestone-linked release can be evaluated? Second, where can computer vision reduce evidential friction without becoming a substitute for professional certification? Third, how should an AI agent reconcile progress, cash, invoices and entitlement while preserving segregation of duties? Fourth, what should a lender dashboard display so that uncertainty, exceptions and approvals remain visible?

The central proposition is bounded. AI can improve the organisation, comparison and traceability of escrow evidence when access, provenance, deterministic calculation, model evaluation and human decision rights are designed into the workflow. This paper does not claim observed financial benefit. Attributed Matchpoint or client revenue, cash cost reduction, loss reduction and alpha remain USD 0 until approved observed evidence exists. Worked examples, amounts, thresholds, timelines and performance values are **[Unverified illustrative scenarios]** unless explicitly attributed to a cited source.

Question	Proposed control answer	Retained authority
Is the request legally and contractually eligible?	Versioned rule pack plus deterministic eligibility tests	Legal adviser, regulator, trustee and authorised account parties
Does evidence support stated progress?	Source-linked documents, approved schedules, imagery, measurements and exception analysis	Approved consultant or engineer
Is the cash movement mathematically permitted?	Double-entry escrow ledger, reserved balances and release calculation	Trustee or bank and required signatories
Can the pack be defended later?	Immutable evidence objects, model-run records and signed approvals	Audit, compliance and authorised management

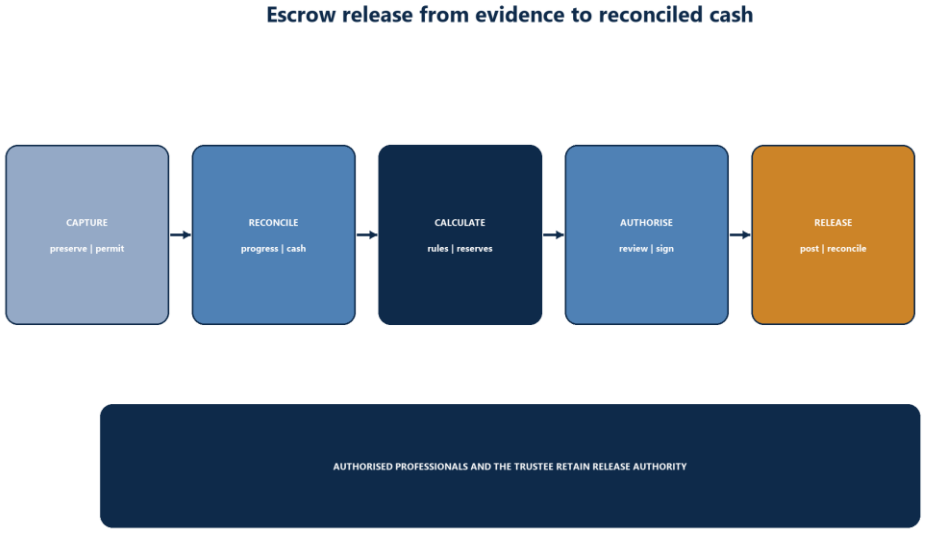

Figure 1. Escrow release from evidence capture to reconciled cash

Source: Matchpoint escrow-analytics framework; Dubai and Saudi control context [1-15].

2. DECISION PERIMETER: B1 REAL-ESTATE FINANCE

2.1 Primary users

The principal operating users are B1 real-estate finance participants. A developer's finance team needs a current view of collections, certified work, invoices, contractual limits, requested releases and blocked items. An account trustee or escrow bank needs a complete instruction pack and an auditable basis for any movement. A project lender needs visibility into progress, cost to complete, liquidity headroom, contractor concentration and compliance with financing conditions. An approved consultant or engineering firm needs an evidence workspace that preserves its independent judgement. A certified public accountant, where required, needs accounting records, supporting invoices, account statements and calculations. Regulators require the statutory reports, notifications and project information specified by the applicable regime.

2.2 Decision-rights map

The system must distinguish analysis from authority. A model can classify an invoice, extract a claimed amount, compare a photograph with an approved model and draft an exception note. Those outputs are provisional. They do not certify construction progress, approve a payment order, amend an escrow agreement, waive a covenant or instruct a bank.

Role	May prepare or analyse	May certify or approve	May not be delegated to the model
Developer finance	Request pack, ledger reconciliation, forecast	Developer-side request and authorised signature	Bank release, independent certification
Project controls	Schedule mapping, quantities, change log	Internal measurement under delegated authority	Regulator or trustee approval
Approved consultant or engineer	Site evidence, measurement, progress certificate	Professional certification within licence and appointment	Automated final certification
Certified public accountant	Financial report, invoice and account review	Required accounting confirmation or signature	Model-generated audit opinion
Account trustee or bank	Eligibility and instruction review	Escrow disbursement within mandate	Release based solely on model output
Lender	Covenant tests, cost-to-complete challenge	Consent or waiver where finance documents require it	Regulatory approval
Regulator	Monitoring data, reports, exception evidence	Statutory direction, approval or enforcement	Private model recommendation

Figure 2. B1 escrow decision-rights map

Source: Matchpoint decision-rights framework; statutory role context [1-15].

2.3 Jurisdiction, project and contract specificity

Every project must be configured from approved source documents. The legal regime is one layer. The project licence, escrow agreement, sale contracts, construction contracts, consultant appointment, financing documents, approved budget and regulator directions add project-specific conditions. The same apparent milestone label can produce different release outcomes because eligible costs, signatories, retentions, caps, timing conditions and documentary requirements differ.

The system therefore stores a rule pack with an effective date, source hash, jurisdiction, project scope, reviewer, approval status and supersession history. A request is evaluated against the approved rule pack that was effective for that request. Later amendments create new versions; they do not silently rewrite prior decisions.

Rule layer	Examples	Required system treatment
Statute and regulation	Dubai escrow law; Saudi off-plan law and regulations	Authoritative source, effective date and legal review
Regulator service or instruction	DLD submission requirements; Wafi reporting or platform process	Operational requirement, source date and refresh trigger
Escrow agreement	Signatories, eligible payees, documents, account mechanics	Project-specific executable rules after approval
Construction contract	Milestones, valuations, retention, variations	Linked to work packages and certified quantities
Finance documents	Conditions precedent, drawstop, consent, reserve	Separate lender-control layer
Internal policy	Materiality, escalation, service level	Cannot relax law, regulation or contract

3. DUBAI RERA ESCROW CONTROL MODEL

3.1 Statutory account and evidence perimeter

Dubai Law No. 8 of 2007 establishes a project-specific escrow structure for off-plan real-estate development. The law addresses deposits, separate accounts, statements, depositor records, financing paid into escrow, a five per cent post-completion retention and regulator responses where completion is at risk [1]. The official English text states that the Arabic text prevails if there is a conflict; production legal interpretation must therefore use approved Arabic and English sources where applicable.

Dubai Land Department guidance provides operational context. The official FAQ states that completion percentage is determined through a consultant approved by DLD, that an investor can follow the project through official services, and that the account trustee's engineer visits the site and verifies achievement before payment under the escrow agreement [2]. DLD's mortgage-to-escrow service requires current project and technical-report conditions, while its completed-project payment service defines submission requirements for a completed project [4-5]. These service pages are living operational sources and require scheduled refresh.

3.2 Dubai control objects

Dubai object	Minimum fields	Primary evidence
Project registration	DLD number, licence status, developer, trustee, approved consultant	Regulator record and approved agreements
Escrow account	Bank, account identifier, currency, status, restrictions	Executed escrow agreement and bank confirmation
Depositor sub-ledger	Investor or financier reference, unit, amount, date, source	Bank statement and sales or finance records
Approved budget	Cost code, amount, category, revision, approval	Approved feasibility and project budget
Progress certificate	Period, work package, percentage, amount, author, signature	Approved consultant certificate
Trustee verification	Site visit, observations, exceptions, approval	Trustee engineer record
Release instruction	Payee, invoice, amount, signatories, basis	Signed instruction and supporting pack
Completion reserve	Base, percentage, release conditions and date	Law, agreement and completion evidence

3.3 Dubai waterfall representation

The proposed Dubai waterfall is a project-specific state machine:

1. Confirm the project, account and request are active and in scope.
2. Confirm all relevant buyer and financier receipts have been reconciled to the escrow account.
3. Confirm the payee, cost code and purpose are eligible under the law and escrow agreement.
4. Confirm the current approved budget and remaining budget for the cost code.
5. Confirm professional progress certification and required trustee verification.
6. Confirm invoice identity, amount, tax treatment, prior payments, retention and variation status.
7. Apply legal, contractual and financing reserves, caps and drawstops.
8. Route the resulting entitlement and exceptions to the required signatories.
9. Release through the trustee's controlled banking process.
10. Reconcile the bank debit and close or escalate differences.

The engine produces a calculated maximum eligible release and a complete exception list. It does not produce an unconditional instruction to pay.

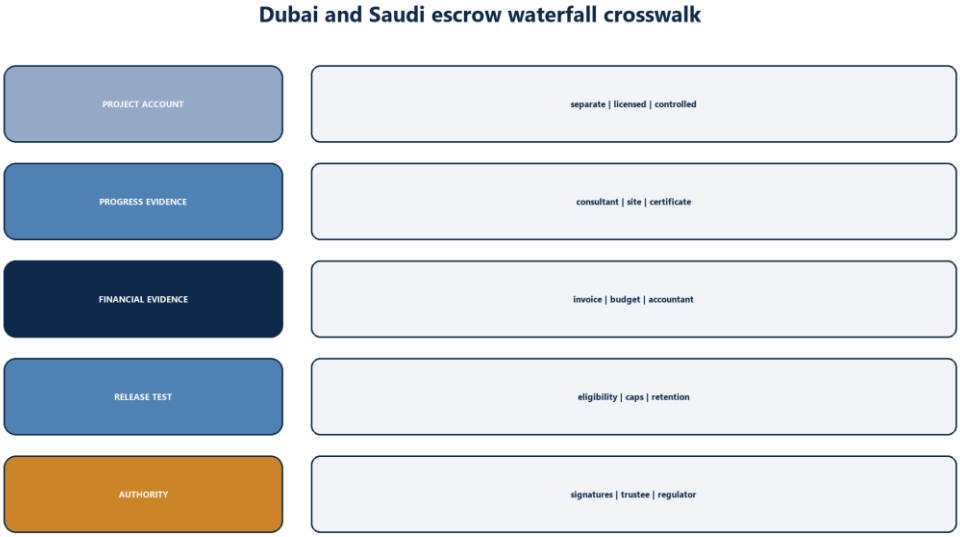

Figure 3. Dubai and Saudi escrow waterfall crosswalk

Source: Matchpoint crosswalk based on official sources [1-15].

4. SAUDI WAFI ESCROW CONTROL MODEL

4.1 Active statutory structure

Saudi Arabia's active Law of Selling and Leasing Off-Plan Real Estate Projects requires a separate escrow account for each project [11]. The account is for the licensed project, funds are protected from attachment for developer creditors, and project-financing funds must be deposited into the account [11]. Article 11 requires a payment order signed by the developer, consulting firm and certified public accountant, subject to the law's exceptional mechanism. Articles 12 to 14 address non-construction expenditure, excess funds and retention [11].

The implementing regulations add operational detail. They address independent accounts and reports for project scopes, public project information, project-reporting frequency, project and unit identifiers, secure withdrawal requests, exceptional withdrawals, delayed-project controls and notification of violations [12]. The official Wafi platform describes the national off-plan licensing service and provides the current operating context [13].

4.2 Wafi control objects

Wafi object	Minimum fields	Control significance
Licensed project	Licence, developer, scope, phases, land and unit identifiers	Determines lawful project perimeter
Project escrow	SAR account, activation state, bank, project reference	Separates cash and instruction chain
Consulting firm	Approval, appointment, scope, authorised signers	Engineering certification control
Certified public accountant	Approval, appointment, reporting period, signer	Financial confirmation control
Monthly or quarterly report	Reporting class, period, progress, financial status	Regulatory monitoring and refresh cadence
Withdrawal request	Payee, purpose, amount, supporting records, three approvals	Core payment-order object
Non-construction cap	Sold-unit values, cumulative eligible non-construction releases	Statutory cap control
Completion retention	Construction-cost base, five per cent amount, alternative security	Post-completion protection

4.3 Wafi waterfall representation

The proposed Wafi waterfall validates the project licence and account status, assigns the request to the correct project scope, matches the payee and cost category, reconciles the invoice and account ledger, tests statutory and approved-budget limits, verifies engineering and accounting evidence, gathers the required signatures, applies retentions and exceptional approvals, submits through the approved channel and reconciles the resulting cash movement.

The Saudi model creates a particularly clear segregation-of-duties requirement. The developer, consulting firm and certified public accountant are separate approval principals for ordinary disbursement. An AI service may prepare a common evidence pack for their review; it must preserve separate identities, review histories and signatures.

Control issue	Dubai analytical treatment	Saudi analytical treatment
Separate account	One account per project under Dubai escrow framework	Separate account per licensed project
Progress evidence	Approved consultant and trustee verification per current process	Consulting-firm reports and approvals
Financial evidence	Project records, statements, trustee pack	CPA reports, accounting records and signature
Ordinary release	Project agreement and required approvals	Three-party payment order under Article 11
Non-construction spend	Eligibility and project-agreement limits; confirm current DLD rules	Statutory 20 per cent framework under Article 12
Completion holdback	Five per cent framework under Dubai law	Five per cent construction-cost framework or permitted alternative
Exceptional release	Applicable regulator and agreement route	Competent-authority route under law and regulations

5. CANONICAL ESCROW DATA MODEL

5.1 Design principle

The proposed architecture treats each consequential statement as an evidence-backed object. A dashboard percentage without lineage is insufficient. The system must retain the source file, exact location, extraction method, transformation, reviewer, approval status, effective period and link to the decision in which the value was used.

The canonical model has six ledgers:

- a **project ledger** for licence, parties, contracts, budgets, units and work packages;
- an **escrow ledger** for receipts, releases, reserves, returns, fees and bank balances;
- a **progress ledger** for planned, measured, certified and accepted progress;
- an **evidence ledger** for documents, images, video, scans, certificates and observations;
- a **decision ledger** for requests, tests, exceptions, approvals, overrides and releases;
- a **model ledger** for prompts, model versions, tools, inputs, outputs, evaluations and reviewer corrections.

5.2 Core identifiers

Object	Stable identifier	Required links
Project	jurisdiction + regulator project ID	developer, licence, escrow, phase
Unit	project ID + official unit reference	sale, buyer, collection, project scope
Work package	project ID + approved WBS code	schedule, budget, contract, BIM element
Evidence asset	cryptographic hash + capture ID	project, location, time, custodian, permissions
Certificate	issuer + serial + period + hash	work packages, evidence, invoice, request
Invoice	supplier + invoice number + tax identity	contract, purchase order, work package, request
Bank transaction	bank reference + account + date	receipt or release, counterparty, reconciliation
Release request	project + sequence + version	rule pack, evidence, approvals, bank transaction

5.3 Atomic evidence object

An evidence object records a single proposition or asset with custody and scope. Its fields include evidence ID, project ID, asset hash, source type, source owner, capture time, receipt time, location, period, work package, claim, unit, value, confidence, permission, reviewer, review status, supersession, retention class and source pointer.

Confidence is not approval. A high model score does not turn an image into a professional certificate. The model score supports routing and review prioritisation. The approved professional status is stored separately.

5.4 Temporal and version controls

Construction, certification, bank and contract data arrive at different times. The architecture stores both event time and processing time. This permits a reviewer to see what was known when a release was evaluated and what arrived later. A schedule revision, budget variation or replacement certificate creates a new version with an explicit effective date. Prior packs remain reproducible.

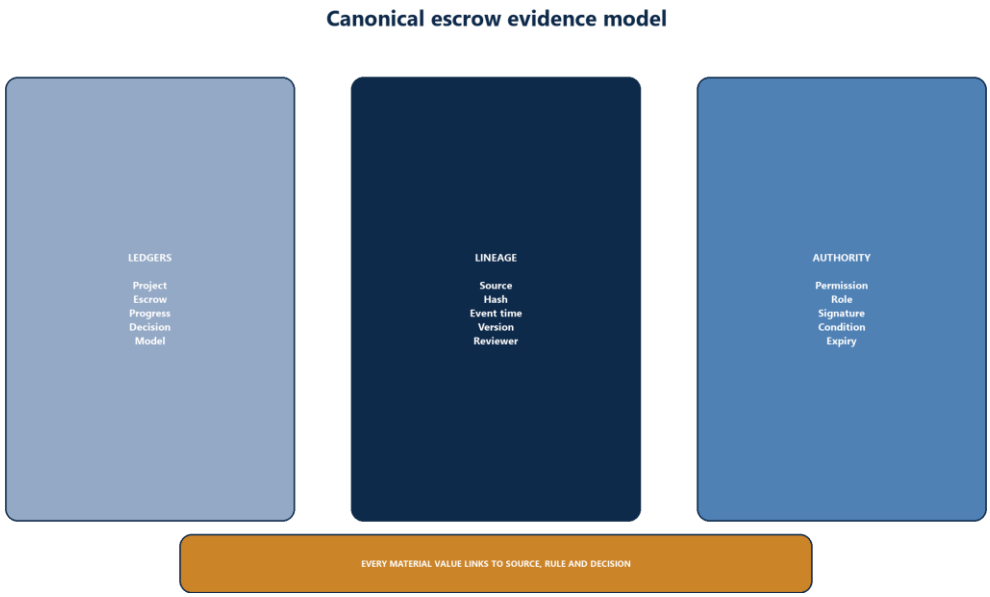

Figure 4. Canonical escrow evidence model

Source: Matchpoint evidence architecture; provenance and risk context [19-27,42-50].

6. ESCROW DATA-FLOW ARCHITECTURE

6.1 Layers

The proposed architecture has eight layers:

1. **Permissioned connectors** receive bank files, regulator data, project-controls data, approved documents and captured media.
2. **Evidence vault** preserves originals, hashes, signatures, metadata, permissions and retention controls.
3. **Canonicalisation services** map account, project, WBS, cost code, payee, invoice and unit identifiers.
4. **Deterministic reconciliation services** balance cash, duplicate invoices, cumulative releases, budget availability, caps, retention and entitlement.
5. **AI analysis services** classify, extract, compare, explain and draft with source pointers.
6. **Policy and rule engine** evaluates the approved jurisdiction and project rule pack.
7. **Workflow service** routes exceptions, reviews, signatures, consent and bank instructions.
8. **Decision surfaces** present developer, trustee, accountant, engineer, lender and regulator views appropriate to their authority.

6.2 Trust boundaries

Boundary	Main risk	Proposed control
Bank to platform	Truncated, duplicated or altered transactions	Signed transfer, control totals, hashes and independent balance check
Site capture to vault	Wrong project, time, location or manipulated media	Authenticated device, capture manifest, chain of custody and review
Document to model	Prompt injection or malicious content	Treat files as untrusted data, isolate instructions and restrict tools
Model to rule engine	Unsupported value or invented field	Schema validation, source pointers and rejection of missing evidence
Rule engine to workflow	Wrong rule version or scope	Approved version, effective-date test and project binding
Workflow to bank	Unauthorised or altered instruction	Segregated signature, secure channel and bank-side mandate
Dashboard to user	False precision or stale data	As-of time, source status, uncertainty and open-exception count

6.3 Event-driven processing

Each change emits a signed event, such as bank statement received, progress capture received, certificate approved, invoice superseded, request submitted, exception opened, approval recorded, release posted or reconciliation failed. Idempotency keys prevent duplicate processing. The system writes append-only events and builds current views from them. Corrections are additional events linked to the original entry.

6.4 Data freshness service levels

Data class	Proposed target	Staleness response
Bank balance and transactions	Daily or bank-supported intraday	Block final release if the configured cut-off is exceeded
Approved project schedule	On every approved revision	Recalculate milestone dependencies
Progress evidence	Per monitoring plan and request	Mark affected work packages unsupported
Professional certificate	On issuance and amendment	Block request until approved version is present
Invoice and variation	On receipt and approval	Detect duplicates and recalculate commitment
Regulator instructions	Scheduled review plus event-driven update	Suspend affected rule pack pending approval

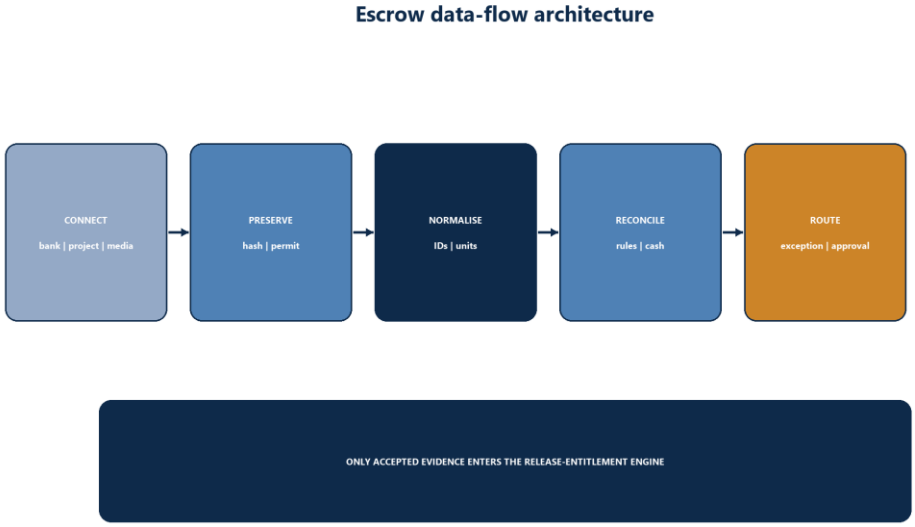

Figure 5. Permissioned escrow data-flow architecture
Source: Matchpoint architecture; official escrow, AI and security context [1-25,42-50].

7. CONSTRUCTION-PROGRESS EVIDENCE

7.1 Evidence hierarchy

Computer vision is one component of a broader evidence hierarchy. The proposed hierarchy moves from approved design and schedule, through contemporaneous capture and quantitative measurement, to professional certification and trustee or regulator review.

Evidence class	Examples	Proposed use
Approved baseline	Drawings, BIM, WBS, programme, bill of quantities	Defines expected scope and sequence
Contemporaneous capture	Geotagged photographs, video, 360-degree imagery, scans	Shows visible site state
Quantitative observation	Point cloud, measured quantity, test result	Supports quantity and completion assessment
Commercial evidence	Invoice, valuation, purchase order, delivery note	Connects work to amount and payee
Professional certification	Consultant or engineer certificate	Authoritative progress opinion within appointment
Trustee or regulatory evidence	Site verification, platform report, direction	Enables required external control

7.2 Capture protocol

Every capture campaign should have an approved plan: project and zone, date window, responsible operator, device, route, viewpoints, lighting tolerance, privacy exclusions, safety controls, file format, resolution, capture manifest and upload deadline. The protocol must preserve negative evidence; missing areas are recorded rather than silently omitted.

For fixed cameras, the system records calibration, field of view, obstruction and uptime. For mobile capture, the operator follows a defined route and confirms checkpoints. For laser scanning or photogrammetry, the technical team records coordinate reference, registration error, coverage and processing parameters. For drone capture, aviation and security approvals are preconditions; Section 17 addresses the jurisdiction-specific constraint.

7.3 BIM and schedule alignment

IFC is an open, vendor-neutral schema for built-asset information and is published as ISO 16739 [26]. The architecture maps an approved IFC or equivalent model to work packages, cost codes and schedule activities. Model elements receive stable identifiers. A change-control service records additions, deletions, geometry revisions and classification changes. A progress algorithm must compare against the approved revision applicable to the observation date.

Research on computer-vision-based progress monitoring commonly separates data acquisition and reconstruction, as-built modelling and progress assessment [32-41]. Methods include photographic reconstruction, object detection, semantic segmentation, scan-to-BIM comparison and schedule-linked visual evaluation. The literature also reports limitations involving occlusion, viewpoint, changing site conditions, labelled data, element granularity and generalisation [32-41]. These limitations support a review-first design.

7.4 Progress state taxonomy

State	Meaning	Release treatment
Not observable	Required area absent, occluded or unusable	No visual support; obtain evidence
Not started	Approved scope visible and no start evidence	Zero visual completion for that element
In progress	Work started but completion criteria unmet	Partial measurement only under approved method
Apparently complete	Visual completion criteria appear met	Requires measurement and professional review
Certified complete	Approved professional certifies criteria	Eligible input to entitlement tests
Accepted or handed over	Contractual acceptance recorded	Supports later release or retention events
Defective or disputed	Quality issue, rework or dispute recorded	Exception and possible hold

8. COMPUTER-VISION PROGRESS VERIFICATION

8.1 Bounded role for vision models

Vision models can identify and localise visible construction elements, compare repeated viewpoints, read supported labels, highlight discrepancies and prepare a reviewer queue. Claude can analyse images and visual PDF content under current platform capabilities, subject to documented limits [21-25]. These functions support evidence preparation. They do not establish hidden work, structural quality, material compliance, test performance, title, contractual acceptance or legal entitlement.

8.2 Model pipeline

The proposed pipeline is:

1. Validate capture identity, hash, time, location, permissions and project binding.
2. Run quality checks for blur, exposure, occlusion, field of view and duplicate frames.
3. Register the image or point cloud to the approved project coordinate system.
4. Retrieve the applicable model elements, work packages and schedule activities.
5. Run approved detection, segmentation or scan-comparison models.
6. Create element-level observations with source crops, model version and confidence.
7. Aggregate only under an approved measurement rule.
8. Route low-confidence, conflicting or material observations for professional review.
9. Store reviewer corrections and final status without overwriting the model output.

8.3 Quality gates

Gate	Test	Failure response
Capture validity	Hash, project, time, operator and permission present	Reject from analytical pipeline
Image quality	Minimum resolution, blur, exposure and coverage	Recapture or manual review
Spatial alignment	Registration within approved tolerance	Block quantitative comparison
Model applicability	Project type, element class and conditions in evaluation perimeter	Route to manual review
Evidence sufficiency	Multiple views or measurement required by protocol	Mark unsupported
Materiality	Potential release impact above approved threshold	Mandatory human review
Conflict	Vision, schedule, certificate or invoice disagreement	Open exception and suspend aggregation

8.4 Evaluation metrics

Object-detection precision, recall and mean average precision describe model performance; they do not measure release-decision safety. A production evaluation also measures element-status accuracy, quantity error, coverage, false-completion rate, conflict detection, source-pointer validity, reviewer correction rate and downstream release impact.

Published studies provide context rather than a transferable production benchmark. For example, Park and Kang report a case-specific visual schedule-progress method and disclose its evaluation metrics [37]. Bhattacharjee and colleagues report a single-project integrated UAV, photogrammetry and BIM study [39]. Reja, Varghese and Ha's systematic framework emphasises the stages and levels of computer-vision progress monitoring [32]. A Matchpoint or client claim requires testing on the intended project's elements, capture conditions, languages, schedule and evidence rules.

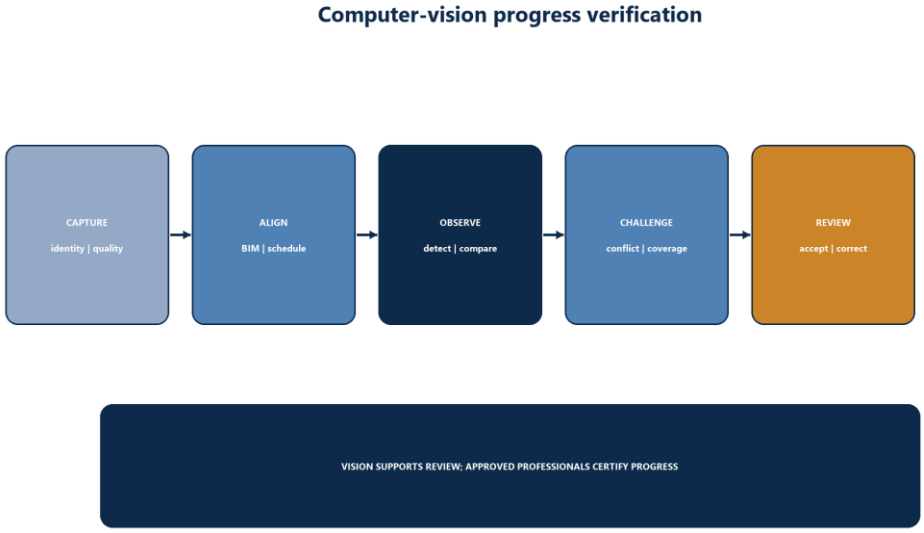

Figure 6. Computer-vision progress-verification workflow
Source: Matchpoint workflow; construction-progress research [32-41].

9. MILESTONE-RECONCILIATION AGENT DESIGN

9.1 Agent contract

The milestone-reconciliation agent receives a release request ID and an approved rule-pack version. It may retrieve only permitted project objects. It produces a structured reconciliation pack, never a free-form payment instruction.

The output schema contains:

- request and rule-pack identifiers;
- project, account, payee and invoice identity;
- milestone and work-package mapping;
- planned, measured, model-observed, certified and accepted progress;
- budget, commitment, prior release, retention and reserve values;
- source pointers for every material input;
- deterministic entitlement calculation result;
- conflicts, omissions and stale evidence;
- proposed routing and required approvers;
- model version, prompt, tools and execution record.

9.2 Task decomposition

Agent task	Permitted model role	Deterministic or human control
Classify request	Map documents and stated purpose to schema	Reviewer confirms material classification
Extract fields	Read amount, date, parties, certificate and invoice data	Schema, checksum and source-pointer validation
Map milestone	Suggest WBS and cost-code links	Approved project map and reviewer confirmation
Compare evidence	Summarise agreement and conflict across sources	Rule engine calculates; professional resolves
Draft exception	Explain missing or conflicting evidence	Named owner accepts, edits or rejects
Draft decision pack	Assemble accepted evidence in template	Required approvers authorise

9.3 Source-grounded extraction

Claude's citation feature can return document-linked citation blocks for supported document content [23]. The production design stores its own immutable source pointers as well: file hash, page or cell, bounding box where available, exact extracted text, parser version and reviewer status. Visual citations require separate crops and coordinates because current citation support may be text-focused under particular platform paths [21-23].

Each numeric field has a unit and sign convention. Amounts retain source currency. Percentages distinguish percentage points from proportions. Dates use ISO format plus source timezone. The model may not calculate final entitlement. It emits parsed inputs; a deterministic service performs calculation and returns a signed result.

9.4 Missing evidence and abstention

The agent must produce unsupported, conflicted, stale or not applicable where evidence is insufficient. It may not infer a certificate date from an upload date, a payee from a filename, a progress percentage from a narrative adjective, or legal eligibility from a prior similar request.

9.5 Prompt-injection resistance

Construction packs can contain arbitrary text. All document content is treated as untrusted data. Model instructions are separated from source content. Tools use allowlisted schemas and read-only access during analysis. The agent cannot send email, alter a bank file, modify a certificate, approve a request or execute a payment. Any source text that asks the model to ignore controls is captured as a security event.

10. ESCROW AND CASH RECONCILIATION

10.1 Double-entry project sub-ledger

The platform maintains a project sub-ledger reconciled to the trustee bank statement. Receipts are classified as buyer collections, financier deposits, developer injections, refunds, interest or other approved categories. Debits are classified by payee, invoice, cost code, release request and bank reference. Unmatched items remain in suspense with an owner and ageing status.

10.2 Control totals

For each cut-off date, the system tests:

Opening bank balance + cleared receipts - cleared debits = closing bank balance.

Opening project ledger + posted ledger entries = closing project ledger.

Bank closing balance - project ledger closing balance = unreconciled difference.

The final release workflow is blocked when the unreconciled difference exceeds an approved tolerance or includes a material unexplained item. Tolerance does not permit concealment; it governs routing and timing.

10.3 Release-base calculations

Quantity	Proposed formula	Evidence
Certified value to date	Approved certified quantity x approved rate, adjusted for authorised variation	Certificate, contract and variation
Gross amount currently due	Certified value to date - prior certified value	Current and prior certificate
Net invoice eligible	Gross due - contractual retention - deductions - prior payment	Invoice and contract
Cost-code availability	Approved budget + approved transfers - commitments - prior eligible releases	Budget and commitment ledger
Cash availability	Cleared escrow balance - protected reserves - pending authorised debits	Bank and reserve ledger
Provisional maximum	Minimum of eligible invoice, cost-code availability, cash availability and applicable rule caps	Deterministic result

10.4 Duplicate and anomaly controls

The platform detects exact and near-duplicate invoice numbers, reused certificate periods, repeated bank references, round-dollar splits, payee-account changes, invoice-date anomalies, duplicate image captures, abrupt progress reversals and requests just below an approval threshold. An anomaly is a review signal. It is not proof of fraud.

10.5 Three-way and four-way matching

Ordinary construction requests should match contract or purchase order, certified work, invoice and bank instruction. Where delivery evidence is material, a delivery note, test certificate or inspection record becomes a fifth component. Each mismatch has a defined owner and status.

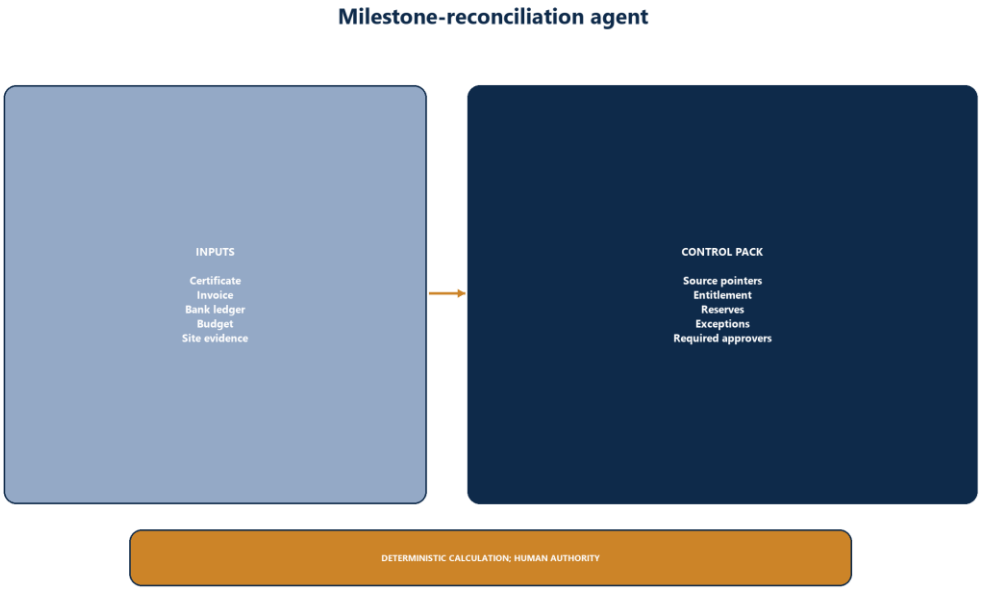

Figure 7. Milestone-reconciliation agent from source evidence to controlled pack

Source: Matchpoint framework; Claude capability and governance context [19-25].

11. RELEASE-ENTITLEMENT ENGINE

11.1 Rule representation

The release-entitlement engine applies approved machine-readable rules to accepted inputs. Each rule has a unique ID, legal or contractual source, exact source pointer, jurisdiction, project scope, cost category, effective date, expression, required evidence, approvers, exception route, test cases and approval history.

A rule is not placed in production because a model extracted it. Legal, escrow, finance and project-control reviewers approve the rule and its test cases. The system preserves the legal text next to the executable expression so reviewers can identify any gap between them.

11.2 Waterfall sequence

The proposed sequence is strict:

1. Validate project, account, request and rule-pack identity.
2. Validate source completeness, authenticity and freshness.
3. Validate payee, cost purpose and account eligibility.
4. Validate professional certifications and required signatures.
5. Calculate gross certified entitlement.
6. Deduct prior releases, retention, liquidated or other approved deductions.
7. Apply budget availability and cumulative category limits.
8. Apply legal and contractual reserves.
9. Apply lender drawstops, consent conditions and cash controls.
10. Calculate a provisional maximum and required approvals.
11. Route all exceptions; do not net unrelated exceptions into one score.
12. After approval, generate a controlled instruction record for the trustee process.

11.3 Release states

State	Meaning	Permitted transition
Draft	Request is incomplete or editable	Submit, cancel
Submitted	Version frozen for analysis	Return, analyse
Analysed	Calculations and exceptions produced	Review, return
Under professional review	Consultant, accountant or other required reviewer engaged	Approve evidence, reject, request information
Under trustee review	Required pack presented to trustee or bank	Approve release, reject, request information
Conditional	One or more explicit conditions remain	Satisfy, expire, reject
Approved	All required approvals present for a defined amount	Issue instruction, revoke before execution
Released	Bank debit confirmed	Reconcile, dispute
Reconciled	Bank and project ledgers match	Close, reopen by controlled exception

11.4 Reserve stack

The engine calculates reserves independently and then applies the approved priority. Typical categories include statutory completion retention, contractual retention, defect reserve, tax reserve, unresolved-variation reserve, lender interest or debt-service reserve, cost-to-complete buffer and disputed-payment hold. The presence and priority of each reserve are project-specific.

Reserve	Basis	Release trigger	Owner
Statutory completion retention	Applicable law and approved calculation base	Statutory condition and approved evidence	Trustee, regulator and authorised parties
Contract retention	Construction contract and certificates	Contractual milestone and certification	Contract administrator

Reserve	Basis	Release trigger	Owner
Defect reserve	Defect list and estimated remediation	Verified remediation or approved security	Engineer and trustee
Variation reserve	Unapproved or disputed variation	Formal variation approval	Developer, consultant and lender as applicable
Lender reserve	Finance documents	Covenant or consent condition	Lender

11.5 Rule conflict

If two approved rules produce inconsistent results, the engine stops. It records the conflicting rule IDs, sources and affected amount. An authorised legal or contractual reviewer resolves the conflict through a new rule-pack version. The system does not choose the more permissive rule.

12. ALERT TAXONOMY AND EXCEPTION WORKFLOW

12.1 Alert design

An alert must identify the affected object, evidence, rule, amount, materiality, owner, clock and permitted resolution. Generic red warnings create noise. The proposed taxonomy distinguishes eligibility, evidence, progress, finance, cash, counterparty, authority, security and data-quality alerts.

Alert class	Example	Default severity driver
Eligibility	Cost category excluded by approved rule pack	Amount and legal consequence
Evidence	Missing current certificate or source pointer	Required-document status
Progress	Certified completion materially exceeds measured observation	Amount, work package and confidence
Finance	Request exceeds remaining budget or cumulative cap	Monetary exposure
Cash	Bank balance stale or reconciliation difference open	Amount and age
Counterparty	Payee bank details changed after approval	Change criticality
Authority	Missing signer, expired appointment or conflicted reviewer	Decision-rights breach
Security	Source contains prompt injection or invalid signature	Access and integrity impact
Data quality	Project, unit or cost-code identifier unresolved	Downstream calculation impact

12.2 Severity

Severity is calculated from consequence, exposure, reversibility, legal significance, evidence reliability and time sensitivity. A low model confidence is not automatically a critical business alert. A missing legally required signature is critical even if all amounts reconcile.

Severity	Proposed response	Release status
Informational	Display with source and refresh date	No automatic block
Review	Named owner checks within service level	May proceed only if rule permits
Material	Independent review and documented resolution	Affected amount held
Critical	Escalation to authorised control owner	Request blocked
Security incident	Isolate inputs, revoke affected access and investigate	Workflow suspended

12.3 Exception lifecycle

Each exception moves through open, assigned, under review, information requested, resolved, accepted risk, rejected or expired. Resolution requires evidence and an authorised person. Accepted risk requires an explicit authority and expiry. Reopening preserves the prior history.

12.4 Alert fatigue controls

The system groups alerts only when they share a root cause and authority. It suppresses exact duplicates, preserves the highest materiality, and displays the number of affected requests and amount. It measures alert precision, override rate, ageing and repeated root causes. A control owner reviews thresholds; the model does not tune materiality autonomously.

13. LENDER DASHBOARD MOCK-UP

13.1 Purpose

The lender view is a decision surface for exposure, completion, liquidity, cost to complete, covenant and exception status. It must state its as-of time and data coverage. It should display planned, observed, certified and accepted progress separately.

13.2 Dashboard hierarchy

The top panel contains project identity, licence status, escrow account status, current data cut-off, total lender exposure, cleared escrow cash, remaining approved project cost, latest certified progress and open critical exceptions. A second panel shows progress against schedule, certified value against release, and forecast cost to complete. A third panel shows releases by cost category and payee concentration. A fourth panel presents covenants, consents and reserves. A final panel lists decision-ready exceptions with source links.

Dashboard field	Definition	Source	Caution
Observed progress	Model or measurement-supported visible progress	Capture and analysis	Provisional until reviewed
Certified progress	Current approved consultant or engineer status	Certificate	Certification scope must be clear
Cash balance	Cleared escrow balance at cut-off	Bank	Pending items shown separately
Cost to complete	Approved remaining cost plus approved forecast adjustments	Budget and forecast	Scenario and confidence disclosed
Release coverage	Cash available divided by approved pending releases	Ledger	Excludes unsupported requests
Exception exposure	Sum of amounts affected by open material exceptions	Workflow	Amount is exposure, not expected loss

13.3 Text wireframe

Dashboard band	Illustrative fields
Project header	Project, licence, account and as-of time
Exposure	Loan exposure, escrow cash, certified progress and critical-exception count
Progress bridge	Planned, observed, measured, certified and accepted progress
Cash waterfall	Opening cash, cleared receipts, reserves, approved pending releases and forecast closing cash
Cost to complete	Base cost, approved changes, contingency and forecast adjustment
Covenants and consents	Status, threshold, headroom, source and required action
Decision queue	Severity, request, amount, rule, evidence gap, owner, age and action

The values in this wireframe are placeholders. They are not observed project data.

13.4 Explainability

Clicking any KPI opens its calculation, source objects, rule version, evidence status and reviewer. The dashboard does not present a single opaque project-health score. A lender can see whether a warning arises from cash, physical progress, a missing approval, a contract issue or stale data.

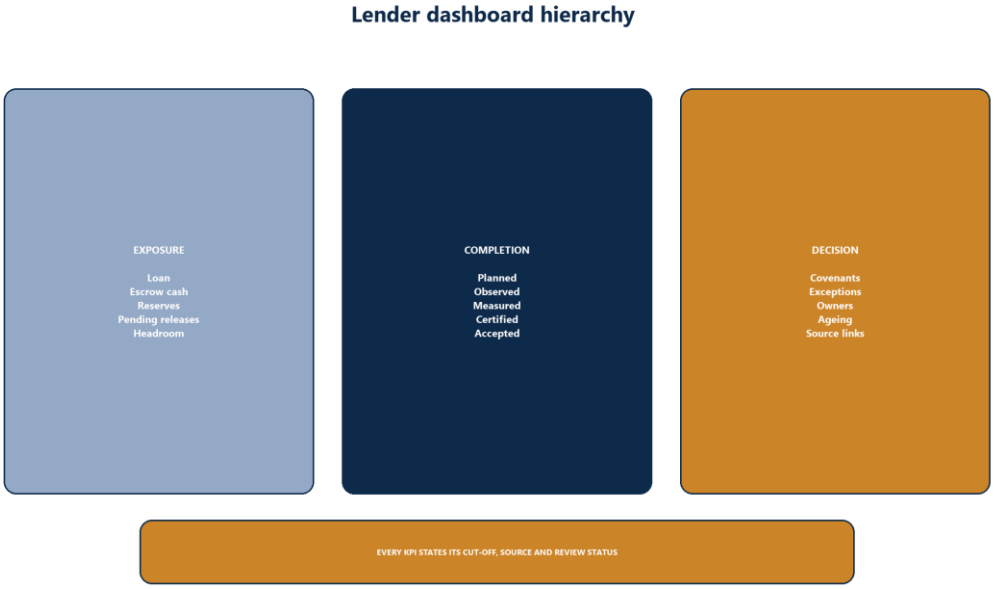

Figure 8. Lender dashboard hierarchy for exposure, completion and decision

Source: Matchpoint lender-control framework; risk-data context [49].

14. HUMAN REVIEW, SIGNATURE AND OVERRIDE

14.1 Separate workspaces

The developer, consultant, certified public accountant, trustee and lender receive separate workspaces and credentials. The system may show a common evidence pack, but each party records its own review, comments, approval scope and signature. One party cannot use the model to impersonate another.

14.2 Professional review checklist

Review question	Evidence	Recorded outcome
Is the request within appointment and licence scope?	Appointment, licence, project record	In scope, out of scope, refer
Is the source set complete for the relevant opinion?	Checklist and evidence objects	Complete, incomplete, qualified
Are physical observations consistent with certification?	Capture, measurement, site record	Consistent, explained difference, unresolved
Are amounts and cumulative values correct?	Deterministic calculation and ledger	Confirmed, corrected, disputed
Are required restrictions and qualifications stated?	Rule pack and professional judgement	Accepted wording or revision

14.3 Electronic signatures

An approval record contains signer identity, role, organisation, authority, appointment version, approved amount, conditions, timestamp, signature mechanism, document hash and revocation status. The signature is bound to the exact pack version. Any change after signature creates a new version requiring the applicable approvals again.

14.4 Override policy

Overrides are exceptional and transparent. An override record contains the failed rule, affected amount, reason, approving authority, supporting source, compensating control, expiry and required notification. Rules classify which failures are non-overridable. The dashboard reports override volume, ageing and concentration by approver or counterparty.

14.5 No autonomous release

The system does not hold bank credentials and cannot submit a final payment instruction without the bank's approved human and technical controls. Where an authorised integration is later implemented, transaction limits, dual control, payee validation, step-up authentication and independent reconciliation remain mandatory.

15. WORKED ESCROW SCENARIOS

15.1 Scenario status

The examples in this section are **[Unverified illustrative scenarios]**. Names, projects, balances, progress percentages, invoices, thresholds, outcomes and timelines are invented to demonstrate the framework. They are not client facts, regulator decisions or observed performance.

15.2 Dubai request

[Unverified illustrative scenario] A Dubai off-plan project submits an AED 12.0 million contractor request. The current approved consultant certificate supports AED 11.4 million of gross work for the period. Contractual retention and a prior payment reduce the net invoice-supported amount to AED 9.7 million. Cost-code availability is AED 10.2 million. Cleared escrow cash after protected reserves is AED 10.0 million. The deterministic provisional maximum is therefore AED 9.7 million, before final trustee review.

The vision service finds that several facade zones visible in the capture appear less complete than the schedule mapping assumed. The model does not reduce the certified amount. It opens a material evidence conflict, links the affected images and BIM zones, and routes the exception to the approved consultant and trustee engineer. The release remains held until they resolve the discrepancy or provide additional evidence.

Dubai scenario input	Illustrative value	Status
Contractor request	AED 12.0m	Unverified illustrative
Gross certified period value	AED 11.4m	Unverified illustrative
Net invoice-supported amount	AED 9.7m	Unverified illustrative
Cost-code availability	AED 10.2m	Unverified illustrative
Cash after reserves	AED 10.0m	Unverified illustrative
Provisional mathematical maximum	AED 9.7m	Calculated from illustrative inputs

15.3 Saudi request

[Unverified illustrative scenario] A Saudi off-plan project prepares a SAR 7.5 million release. The project record confirms the licensed scope and escrow account. The consulting firm approves the engineering evidence and the certified public accountant confirms the financial calculation. A payee-bank change was entered after the invoice review. The system blocks instruction generation, requires independent payee verification and preserves the three approval records. Once the payee change is verified under the bank's approved process, the signatories review the final pack version.

15.4 Cross-scenario lesson

The main control value is the separation of evidence, arithmetic and authority. A vision discrepancy creates a review item. A bank-detail change creates a security and counterparty control. A calculated maximum constrains the amount. None of those outputs substitutes for the required professional and banking decisions.

16. MODEL EVALUATION AND PRODUCTION MONITORING

16.1 Golden set

Before production, the project team creates a permissioned, representative golden set of past requests. It includes ordinary, incomplete, disputed, amended, multilingual, low-quality, duplicate and adversarial cases. Specialists label fields, source pointers, eligibility, progress states, exceptions and final human outcomes. The evaluation set remains separate from prompt and workflow development.

16.2 Component evaluations

Component	Primary metric	Release gate
Document classification	Macro F1 plus material-class recall	No critical class below approved recall
Numeric extraction	Exact match with unit, sign and source pointer	Zero critical unsupported amounts in release set
Entity matching	Precision, recall and false payee match	No unresolved material counterparty match
Vision observation	Class and state precision, recall and coverage	Project-specific approved thresholds
Citation or pointer	Entailment and location validity	Every material claim traceable
Rule calculation	Test-vector exact match	100 per cent on approved deterministic cases
Exception drafting	Correct rule, amount, evidence and owner	Human acceptance and correction threshold

16.3 End-to-end evaluation

The end-to-end unit is a release pack. Reviewers compare the AI-supported pack with the approved human baseline on amount, unsupported release risk, missed exception risk, time, specialist effort, reviewer disagreement and reproducibility. Cases are stratified by jurisdiction, project phase, value, cost category, evidence quality and language.

16.4 Severity-weighted error

A false positive visual alert creates review cost. A missed duplicate invoice or unsupported payee change can create a larger exposure. The evaluation therefore weights errors by approved severity and affected amount. Weighting is governance policy, not a model-selected parameter.

16.5 Production monitoring

Production monitoring covers input drift, capture quality, extraction accuracy, correction rate, source-pointer failure, rule-pack version, tool errors, latency, security events, exception ageing and override patterns. Any material model, prompt, parser or rule change triggers regression testing.

16.6 Incident response

An incident playbook defines detection, containment, evidence preservation, impacted requests, access revocation, bank and regulator escalation, human fallback, root-cause review and controlled restart. The platform retains model inputs and outputs subject to privacy and legal retention rules.

17. PRIVACY, SECURITY AND MEDIA PROVENANCE

17.1 Data-protection perimeter

Site imagery may contain workers, visitors, vehicle plates, neighbouring properties and location data. Payment packs contain identities, account details and signatures. UAE Federal Decree-Law No. 45 of 2021 defines and regulates personal-data processing [16]. Saudi Arabia's Personal Data Protection Law and its implementing guidance establish rights and controller obligations [17-18]. A project must obtain jurisdiction-specific legal advice, define purpose and lawful basis, minimise capture, restrict access, set retention and manage cross-border processing.

17.2 Privacy-by-design controls

Risk	Proposed control
Incidental faces or plates	Avoid capture where possible; approved redaction for analytical copies
Neighbouring property	Geofence or mask excluded zones; route approval
Location leakage	Role-based access and restricted exports
Signature and bank data	Field-level protection, limited views and audit logging
Model-provider processing	Approved data-processing terms, region and retention configuration
Secondary use	Prohibit training or unrelated use without approved basis

17.3 Evidence integrity

Every original asset receives a cryptographic hash on ingestion. The system stores device, operator, capture time, upload time, geospatial metadata where permitted, transformations and derivative hashes. C2PA defines an opt-in technical standard for content provenance and authenticity manifests [27]. Where supported by capture devices and software, C2PA-compatible credentials can supplement the custody record. They do not prove the semantic truth of the scene; they help verify declared provenance and tamper evidence.

17.4 Access control

Access is granted by project, organisation, role, object class and purpose. Retrieval filters are enforced before a source reaches the model. Privileged actions require step-up authentication. Service accounts receive narrowly scoped permissions. The system records read, export, correction, approval and administrative events.

17.5 Cybersecurity baseline

The control programme maps the service to NIST AI RMF governance, mapping, measurement and management functions [19-20], the organisation's information-security management system, secure software practices and incident processes [42-46]. Generative-AI risk controls include pre-deployment testing, provenance, incident disclosure, model and supplier governance, and documented human roles [20].

18. DRONE AND REMOTE-CAPTURE CONSTRAINTS

18.1 UAE

The UAE GCAA treats commercial photography, aerial survey and related work as regulated professional drone operations and describes registration, operator authorisation, security clearance and operational permission requirements [28]. Current airspace publications and safety decisions can change quickly. A GCAA decision dated 28 February 2026 temporarily suspended drone operations [29]. A later GCAA alert dated 2 May 2026 addressed the resumption of normal air navigation operations [30]. **I cannot verify from the cited publications that the drone-specific suspension was explicitly cancelled for every proposed construction-capture operation.** A project must obtain current written confirmation and all required approvals before any flight.

18.2 Saudi Arabia

Saudi GACA material requires applicable government approvals, registration and operational authorisation for small UAS; aerial survey or photography can require additional approvals [31]. Current GACA rules and the intended project's location and operation must be verified before capture.

18.3 Capture fallback

The operating model must function without drones. Approved fixed cameras, ground-based mobile routes, 360-degree capture, handheld imagery and terrestrial laser scanning can supply evidence where legally, safely and technically permitted. Capture method is recorded as part of evidence quality; the system does not merge methods without an approved comparison protocol.

Capture method	Strength	Limitation	Approval check
Fixed camera	Consistent view and frequency	Occlusion and limited coverage	Site, privacy and security approval
Ground mobile	Flexible and relatively accessible	Operator and route variability	Site safety and privacy approval
360-degree camera	Broad contextual record	Distortion and privacy exposure	Site and data-protection approval
Terrestrial scan	Quantitative geometry	Cost, registration and reflective surfaces	Technical and site approval
Drone imagery	Roof, facade and site coverage	Aviation, security, weather and privacy constraints	Current aviation and security permissions

19. ECONOMICS, CAPACITY AND NINETY-DAY ROADMAP

19.1 Evidence boundary

No supplied Matchpoint or client dataset establishes time saved, cash cost reduction, loss reduction, financing improvement, release acceleration or additional revenue from this architecture. Those values remain USD 0 for attribution until a controlled pilot produces approved observed evidence.

19.2 Measurement model

The baseline and pilot use the same request definition and quality gate. Measures include active human hours, elapsed calendar time, specialist hours, exception detection, rework, unsupported-field rate, release-pack quality, incidents and technology cost.

Measure	Definition	Evidence source
Decision-ready pack	Request with complete accepted evidence and required reviews ready for authority	Workflow state and checklist
Active human hours	Time spent performing or reviewing the case	Approved time record
Elapsed cycle time	Submission to final decision excluding defined pauses	Event log
Quality-gated throughput	Decision-ready packs meeting the approved quality threshold	QA record
Cost per pack	Loaded labour, specialist, technology and exception cost divided by accepted packs	Finance and time evidence
Prevented exposure	Amount of a request held due to a valid exception	Decision record; not realised saving

19.3 Ninety-day roadmap

Days 0 to 15: authority and source map. Confirm jurisdictions, projects, professional roles, current laws, regulator services, account agreements, finance documents, capture permissions, data-protection requirements and system boundaries. Freeze the initial source register.

Days 16 to 30: canonical data and evidence vault. Configure identifiers, bank reconciliation, WBS and cost-code maps, evidence objects, access, retention, hashes and event records. Load a limited historical set.

Days 31 to 45: deterministic waterfall. Encode and approve one narrow request category, calculate budget, cash, retention and release constraints, and test against approved examples.

Days 46 to 60: AI shadow workflow. Add controlled document extraction, source pointers, progress-image analysis and exception drafting. Run in shadow mode with no production decision effect.

Days 61 to 75: professional and lender review. Approved professionals compare outputs with their current process. The team measures correction, missed exceptions, false alerts, time and usability.

Days 76 to 90: governance decision. Review security, privacy, evaluation, incidents, supplier terms, operational support and observed economics. Authorised management decides whether to stop, extend shadow mode or permit a tightly scoped production pilot.

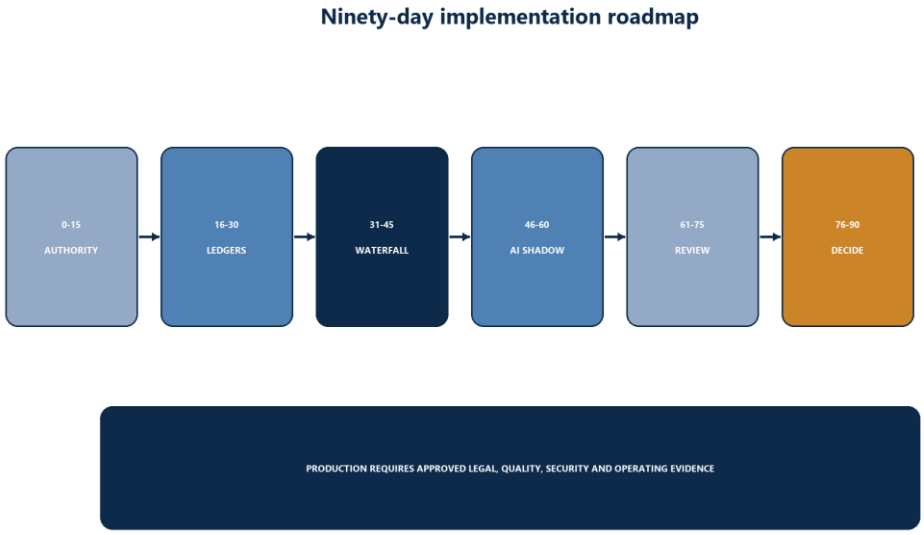

Figure 9. Ninety-day implementation roadmap

Source: Matchpoint implementation framework; governance context [19-25,42-50].

19.4 Minimum production gates

Gate	Evidence required
Legal and contractual	Approved current rule pack and professional review
Data	Reconciled identifiers, provenance, permissions and retention
Calculation	Exact-match deterministic test suite
Model	Project-specific golden-set results and accepted thresholds
Workflow	Separate identities, approvals, signature and override controls
Security	Threat model, access tests, logging and incident drill
Operations	Owners, service levels, fallback and change control
Economics	Approved observed pilot evidence or explicit non-financial rationale

20. LIMITATIONS AND CONCLUSION

20.1 Limitations

This paper is a research and operating-design document. It does not provide legal, regulatory, engineering, audit, accounting, banking, privacy, cybersecurity, aviation, valuation or investment advice. Official translations may not prevail over Arabic source texts. Laws, implementing regulations, service requirements, regulator directions, bank processes and platform capabilities can change. Every project requires current professional review.

The computer-vision literature includes diverse datasets, project types, capture methods, element classes and metrics [32-41]. Reported case performance is not evidence of equivalent performance on a Dubai or Saudi project. Visual evidence cannot reliably establish hidden work, material quality, test compliance or contractual acceptance without additional evidence. BIM and schedule data can themselves be incomplete or stale. Model outputs may be wrong, unsupported or manipulated.

The proposed rule engine requires accurate approved legal and contractual interpretation. The dashboard depends on bank, project-controls, certification and evidence freshness. A well-designed platform cannot repair a defective appointment, fraudulent source, unauthorised capture, missing professional independence or compromised banking process by itself.

20.2 Conclusion

Milestone-linked escrow releases are a data, evidence and authority problem. Dubai and Saudi Arabia provide distinct legal structures with a common need for project-specific accounts, professional evidence, controlled disbursement and records. A defensible digital architecture joins those structures to a canonical ledger, immutable evidence, deterministic entitlement, exception-led workflow and segregated approval.

Claude and construction computer vision can support document analysis, imagery review, comparison, source-linked drafting and exception preparation. Their useful role is bounded by custody, evaluation, abstention, deterministic calculation and human authority. The authorised consultant, accountant, developer, trustee, lender and regulator remain responsible for the decisions allocated to them.

The recommended first implementation is one jurisdiction, one project, one request category and one shadow-mode pilot. Expansion should follow approved evidence on quality, security, reviewer effort and operating economics. Attributed Matchpoint or client revenue, cash cost reduction, loss reduction and alpha remain USD 0 until approved observed evidence exists.

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APPENDIX A. RELEASE REQUEST OBJECT

Field	Type	Required control
request_id	Stable string	Unique and immutable
project_id	Reference	Active licensed project
rule_pack_id	Version reference	Approved and effective
account_id	Reference	Project escrow account
payee_id	Reference	Verified counterparty
invoice_ids	List	Source-linked and duplicate-checked
certificate_ids	List	Current approved versions
work_packages	List	Approved WBS mapping
requested_amount	Currency amount	Unit, sign and source required
provisional_maximum	Currency amount	Deterministic signed calculation
exceptions	List	Owner, severity, status and amount
approvals	List	Separate identity and scope
status	Enum	Controlled transition

APPENDIX B. PROGRESS OBSERVATION OBJECT

Field	Description
observation_id	Unique element-level observation
evidence_id	Link to immutable source asset
model_element_id	Approved model element reference
work_package_id	Approved schedule and cost mapping
observed_state	Controlled progress taxonomy
quantity	Value, unit and approved method
model_name_version	Exact model and configuration
confidence	Model score; never approval
source_crop	Coordinates or derivative hash
applicability	In-perimeter, out-of-perimeter or unknown
reviewer_status	Pending, accepted, corrected or rejected
reviewer_identity	Approved professional identity

APPENDIX C. RULE OBJECT

Field	Description
rule_id	Stable rule identifier
source_id	Statute, regulation, service, agreement or policy source
source_pointer	Article, clause, page or controlled location
jurisdiction	Dubai, Saudi Arabia or project-specific layer
project_scope	Applicable projects, phases and categories
effective_from	Effective date and time
effective_to	Supersession date where applicable
expression	Deterministic executable rule
required_evidence	Evidence and approval prerequisites
exception_route	Permitted legal or contractual escalation
tests	Approved positive, negative and boundary cases
approval	Legal, finance and control approvals

APPENDIX D. MODEL RUN RECORD

Field	Description
run_id	Unique execution identifier
task	Approved bounded task
model	Provider, model and version
prompt_version	Approved system and task prompt IDs
tool_versions	Parsers, retrieval, vision and calculation tools
input_hashes	Exact source objects supplied
output_hash	Immutable output record
citations	Source pointers returned and validated
safety_events	Prompt injection, policy or access events
latency_and_cost	Technical operating metrics
reviewer_outcome	Accepted, corrected, rejected or escalated

APPENDIX E. RELEASE PACK CHECKLIST

- [ ] Project, licence, account and rule-pack identities confirmed.
- [ ] Bank cut-off and project ledger reconciled.
- [ ] Payee and bank details independently verified.
- [ ] Invoice, contract, work package and cost code matched.
- [ ] Current approved progress certificate present.
- [ ] Required site, measurement and trustee evidence present.
- [ ] Budget, prior release, retention and reserve calculations validated.
- [ ] Statutory and contractual caps tested.
- [ ] Lender conditions, consents and drawstops tested.
- [ ] All model-supported fields have valid source pointers.
- [ ] Material exceptions resolved by authorised owners.
- [ ] Required separate signatures bind to the final pack version.
- [ ] Bank instruction uses the approved secure channel.
- [ ] Bank debit is reconciled after release.