Auditable Documentation for Guizhou Miao Batik-Inspired Design: A Provenance- and Context-Constrained Application Profile

YiXin Sun[1*], Yibiao Long[2], Xiong Xiao[3], Yiqing Qin[4]

[1,2]Liuzhou Polytechnic University, Liuzhou, Guangxi, China

[3]Guangxi Second Light Industry Technician College, Nanning, Guangxi, China

[4]Liuzhou Polytechnic University, Liuzhou, Guangxi, China

***Corresponding Author**

DOI: https://doi.org/10.47772/IJRISS.2026.100800133

Received: 11 August 2026; Accepted: 17 August 2026; Published: 27 August 2026

ABSTRACT

Digital resources make Guizhou Miao batik materials easier to locate and recombine, but downstream records may collapse source, attributed interpretation, transformation, review and intended-use scope into a single "inspired by" relation. This study treats that collapse as a record-structure problem and develops the Provenance- and Context-Constrained Translation Model (PCCTM), a design-technology and digital-heritage application profile implemented with executable Shapes Constraint Language (SHACL) rules. "Guizhou" denotes the provincial setting, "Miao" follows cited-source terminology, Danzhai identifies one county context, and "batik" denotes wax-resist textile practice rather than a generic printed aesthetic. Literature was used for requirements elicitation and comparative positioning, not as an empirical sample; all evaluation units were author-constructed Resource Description Framework (RDF) graphs. PCCTM separates seven record responsibilities, records six transformation dimensions, represents intended-use scope through five controlled identifier fields and a date interval, and uses property-driven targets to resist type evasion. Its non-amplification rules keep source, interpretation, transformation, review and scope evidence as distinct record objects so that later derivation does not silently broaden attributed claims or use scope. Evaluation was limited to implementation-level technical validity. Expected diagnostic-code sets matched validator outputs in 97/97 regression cases and 288/288 generated challenge cases. Within the specified 26-family coverage, a same-team procedural checker also matched all 288 expected sets; signatures remained unchanged in 864/864 non-reference inference comparisons and 864/864 serialisation round trips. These fractions describe authored cases and do not establish rule completeness, domain adequacy, usability, cultural and community validity or real-world effectiveness. PCCTM is therefore presented as a bounded, testable record architecture for documenting Guizhou Miao batik-inspired design. Adaptation to other craft domains requires new requirements and independent participant-led evaluation.

Keywords: design documentation, digital heritage, Guizhou Miao batik, provenance, SHACL

INTRODUCTION

Guizhou Miao wax-resist dyeing (hereafter, batik) is increasingly represented through digital collections, image classification, knowledge graphs and computational design. China's national representative list identifies a "Miao batik technique" project submitted by Danzhai County, Guizhou Province, and describes linked making stages and situated uses (China Intangible Cultural Heritage Network and Digital Museum, n.d.). Field research in Danzhai further situates production within social relations, market negotiation, cultural meanings and maker agency (Chen et al., 2021). These bounded accounts resist treating either Guizhou or Miao wax-resist practice as a uniform visual dictionary.

Terminology is bounded to the source base. "Guizhou Miao batik" is retained as an established English retrieval label, while "wax-resist textile practice" is used when material making is at issue. "Miao" follows the terminology of cited records without collapsing distinct communities, self-identifications or localities. Danzhai provides one documented county context rather than standing for all Guizhou practices. In this article, "Guizhou Miao batik-inspired design" denotes only a design record that declares reference to identifiable material described in those terms.

Recent work has made batik resources more computationally tractable. Quan et al. (2024) and Wu et al. (2025) focus on classification, semantic relations and graph updating. Lyu et al. (2025) examine the formal organisation of selected border patterns, while Kang et al. (2025) combine generative modelling with preference ranking for contemporary product design. These approaches support retrieval, formal analysis and redesign at their stated levels. PCCTM addresses a downstream documentation question: whether reused relations retain attribution, contestability, material-process information and use-specific scope evidence.

That distinction creates a downstream documentation problem. A record may identify a Danzhai source yet omit its precise locator and local context; attach an unattributed "meaning" to a pattern category; reproduce a contour while removing wax-resist material behaviour; or label a design "reviewed" without recording what was reviewed and for which intended use. Once source, interpretation, transformation, review and scope are collapsed into "inspired by", traceability can be mistaken for continuity, similarity for attributed meaning, or technical review for recorded scope evidence. The design question is how to retain these boundaries so that attributed certainty and scope remain queryable rather than being expanded by default.

The Provenance- and Context-Constrained Translation Model (PCCTM) addresses this documentation problem as a design-science artefact. "Translation" denotes a recorded design transformation. The model is informed by the W3C Provenance Ontology (PROV-O), represented in RDF and the Web Ontology Language (OWL), and constrained through SHACL Core and SHACL-SPARQL. Its organising principle is non-amplification: derivation may create a new artefact and new attributed claims, but it must not silently inherit meaning, erase recorded conflict or restriction, or broaden an evidenced use scope.

Three questions guide the study. RQ1 asks how PCCTM represents source evidence, attributed interpretation, design transformation, review and intended-use scope as separate record objects in Guizhou Miao batik-inspired design documentation. RQ2 asks how non-amplification is operationalised through executable constraints. RQ3 asks what implementation-level technical evidence is obtained from regression and generated challenge suites, a same-team procedural cross-check, rule-group removal, and inference and serialisation changes.

The contribution is threefold: (1) a problem framing situated in Guizhou Miao batik-inspired design records; (2) a motif-independent application-profile architecture linking seven responsibility classes, a six-field transformation record, versioned persistence and field-wise scope-evidence alignment; and (3) implementation-level evidence from explicitly described authored test suites. Transfer to another craft domain would require new requirements, terminology and independent participant-led evaluation.

LITERATURE REVIEW

Guizhou Miao batik as a localised material-design domain

The official Danzhai project record connects Miao batik to linked making stages and situated uses rather than to a context-free catalogue of forms (China Intangible Cultural Heritage Network and Digital Museum, n.d.). Danzhai fieldwork likewise presents production as a negotiated practice rather than a purely visual object (Chen et al., 2021). Peer-reviewed digital studies show why visual-semantic access matters. Quan et al. (2024) connect classified Guizhou Miao batik patterns to retrieved meanings, taboos and cultural connotations, while Wu et al. (2025) model pattern type, theme and "intentional reverence" alongside clustering and graph updating.

These systems make sources, categories and semantic relations more findable. PCCTM addresses the downstream risk that a reusable relation may lose its claimant, evidence boundary, contestability, locality or proposed-use context.

Computational redesign sharpens this distinction. Formal analysis can expose repetition and symmetry in selected borders (Lyu et al., 2025), while generative workflows can combine pattern corpora, shape operations and aesthetic ranking (Kang et al., 2025). A modelled or preferred output does not thereby retain the material process, social setting or attributed account of its reference. This is where a knowledge-representation question becomes a design-record integrity question.

From visual transformation to material and contextual discontinuity

Shape grammar makes operations such as rotation, scaling, repetition and substitution inspectable (Stiny, 1980). Material Driven Design adds that material experience includes sensorial, interpretive, affective and performative dimensions that geometry alone cannot carry (Karana et al., 2015). Traditional-craft protocols connect artefacts to actions, tools, materials and narratives and were developed through practitioner-facing work rather than appearance alone (Partarakis et al., 2022; Zabulis et al., 2022). Applied to a Guizhou Miao batik-inspired record, these approaches require the designer to distinguish a reproduced visual relation from wax-resist process, hand variation, cloth behaviour and use context.

PCCTM therefore records $\Delta(T)$ = (form, colour, material, scale, composition, use context), with each field taking unchanged, changed, removed or unknown. These fields are motif-independent because they describe transformation-record responsibilities rather than motif categories. Unknown marks an explicit evidence boundary.

Provenance, polyvocality and evidence layers

PROV-O supplies Entity–Activity–Agent provenance and relations for use, generation, derivation, association and attribution (Lebo et al., 2013). CIDOC CRM provides an event-centred reference model for integrating heterogeneous cultural-heritage information (Bekiari et al., 2024). Both are deliberately general. A downstream profile must still specify which source context, claim attribution, transformation and decision records are mandatory.

Cultural-heritage projects also separate development evidence from later adoption. Application-profile work links motivating scenarios, competency questions, example data and test cases during iterative development, while treating use in other settings as a later question (Barzaghi et al., 2025). ArCo connects competency questions, ontology patterns and unit tests in an open knowledge graph (Carriero et al., 2021). Beyond 2022 grounds priorities in historians' questions and archival reconstruction (Debruyne et al., 2022). Shoilee et al. (2023) elicit requirements from provenance specialists, model polyvocal reports and test unseen reports with expert-derived questions. User-centred studies add a different evidence tier: Pattuelli (2011) involved intended users in staged ontology development and evaluation, Matusiak (2022) combined questionnaires and interviews with community members, and Diulio et al. (2023) found that usability remained under-evaluated across cultural-heritage data interfaces. Logical execution, domain adequacy, usability and cultural and community validity are therefore non-interchangeable claims. For PCCTM, an attributed interpretation is a proposition with an evidence locator, speaker and bounded context, not a motif's unqualified "true meaning".

Executable constraints and scope-evidence records

SHACL expresses cardinality, datatype, class, value-set and SPARQL constraints over RDF graphs and returns structured validation reports (Knublauch & Kontokostas, 2017). Faraj and Micsik (2021) combine SHACL, OWL reasoning and SPARQL checks for a real cultural-heritage mapping; Andrews (2026) uses deliberately erroneous artificial graphs to test SHACL constraints. Constructed faults can therefore support implementation claims, but conformance remains relative to authored shapes. Competency questions improve requirement-to-test traceability (Grüninger & Fox, 1995; Uschold & Grüninger, 1996); they do not establish that a vocabulary is complete, accepted or culturally legitimate.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

CARE distinguishes collective benefit, authority, responsibility and ethics (Carroll et al., 2020). Local Contexts separates provenance, protocol and permission and reserves Label adoption to community decision-making (Local Contexts, n.d.). The United Nations Educational, Scientific and Cultural Organization (2003, 2015) emphasises participation, dialogue and customary access, while the World Intellectual Property Organization (n.d.) notes that protection of traditional cultural expressions varies by legal setting. These frameworks inform a conservative separation between access, technical review and scope evidence. A ScopeEvidenceRecord stores an attributed finding, evidence locator, time, lifecycle status and typed scope fields for one artefact; its provider role records who supplied the entry without independently authenticating identity or authority.

Bounded integration gap and design requirements

Comparison across the purposively selected domain, craft-documentation, provenance and constraint-validation works reveals an integration opportunity. Versioned design provenance, attributed and conflicting interpretations, explicit material and contextual change, restriction persistence, role-separated review and field-wise scope evidence are distributed across different systems or evidence tiers. PCCTM integrates these functions in one testable application profile. Table 1 presents the authors' constructive synthesis of five documentation risks, their requirement bases, a PCCTM response and an explicit claim boundary.

Table 1: Domain risks, design requirements and claim boundaries

Guizhou Miao batik-inspired record risk	Constructive requirement basis	PCCTM response	Explicit non-claim
A source link loses locality, object and process context	Official Danzhai record; Chen et al. (2021); PROV-O	SourceRecord with locator, bounded context and conservative source-use notice	Traceability does not establish origin, ownership or permission
Visual reuse hides material or contextual discontinuity	Lyu et al. (2025); shape grammar; Material Driven Design; craft protocols	Operation, loss note and categorical six-field transformation tuple	Description does not measure cultural distance or continuity
A pattern label becomes an unattributed meaning	Quan et al. (2024); Shoilee et al. (2023); competency-question literature	Attributed and scoped InterpretationClaim; explicit conflict; no inheritance	The validator neither discovers nor resolves motif meaning
Versioning erases conflict or restriction notice	PROV-O; polyvocal modelling	Reverse lineage, previousVersion and notice-persistence rules	Persistence does not judge which account is true
Review or similarity becomes scope evidence	CARE Principles; Local Contexts; UNESCO ethical principles; WIPO guidance	Role separation and field-wise ScopeEvidenceRecord gate	A matching record does not verify mandate, legality, permission or approval

Source: Authors' constructive synthesis of cited sources and standards

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

METHODOLOGY

Design-science strategy, problem domain and evidence boundary

The study separates three objects. The problem domain is documentation records for Guizhou Miao batik-inspired design. The constructed artefact is PCCTM, a design-technology and digital-heritage application profile with executable SHACL shapes. The evaluation units are artificial RDF graphs and validation reports. Design science is appropriate because the research constructs and tests a record mechanism. Development follows problem identification, objective definition, design and development, demonstration, evaluation and communication (Peffers et al., 2007). The evaluation uses the artificial evaluation paradigm in the Framework for Evaluation in Design Science Research (FEDS) and is limited here to implementation behaviour (Venable et al., 2016).

Four non-interchangeable validity layers bound the claims. Technical validity asks whether the implementation behaves as specified against declared artificial cases; this is the only layer assessed here. Domain validity asks whether the classes, fields and stop rules adequately represent real Guizhou Miao batik documentation practice; it was not independently assessed. Usability asks whether intended users can complete record tasks accurately and efficiently; it was not tested. Cultural and community validity asks whether terminology, distinctions and proposed uses are acceptable to relevant recognised practitioners and participants; it was not tested. Permission and legal sufficiency remain separate external determinations. Table 3 reports the evidence status and warranted interpretation for each layer.

Requirements were developed through purposive concept sampling and targeted updating completed on 20 August 2026. Searches of publisher platforms, DOI records, official standards and backward citations combined Miao batik, Guizhou, craft documentation, design transformation, knowledge graph, provenance, polyvocality, SHACL and design-science evaluation. A source was retained only when it supported a domain risk, a record distinction, an executable constraint, an evaluation choice or a claim boundary. Table 1 traces each retained risk to a record distinction and a PCCTM response; later methodology subsections report the operational rule groups and diagnostic-code coverage. The literature was used for requirements elicitation and comparative positioning rather than treated as an empirical sample. Source counts were not used for population inference, and prior authors' images and findings were not re-analysed as study data.

Five problem frictions shape the artefact: locality cannot be inferred from a broad ethnic or provincial label; a vector contour cannot stand for wax-resist material process; motif interpretation requires attribution and contestability; iterative redesign requires persistent version and restriction records; and a review cannot answer a use-specific scope-evidence query. The resulting primitives are intentionally motif-independent so that documentation does not depend on a universal motif taxonomy. That architectural choice enables technical reuse but is not evidence of cultural universality or domain acceptance.

The evaluation criteria are representational integrity, complete diagnostic-set agreement, machine source-set reconstruction and computational invariance. All identifiers, claim texts, scope values and geometries in the tests are authored and artificial. No batik image, motif-meaning annotation, interview, observation, community decision, private record or real-world permission is an evaluation unit.

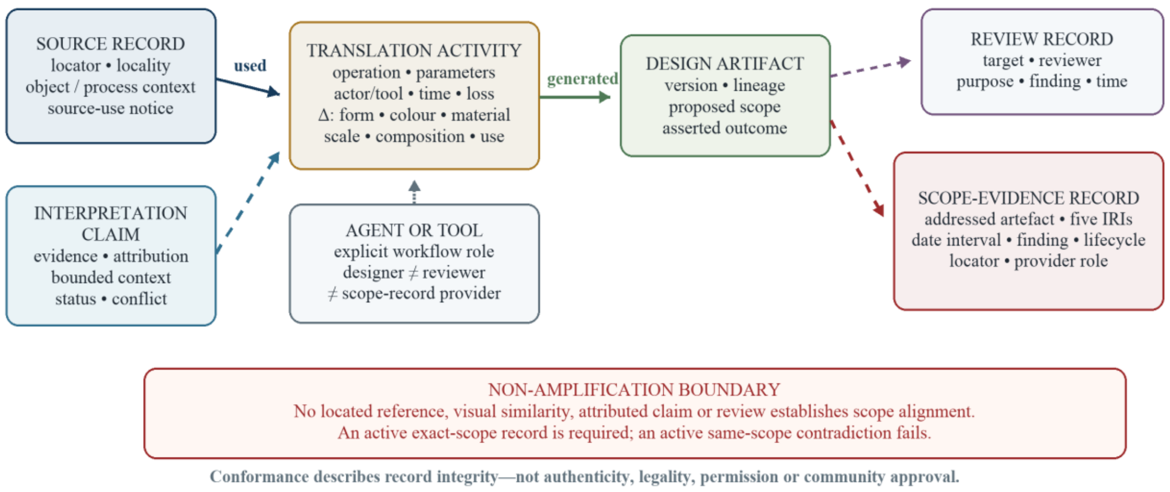
Requirement synthesis and PCCTM specification

PCCTM has four components: a record graph, controlled vocabularies, integrity rules and a validation function. Formally, PCCTM is $\langle G, \Sigma, C, \Phi\rangle$. The directed multigraph $G = (N, E, \tau, \alpha)$ contains nodes and relation instances; τ assigns explicit classes, and α assigns literal- or Internationalized Resource Identifier (IRI)-valued attributes. Σ contains controlled states and field vocabularies, C is the integrity-rule set, and Φ returns conformance with stable diagnostic codes.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

Seven node classes separate SourceRecord, InterpretationClaim, TranslationActivity, DesignArtifact, AgentOrTool, ScopeEvidenceRecord and ReviewRecord. These classes specialise PROV-O Entity, Activity and Agent, while the profile reuses PROV-O properties for use, generation, association and attribution. Local predicates include assertedAbout, conflictsWith, addressesArtifact and previousVersion. Figure 1 separates a declared Guizhou Miao batik reference from later claims, transformations, reviews and scope-evidence records; Table 2 summarises each class's function and boundary.

Figure 1: Boundary-aware documentation architecture for a declared Guizhou Miao batik reference



Source: Authors' model

Table 2: PCCTM record specification and executable boundaries

Record type	Recorded content	Principal executable check	Boundary
SourceRecord	Locator; bounded locality, object and process context; source-use notice	Requires recorded source context and preserves restriction notices through descendant lineage	Not proof of origin, ownership or permission
InterpretationClaim	Target; claim text; evidence locator; attributed agent; bounded context; epistemic state	No automatic inheritance; a contested claim requires a non-reflexive conflict relation	Not a universal motif meaning
TranslationActivity	Inputs/output; agent or tool; operation, parameters and time; loss note; six transformation fields	Reciprocal generation and a controlled value for every transformation field	Not cultural distance or continuity
DesignArtifact	Generator; version or predecessor; five scope IRIs; date interval; outcome	Acyclic lineage, ordered dates and synchronisation between outcome and exact-scope evidence	Not authenticity or permission
AgentOrTool	Identifier and workflow role	Separates designer or tool, reviewer and scope-record-provider	Does not authenticate identity, standing or mandate
ScopeEvidenceRecord	Target; provider; locator; timestamp, lifecycle and finding; matching scope fields and dates	Only an active exact-scope record can support alignment or restriction; conflicting active findings fail	Not legal advice, permission or verified authority

Record type	Recorded content	Principal executable check	Boundary
ReviewRecord	Target; reviewer; purpose; finding; timestamp	Requires reviewer role and cannot substitute for ScopeEvidenceRecord	Technical or interpretive review only

Source: Authors' model specification

Table 2 consolidates the recorded content and principal checks needed to interpret PCCTM. "Scope evidence" remains a neutral term: an entry may record alignment or restriction, but neither the entry nor structural conformance creates, verifies or confers authority.

Executable non-amplification invariants

Three rule paths implement non-amplification. Epistemic non-amplification blocks automatic inheritance of InterpretationClaim through derivation. Each claim requires text, evidence locator, attribution, bounded context and one documentary state—documented, inferred, contested or unknown. Contested claims require a non-reflexive conflictsWith relation that remains visible downstream.

Transformational non-amplification requires each TranslationActivity to record information loss and the six-field tuple $\Delta(T)$ = (form, colour, material, scale, composition, use context). Each field uses one controlled state: unchanged, changed, removed or unknown. Unknown marks an evidence boundary rather than continuity.

Scope non-amplification compares typed fields rather than a concatenated text signature. For each DesignArtifact or ScopeEvidenceRecord x, q(x) = ⟨object, use, medium, audience, territory, [validFrom, validUntil]⟩. The first five values are IRIs and the dates are xsd:date literals. An alignment state is admissible only when an active ScopeEvidenceRecord addresses the same artefact, matches every field and date, records an alignment finding, and includes a locator, timestamp and provider role. An unresolved state is admissible only when no complete active exact-scope alignment or restriction record exists. Superseded or withdrawn records cannot resolve the state, and contradictory active findings are non-conforming.

Property-driven target shapes select candidate nodes from characteristic relations and then require the correct explicit class, so deleting or replacing rdf:type cannot remove a candidate from validation. This anti-evasion pattern covers all seven classes. Sixty stable report-level diagnostic codes implement the rule families; multiple low-level constraints may share one report-level code. The controlled pc:scopeOutcome vocabulary contains scope_evidence_unresolved, scope_evidence_alignment_recorded and scope_restriction_evidence_recorded; ScopeEvidenceRecord.scopeFinding accepts the latter two. Φ returns a SHACL conformance boolean and violation report.

Two-stage artificial evaluation

Published application-profile and cultural-heritage knowledge-graph projects link motivating scenarios or competency questions to examples and tests (Barzaghi et al., 2025; Carriero et al., 2021). Following that traceability principle, the construction and decision rule for both artificial phases are stated here.

Phase I was a fixed regression design. Before execution, the team froze the evaluated PCCTM profile, SHACL definitions, evaluator, eight structurally conforming graphs, 89 targeted fault graphs and the expected diagnostic-code set for each graph. The faults covered missing or incorrect class types; absent, literal or mismatched scope fields; reversed date intervals; lifecycle and scope-state conflicts; and claim, lineage, restriction-notice, role and version rules. The 97 cases exercised all 60 declared report-level codes. The oracle was the complete predeclared set of expected report-level codes for a case; any missing or additional code failed that case. This phase tested requirement-to-rule traceability, not independent confirmation.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

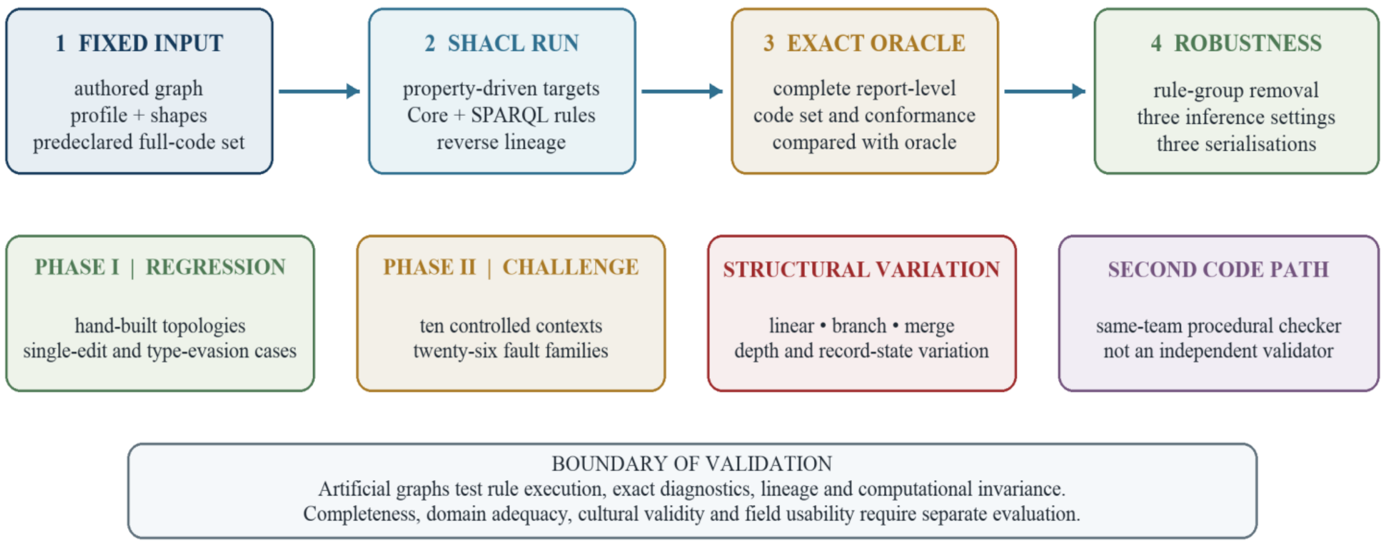
Phase II used the same fixed profile and SHACL definitions. A deterministic generator created 80 structurally conforming cases across ten controlled context variants and 208 mutants—eight instances in each of 26 fault families, giving 80 + (26 × 8) = 288 cases. The families covered conflict, cycle, scope-field, date, lifecycle, restriction, scope-state synchrony and all seven class-type erasure and mistyping paths. Identifier-insensitive signatures summarised class and predicate counts, literal datatypes, controlled values, activity arities and version edges by family. The conforming context varied, but each fault remained inserted at a fixed probe role. This was a generated challenge suite, not a sampled or externally held-out corpus. None of the 288 cases represented an actual Miao batik object, claim or use finding.

Cross-checks, robustness and analysis criteria

A procedural checker separately implements every code exercised by the Phase-II families without reading SHACL reports or mutation-family labels. The same team fixed the requirements, graphs, mutations, expected sets and both code paths. The checker shares graph construction and remains partial relative to the 60-code profile. Agreement is therefore a same-team two-code-path consistency check, not independent replication or a second SHACL engine. For localisation, the 60 report-level codes were partitioned into four disjoint operational groups: epistemic/claim typing (9 codes), lineage/version/core typing (10), scope-evidence/record typing (18), and source/translation/review/agent controls (23). Deleting one group's constraints had to leave exactly the predeclared remainder for each affected case, yielding 24, 56, 112 and 48 affected case–group checks respectively (240 total). This audits diagnostic wiring rather than effect size, superiority or field performance; the groups are an operational partition, not a conceptual taxonomy.

Robustness was tested under no inference, RDF Schema (RDFS), OWL 2 RL and combined RDFS/OWL 2 RL settings. Each Phase-II graph was also written and parsed by RDFLib through Turtle, N-Triples and JSON-LD, checked for digest-preserving graph equivalence and revalidated. Phase I source reconstruction covered 96 explicitly typed DesignArtifact nodes; the remaining fixture was the predeclared DesignArtifact type-erasure case and therefore did not meet this check's explicit-type inclusion criterion. The 97 graphs yielded 97 × 3 = 291 serialisation round trips and 97 × 5 = 485 repeat-validation comparisons. Phase-II robustness comprised 288 × 3 non-reference inference comparisons, 288 × 3 serialisation round trips, one direct repeat per graph and 240 affected case–group checks across the four rule-group removals (24 + 56 + 112 + 48). Both phases validated explicitly asserted graphs against the same profile and SHACL definitions; their suite construction and robustness procedures differed, so results are reported by phase. The implementation used Python 3.12.13, pySHACL 0.30.1, RDFLib 7.6.0 and owlrl 7.6.2. Figure 2 summarises the evidence paths.

Figure 2: Authored-case evaluation paths and robustness checks



Source: Authors' evaluation design; denominators and outcomes are reported in Table 3

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

Each fault fixture is assessed against two predeclared conditions: every required code must be present, and the deduplicated returned report-level code set must equal the complete allowed set. Any missing or additional code fails the case. A conforming graph is falsely rejected if any violation is returned. The procedural check compares complete sets within its stated coverage. Inference and serialisation checks require equality of conformance and sorted code signature against the no-inference source graph; serialisation also requires an unchanged graph digest. Fractions retain explicit denominators because the cases are constructed rather than sampled.

RESULTS AND DISCUSSION

RQ1: a boundary-aware record architecture

PCCTM instantiates the provisionally derived requirements by separating seven responsibilities. In a Guizhou Miao batik-inspired workflow, SourceRecord identifies the material actually consulted and its bounded context; InterpretationClaim attributes a proposition without promoting it to consensus; TranslationActivity exposes formal, material and contextual change; and DesignArtifact preserves version and intended scope. AgentOrTool makes recorded roles explicit. ReviewRecord and ScopeEvidenceRecord retain technical or interpretive review and attributed scope evidence as different responsibilities. Alternative factorisations remain possible, but a single source-to-output relation does not encode these distinctions, their lifecycle states or

their evidence boundaries.

This architecture changes the question asked of a design record. Instead of asking whether an output “is Miao batik”, it asks whether the declared reference can be located, whose interpretation is present, what transformation and information loss occurred, what review was performed, and whether a located, attributed record exactly addresses the proposed use. These are auditable documentation questions. They neither classify the design’s cultural identity nor identify the person or body entitled to decide.

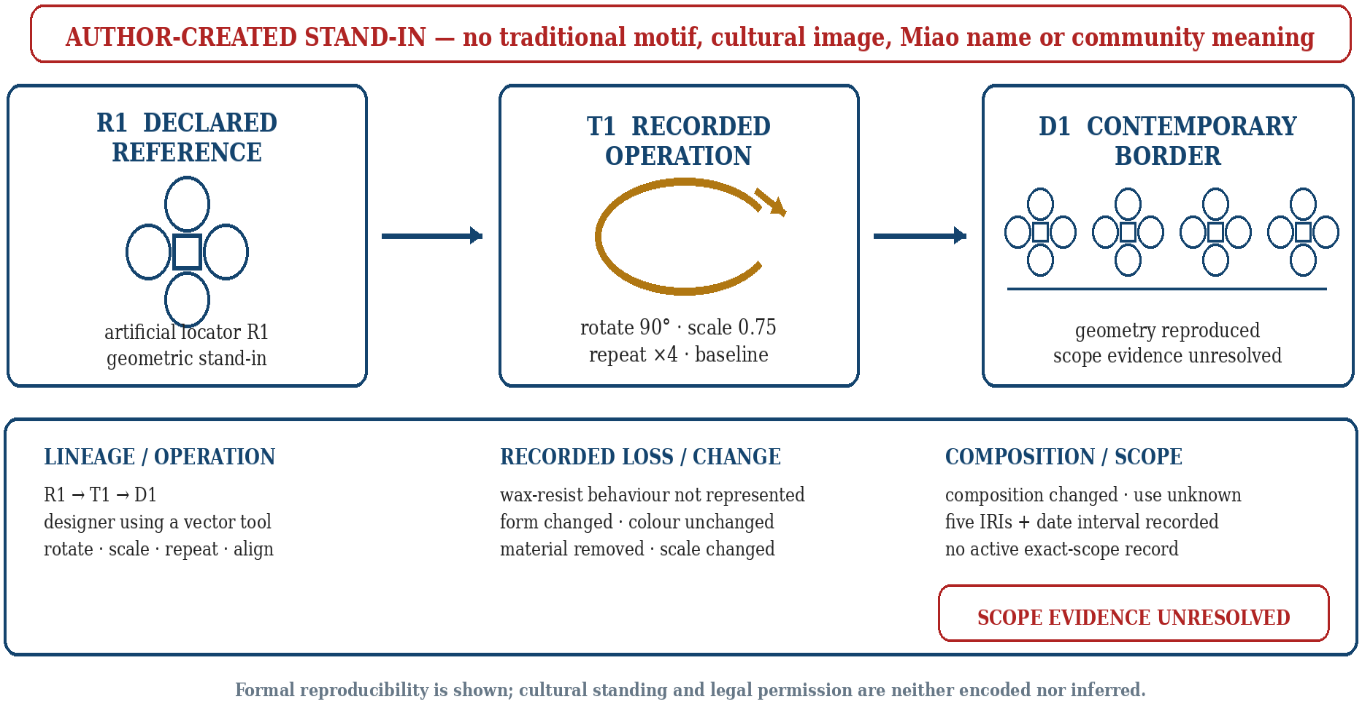
RQ2: three executable non-amplification paths

Epistemic non-amplification is operationalised by not copying InterpretationClaim through derivation and by retaining attribution and conflict links. Transformational non-amplification records the six transformation states separately, so a visual-form value does not supply a material or contextual value. Scope non-amplification accepts an asserted scope_evidence_alignment_recorded state only when an active ScopeEvidenceRecord supplied by a scope_record_provider addresses the artefact and matches all five categorical fields and the validity interval. A matching active restriction record instead supports an asserted scope_restriction_evidence_recorded state. A changed object, use, medium, audience, territory or date defines a different record query. The validator checks declared record consistency; it does not infer cultural, legal or permission outcomes.

Figure 3 illustrates the three paths through an author-created geometric stand-in that is not derived from a traditional motif. Rotation, scaling and repetition produce a reproducible border. The record marks form, scale and composition as changed, material as removed and use context as unknown. Because no active ScopeEvidenceRecord supplies field-wise alignment, the result remains scope_evidence_unresolved. The scenario assigns no Miao name or meaning and supplies no real-world scope finding.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

Figure 3: Constructed documentation example using an author-created geometric stand-in not derived from a traditional motif



Source: Authors' constructed demonstration

RQ3: implementation-level technical evidence

Table 3 reports the core pass/fail denominators and aggregate outcomes. Phase-I outputs matched the predeclared diagnostic set in 97/97 authored cases, and Phase-II outputs matched in 288/288 authored cases; neither suite returned a missing or additional report-level code. The 96/96 source-reconstruction denominator excludes the predeclared DesignArtifact type-erasure fixture because it lacked the explicit type required by that check. The same-team procedural path agreed with both the oracle and the SHACL set for all 288 Phase-II cases, but it was not independent. Inference, serialisation, repetition and rule-group-removal comparisons also matched their stated references. The 80 conforming cases produced nine identifier-insensitive signatures. Each eight-case fault family produced seven signatures, showing that at least two context variants collapsed under the selected signature abstraction. These counts describe controlled variation within authored cases, not external diversity.

Table 3: Evaluation design, aggregate outcomes and validity boundaries

Evidence layer or check	In-text design and denominator	Observed result	Warranted interpretation
Technical—Phase I	97 artificial graphs: 8 conforming + 89 faults; 60 report-level diagnostic codes; 96 explicitly typed DesignArtifact nodes	Expected sets 97/97; source sets 96/96; serialisations 97 × 3 = 291/291; repeats 97 × 5 = 485/485	Bounded evidence for specified paths; not completeness or field effectiveness
Technical—Phase II	288 artificial graphs: 80 conforming + 208 mutants across 26 eight-case families	Expected sets 288/288; same-team procedural-oracle and procedural-SHACL agreement 288/288 each; 9 distinct signatures across 80 conforming cases and 7 within each eight-case fault family	Internal consistency and controlled variation, not accuracy, independent replication or completeness

Evidence layer or check	In-text design and denominator	Observed result	Warranted interpretation
Technical—robustness and localisation	288 × 3 inference; 288 × 3 serialisation; one repeat per graph; removals: epistemic/claim 24, lineage/version/core 56, scope-evidence/record 112, source/translation/review/agent 48	Inference 864/864; serialisation 864/864; repeats 288/288; localisation 240/240	Computational invariance and diagnostic wiring only within authored cases
Domain validity	No independent domain-participant review	Not evaluated	No adequacy claim for actual Guizhou Miao batik documentation practice
Usability	No independent user or real documentation task	Not evaluated	No usefulness, comprehensibility or efficiency claim
Cultural and community validity	No recognised practitioner or community deliberation	Not evaluated or claimed	No cultural legitimacy, acceptance, authority or permission claim

Source: Authors' artificial evaluation and validity framework

These fractions show behaviour along specified implementation paths. Because the suites, oracles and both code paths were author-constructed, the results do not estimate rule completeness, domain adequacy, usability, cultural and community validity or real-world effectiveness.

Implications for Guizhou Miao batik-inspired design documentation

First, PCCTM treats resource retrieval and downstream documentation as different operations. Quan et al. (2024) organise and retrieve Guizhou Miao batik resources, while Wu et al. (2025) construct an image-driven knowledge graph for batik products; Kang et al. (2025) recombine Guizhou Miao formal features. PCCTM examines whether the downstream record distinguishes located source, attributed claim, transformation, review and scope evidence. It is not a competing classifier or generator.

Second, formal similarity and material or contextual status occupy separate fields. Danzhai field research describes production through social relations, market negotiation, cultural meanings and maker agency rather than geometry alone (Chen et al., 2021). In PCCTM, removal of material process, changes in scale or composition and unknown use context remain inspectable record states. Unknown denotes absence of a recorded basis; it is not converted to unchanged.

Third, ReviewRecord and ScopeEvidenceRecord produce different record states. A conforming graph may still contain a disputed interpretation, an unverified actor or unresolved scope, and an aligned evidence record does not establish permission. The domain contribution is a situated problem framing and set of documentation questions for Guizhou Miao batik-inspired design; the technical contribution is a motif-independent executable architecture. Architectural adaptation elsewhere remains a design proposition requiring new requirements and validation, not evidence of cultural universality.

Comparative position, limitations and next validation

Table 4 distinguishes PCCTM from nearby domain and technical work. Batik knowledge graphs and generative studies use cultural images and task-specific computational or human evaluation (Quan et al., 2024; Wu et al., 2025; Kang et al., 2025). Practitioner-facing craft protocols provide evidence about documentation practice across three craft cases (Partarakis et al., 2022; Zabulis et al., 2022), and polyvocal provenance modelling demonstrates expert-derived requirements and unseen records (Shoilee et al., 2023). SHACL studies with real mappings or seeded errors illustrate different implementation-evidence tiers (Faraj & Micsik, 2021; Andrews, 2026). PCCTM adds an integrated non-amplification mechanism but has neither cultural images nor participant evaluation as evidence.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

Table 4: Evidence position relative to domain and technical comparators

Study	Domain material / requirements	Evaluation evidence	Contribution and boundary
Quan et al.	Literature-derived text plus an author-collected Qiandongnan batik-image dataset	Knowledge-graph and image-classification tests	Organises and classifies the study corpus; universal category validity and downstream-record auditing were outside the reported evaluation
Wu et al.	Batik-product images and an image-driven ontology	Clustering, detection and graph-update tests	Adds visual entities and relations; independent validation of cultural interpretation and actor authority was outside the reported evaluation
Kang et al.	Guizhou Miao batik pattern resources	Diffusion/LoRA generation, Fuzzy TOPSIS preference evaluation (44 respondents), and reported cultural/artisan review	Evaluates generation and aesthetic/preference selection with human input; claim-provenance and field-wise use-scope auditing were outside the reported evaluation
Craft protocols	Actions, tools, materials and narratives across three practitioner-involved craft cases	Protocol/platform development and application with practitioners	Grounds material-process documentation; evaluation of PCCTM was outside the reported studies
Shoilee et al.	Provenance specialists and polyvocal reports	Expert questions, seen and unseen records	Grounds attributed disagreement; a design-use scope gate was outside the reported model and evaluation
Barzaghi et al.; Faraj & Micsik; Andrews	Cultural-heritage application profile / real mapping / seeded artificial errors	SAMOD test cases / OWL-SPARQL-SHACL / SHACL fault checking	Complementary technical-development tiers; not participant validation of PCCTM
PCCTM	Provisional literature- and standards-derived requirements; artificial records	Two suites, partial cross-check, localisation and invariance	Engineers an executable integration; domain adequacy, use and acceptance remain untested

Source: Authors' comparative analysis of cited studies

Three limitations define the evidence boundary. First, rule coverage remains uncertain because the same team specified requirements, generated cases and implemented both code paths. Second, no independent participant assessed whether the classes, terminology and record distinctions fit actual Guizhou Miao batik documentation practice. Third, no user completed a real documentation task. Exact field equality detects IRI and datatype mismatch rather than semantic equivalence; provider roles and evidence locators improve traceability without authenticating actors or evidence.

Operationally, an integrity violation yields non-conformance. An asserted scope_evidence_unresolved state is accepted only when no complete active exact-scope record supplies either finding; an active exact-scope restriction conflicts with simultaneous alignment. Superseded or withdrawn records do not support a resolved state. PCCTM does not infer outcomes or adjudicate legal priority, actor mandate or the truth of a supplied finding. A changed scope field or validity interval is evaluated as a different query, and ReviewRecord does not substitute for ScopeEvidenceRecord.

A next-stage evaluation should compare a conventional source table, a PROV-O-only record and PCCTM in a preregistered, counterbalanced study. Tasks should be co-developed with independent domain participants using lawfully usable, non-sensitive documentation records and should cover lineage reconstruction, omitted attribution or context, conflicting claims, scope matching and record repair. Participants should include digital-heritage or ontology specialists, designers, researchers, curators or heritage workers and, where ethically and locally agreed, recognised Guizhou Miao batik practitioners or community representatives. No model constructor should serve as a primary evaluator.

Outcomes should include task completion, lineage recovery, omission detection with false alarms, disagreement visibility, time to a correct or stopped response and repair burden. Independent condition-blinded scoring should be used where feasible. Cultural and community validity should be assessed separately through consented deliberation, with ethics review, informed consent, compensation, language support and agreed governance for sensitive knowledge completed before recruitment. This protocol is future work and provides no present evidence that PCCTM outperforms either baseline.

CONCLUSION

PCCTM instantiates provisionally derived record distinctions for source evidence, attributed interpretation, transformation, review and intended-use scope. The profile uses seven responsibility classes, a six-field transformation record, typed scope fields, versioned persistence and lifecycle-aware scope-evidence alignment.

Across the authored artificial suites, expected diagnostic sets matched in 97/97 regression cases and 288/288 generated challenge cases, and the declared same-team cross-checks also matched. These results are bounded implementation-level technical evidence.

PCCTM is therefore a diagnostic record architecture for the situated documentation problem examined here. Adaptation to another craft domain requires new requirements and independent participant-led evaluation.

ACKNOWLEDGEMENTS/FUNDING

No specific funding was received for this research.

Conflict Of Interest Statement

The authors declare no conflict of interest.

Authors' Contributions

YiXin Sun: Conceptualisation, methodology, formal analysis, investigation, software, visualisation and writing—original draft; Yibiao Long: Conceptualisation, methodology, supervision, validation and writing—review and editing; Xiong Xiao: Investigation, data curation, formal analysis, validation and writing—review and editing; Yiqing Qin: Resources, data curation, visualisation, validation and writing—review and editing. All authors reviewed and approved the final manuscript.

Data Availability

No human-participant, community, private or culturally sensitive data were collected. The evaluation used author-constructed RDF graphs. The SHACL shapes, artificial graphs, expected diagnostic-code sets, procedural checker and test-generation scripts supporting the reported results can be made available by the corresponding author on reasonable request.

ETHICS STATEMENT

This study involved no human participants, animals, private records or community data. All evaluation graphs and visual geometries were created for testing. Any future cultural and community evaluation would require ethics review, informed consent and governance agreed with appropriately recognised practitioners or representatives.

REFERENCES

1. Andrews, T. L. (2026). Graph schema validation at last? Work towards a StemmaREST ontology with Neo4J, RDF-STAR, and SHACL. Digital Scholarship in the Humanities, 41(Supplement 1), i3–i12. https://doi.org/10.1093/llc/fqaf067

2. Barzaghi, S., Heibi, I., Moretti, A., & Peroni, S. (2025). Developing application profiles for enhancing data and workflows in cultural heritage digitisation processes. In G. Demartini, K. Hose, M. Acosta, M. Palmonari, G. Cheng, H. Skaf-Molli, N. Ferranti, D. Hernández, & A. Hogan (Eds.), The Semantic Web—ISWC 2024 (Lecture Notes in Computer Science, Vol. 15233, pp. 197–217). Springer. https://doi.org/10.1007/978-3-031-77847-6_11
3. Bekiari, C., Bruseker, G., Canning, E., Doerr, M., Michon, P., Ore, C.-E., Stead, S., & Velios, A. (Eds.). (2024). Definition of the CIDOC Conceptual Reference Model (Version 7.1.3). CIDOC CRM Special Interest Group. https://www.cidoc-crm.org/Version/version-7.1.3
4. Carriero, V. A., Gangemi, A., Mancinelli, M. L., Nuzzolese, A. G., Presutti, V., & Veninata, C. (2021). Pattern-based design applied to cultural heritage knowledge graphs: ArCo: The knowledge graph of Italian Cultural Heritage. Semantic Web, 12(2), 313–357. https://doi.org/10.3233/SW-200422
5. Carroll, S. R., Garba, I., Figueroa-Rodríguez, O. L., Holbrook, J., Lovett, R., Materechera, S., Parsons, M., Raseroka, K., Rodriguez-Lonebear, D., Rowe, R., Sara, R., Walker, J. D., Anderson, J., & Hudson, M. (2020). The CARE principles for Indigenous data governance. Data Science Journal, 19(1), Article 43. https://doi.org/10.5334/dsj-2020-043
6. Chen, Z., Ren, X., & Zhang, Z. (2021). Cultural heritage as rural economic development: Batik production amongst China's Miao population. Journal of Rural Studies, 81, 182–193. https://doi.org/10.1016/j.jrurstud.2020.10.024
7. China Intangible Cultural Heritage Network and Digital Museum. (n.d.). Miaozu laran jiyi [Miao batik technique; in Chinese]. Retrieved August 6, 2026, from https://www.ihchina.cn/project_details/14300/
8. Debruyne, C., Munnelly, G., Kilgallon, L., O'Sullivan, D., & Crooks, P. (2022). Creating a knowledge graph for Ireland's lost history: Knowledge engineering and curation in the Beyond 2022 project. Journal on Computing and Cultural Heritage, 15(2), Article 25. https://doi.org/10.1145/3474829
9. Diulio, M. de la P., Gardey, J. C., Gomez, A. F., & Garrido, A. (2023). Usability of data-oriented user interfaces for cultural heritage: A systematic mapping study. Journal of Information Science, 49(2), 359–372. https://doi.org/10.1177/01655515211001787
10. Faraj, G., & Micsik, A. (2021). Representing and validating cultural heritage knowledge graphs in CIDOC-CRM ontology. Future Internet, 13(11), Article 277. https://doi.org/10.3390/fi13110277
11. Grüninger, M., & Fox, M. S. (1995). Methodology for the design and evaluation of ontologies. In D. Skuce (Ed.), Proceedings of the IJCAI'95 Workshop on Basic Ontological Issues in Knowledge Sharing (pp. 6.1–6.10). AAAI Press.
12. Kang, X., You, W., & Xie, H. (2025). An innovative and sustainable design of intangible Miao wax printing patterns in combination of diffusion model and fuzzy TOPSIS. Humanities and Social Sciences Communications, 12(1), Article 1365. https://doi.org/10.1057/s41599-025-05724-9
13. Karana, E., Barati, B., Rognoli, V., & Zeeuw van der Laan, A. (2015). Material driven design (MDD): A method to design for material experiences. International Journal of Design, 9(2), 35–54. https://www.ijdesign.org/index.php/IJDesign/article/view/1965/693
14. Knublauch, H., & Kontokostas, D. (Eds.). (2017, July 20). Shapes Constraint Language (SHACL) (W3C Recommendation). World Wide Web Consortium. https://www.w3.org/TR/2017/REC-shacl-20170720/
15. Lebo, T., Sahoo, S., & McGuinness, D. (Eds.). (2013, April 30). PROV-O: The PROV ontology (W3C Recommendation). World Wide Web Consortium. https://www.w3.org/TR/2013/REC-prov-o-20130430/
16. Local Contexts. (n.d.). Working with labels. Retrieved August 21, 2026, from https://localcontexts.org/support/working-with-labels/
17. Lyu, Z. N., Yahaya, S. R., & Guo, X. H. (2025). A mathematical inquiry into the structure complexity of Miao batik patterns: A frieze group analysis. PaperASIA, 41(1b), 70–80. https://doi.org/10.59953/paperasia.v41i1b.159
18. Matusiak, K. K. (2022). Evaluating a digital community archive from the user perspective: The case of formative multifaceted evaluation. Library & Information Science Research, 44(3), Article 101159. https://doi.org/10.1016/j.lisr.2022.101159
19. Partarakis, N., Doulgeraki, V., Karuzaki, E., Galanakis, G., Zabulis, X., Meghini, C., Bartalesi, V., & Metilli, D. (2022). A web-based platform for traditional craft documentation. Multimodal Technologies and Interaction, 6(5), Article 37. https://doi.org/10.3390/mti6050037

20. Pattuelli, M. C. (2011). Modeling a domain ontology for cultural heritage resources: A user-centered approach. Journal of the American Society for Information Science and Technology, 62(2), 314–342. https://doi.org/10.1002/asi.21453
21. Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. Journal of Management Information Systems, 24(3), 45–77. https://doi.org/10.2753/MIS0742-1222240302
22. Quan, H., Li, Y., Liu, D., & Zhou, Y. (2024). Protection of Guizhou Miao batik culture based on knowledge graph and deep learning. Heritage Science, 12(1), Article 202. https://doi.org/10.1186/s40494-024-01317-y
23. Shoilee, S. B. A., de Boer, V., & van Ossenbruggen, J. (2023). Polyvocal knowledge modelling for ethnographic heritage object provenance. In M. Acosta, S. Peroni, S. Vahdati, A.-L. Gentile, T. Pellegrini, & J.-C. Kalo (Eds.), Knowledge graphs: Semantics, machine learning, and languages: Proceedings of the 19th International Conference on Semantic Systems, 20–22 September 2023, Leipzig, Germany (pp. 127–143). IOS Press. https://doi.org/10.3233/SSW230010
24. Stiny, G. (1980). Introduction to shape and shape grammars. Environment and Planning B: Planning and Design, 7(3), 343–351. https://doi.org/10.1068/b070343
25. United Nations Educational, Scientific and Cultural Organization. (2003). Convention for the safeguarding of the intangible cultural heritage. https://ich.unesco.org/en/convention
26. United Nations Educational, Scientific and Cultural Organization. (2015). Ethical principles for safeguarding intangible cultural heritage. https://ich.unesco.org/en/ethics-and-ich-00866
27. Uschold, M., & Grüninger, M. (1996). Ontologies: Principles, methods and applications. The Knowledge Engineering Review, 11(2), 93–136. https://doi.org/10.1017/S0269888900007797
28. Venable, J., Pries-Heje, J., & Baskerville, R. (2016). FEDS: A framework for evaluation in design science research. European Journal of Information Systems, 25(1), 77–89. https://doi.org/10.1057/ejis.2014.36
29. World Intellectual Property Organization. (n.d.). Traditional cultural expressions. Retrieved August 6, 2026, from https://www.wipo.int/en/web/traditional-knowledge/traditional-cultural-expressions/index
30. Wu, X., Yuan, Q., Qu, P., & Su, M. (2025). Image-driven batik product knowledge graph construction. npj Heritage Science, 13(1), Article 20. https://doi.org/10.1038/s40494-025-01586-1
31. Zabulis, X., Partarakis, N., Meghini, C., Dubois, A., Manitsaris, S., Hauser, H., Magnenat Thalmann, N., Ringas, C., Panesse, L., Cadi, N., Baka, E., Beisswenger, C., Makrygiannis, D., Glushkova, A., Padilla, B. E. O., Kaplanidi, D., Tasiopoulou, E., Cuenca, C., Carre, A.-L., . . . Metilli, D. (2022). A representation protocol for traditional crafts. Heritage, 5(2), 716–741. https://doi.org/10.3390/heritage5020040