

Participatory practices in AI design for cultural heritage: a scoping review on methods, inclusion, and epistemic justice

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Abstract

Purpose – This study aims to examine how users and communities are integrated into the design and evaluation of semantic or neurosymbolic (NeSy) information systems in digital libraries. Through a structured scoping review and content analysis of academic databases, it identifies and describes multidisciplinary participative practices in the development of these systems; maps methodological trends, gaps and practical recommendations for collaboration in epistemically just designs to support inclusion in digital libraries.

Design/methodology/approach – The study combines a search, appraisal, synthesis, analysis-based scoping review with bibliometric mapping and qualitative content analysis. It is useful for identifying multidisciplinary participative practices and for observing their methodologies in analytical variables: 1-Timing and process-driven patterns, 2-Methods, 3-Engagement and levels of user participation and 4-Ownership, inclusion, representational gaps and epistemic-justice considerations.

Findings – Analysis reveals that participative practices are integrated and documented in all 22 analyzable cases, with uneven reporting across phases: early user integration occurs in seven practices (32%), while users are positioned in the late evaluation phase or in narrowly scoped continuous contribution in other cases. Participatory methods cluster around co-design workshops, usability testing and crowd-science. The participation levels concentrate in consultative and collaborative stages, with some empowerment actions. Epistemic-justice considerations are under-documented. Bias-aware modeling and provenance tracking are found in specific cases. Evaluation practices tend to rely on usability and information-retrieval metrics, leaving participation impacts, trust-building and inclusion outcomes under-documented.

Research limitations/implications – The analysis is constrained by uneven documentation across practices, a temporal focus on the past decade and a corpus dominated by English-language and Global North sources, which limits generalizability. Geographic and linguistic coverage remain uneven: cases cluster in Europe and the Global North and several source papers do not report site geography explicitly. Hybrid initiatives often resist neat categorization, which underscores the need for more transparent reporting of participatory processes and evaluation methods. Future research should combine longitudinal and comparative designs, broaden geographic and linguistic coverage and refine tools for assessing participation, trust and epistemic justice in human-centered AI systems for digital libraries.



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Originality/value – By mapping who is involved, the timing, the methodology, the engagement and the ownership, the study offers a structured lens on the inclusiveness, trustworthiness and accountability of human-centered semantic and AI practices in digital libraries. To authors’ knowledge, no prior synthesis integrates participatory design, citizen science, semantic/NeSy and epistemic-justice literatures in a single cross case map of existing documentation of participative practices on digital library and cultural heritage information systems. The five-lens framework and four-dimension codebook serve as analytical tools; corpus findings and recommendations serve as a pragmatic guide for practitioners seeking bias-aware participation in digital library infrastructures.

Keywords User-centered design, Participatory design, Citizen science, Human–computer interaction, Epistemic justice, Gender-inclusive design, Digital libraries, Bibliometric analysis, SALSA, Content analysis, Semantic web technologies, Knowledge graphs, Citizen science

Paper type Literature review

Introduction

Digital libraries have shifted from technical repositories to socio-technical systems that mediate access, representation and meaning-making across cultural and knowledge domains (Wang *et al.*, 2024). In this approach, infrastructures shape how cultural heritage is discovered, narrated and contested (Fox and Chandrasekar, 2021; Patti *et al.*, 2015), raising questions of trust, accountability and epistemic justice for diverse communities (Shneiderman, 2021; Haraway, 1991; Wang *et al.*, 2024). Cultural heritage is a multidimensional resource (Ranjgar *et al.*, 2024) supporting cultural memory, diversity, local development and well-being. These infrastructures are increasingly designed with semantic and neurosymbolic (NeSy) artificial intelligence (AI) systems (Desul *et al.*, 2023; Ranjgar *et al.*, 2024), though often only partially and through participative practices. Semantic technologies include ontological models, semantic-based repositories, portals and search services, as well as knowledge graph systems, linked open data platforms and other specialized semantic tools for knowledge organization (Xu *et al.*, 2024). NeSy AI systems extend these foundations with AI and artificial neural network components. It “has been proved to be a successful tool for empirical research regarding humanities and social sciences” (Huang, 2022, p. 1868). This accomplishes that “explicit connections such as semantically enriched links are indeed rules” (Palma, 2023) and has been used for bias and hallucination mitigation and for semi-automatic narrative generation.

User participation has become an important trend in digital-library projects. To capture its diverse forms in the literature, this article uses the term *participative practices* for complex, context-dependent, multidisciplinary tasks (Tinker-Perrault *et al.*, 2015) focused on integrating library users into research and design processes; some authors describe this as a *participative turn*. The title retains *participatory* in line with common digital-library and design literature; *participative practices* denotes the unit of analysis in this scoping review. The established field term *participatory design* is used only when referring to that methodological tradition (Stappers and Sanders, 2008; Delgado *et al.*, 2023). In cultural-heritage collections (Lähdesmäki *et al.*, 2025), users appear as co-designers, co-annotators, co-evaluators or data subjects, with responsibilities spanning usability, provenance and bias mitigation. Epistemic-justice frameworks foreground how bias, representation, gender and intersectionality (Fricker, 2007) shape whose knowledge is recognized (Haraway, 1991), while human-centered AI scholarship highlights risk of inscrutable models and embedded bias when systems lack accountability (Capel and Brereton, 2023). Where safeguards are absent, claims of participation can mask persistent power asymmetries.

Prior work has examined participative practices in disciplinary pockets, including participatory design (Tinker-Perrault *et al.*, 2015), showing how methods, roles and power are configured in specific projects. Human-computer interaction (HCI) and human-computer artificial intelligence

(HCAI) research stresses coupling UX researchers, user-centered design (UCD) specialists, domain experts and developers in knowledge-graph workflows (Fox and Chandrasekar, 2021). Participatory indexing, for example, surfaces user needs and tensions with expert vocabularies (Leblanc, 2020). Although these approaches come from different fields, they are often merged in practice.

Symbolic and NeSy AI evaluations have also been reviewed where human control is a design requirement (Calvano, 2024). Participatory design, citizen science, semantic technology and digital library literatures each document user involvement, but largely in separate argumentative lines. Reviews of participatory and human-centered AI design (Wacnik *et al.*, 2025; Delgado *et al.*, 2023) establish repertoires of methods and consultative-to-collaborative participation levels, yet rarely map how those repertoires are reported on semantic or NeSy information systems in library and heritage infrastructures. Evaluations of NeSy AI stress human oversight and lifecycle inclusion (Calvano, 2024, 2025) without systematically comparing participative practices across cases. Bibliometric and review work on semantic technologies for cultural heritage (Desul *et al.*, 2023) foregrounds technical adoption more than participation timing, agency or epistemic-justice safeguards. Digital-library and Galleries-Libraries-Archives & Museums (GLAM) scholarship (Fox and Chandrasekar, 2021; Ranjgar *et al.*, 2024) describe process-driven engagement but seldom integrate those patterns with NeSy and knowledge-graph design reports in one comparative corpus. Documented participative practices are therefore often invoked with limited and uneven reporting, reducing impact, replicability and operationalization. The gap is a lack of an integrated cross-case account of documented participative practices on semantic and NeSy systems for digital libraries and cultural heritage, analyzed along with when users enter, how participation is done, how much agency is reported and whose knowledge counts. This study fills that gap through a search, appraisal, synthesis, analysis (SALSA) scoping review and content analysis of 22 practices with sufficient methodological traceability, organized by five theoretical lenses below and synthesized in four analytic dimensions in the methodology. Its contribution is an empirically grounded map of reported practices, a replicable four-dimension codebook linked to prior reviews and practice-oriented recommendations grounded in both framework literature and corpus patterns. The study is guided by two questions:

- Q1. Are participative practices integrated into (and documented in) the design and evaluation of semantic and NeSy AI systems for digital libraries and cultural heritage?
- Q2. How do academic literature and curated preprints describe timing, method, engagement and ownership of these participative practices?

Together, they map where participative practices are documented in the literature and how they are characterized. This provides a basis for more inclusive, accountable and epistemically just infrastructures and helps researchers and practitioners align technical and institutional demands with the situated needs and rights of the communities concerned.

This scoping review maps English-language publications indexed in Scopus and Web of Science. It is not limited to a single country. The 22 analyzable participative practices reported in the literature span multiple regions: Europe (15 practices), North America (3), Asia (2) and Australia (1), with one further case not reporting site geography explicitly. Findings describe documented patterns in the indexed literature, not universal rules for all digital-library contexts worldwide.

Theoretical framework

The literature review is structured around five thematic lenses. Each lens first synthesizes what the field already knows from prior reviews and conceptual work; each is then operationalized in

the content analysis of the 22 practices, informing inclusion criteria, coding and interpretation alongside the four analytic dimensions applied in synthesis (timing, methods, engagement, ownership).

The first lens draws on multidisciplinary participatory practices with a design-driven focus across UCD, participatory design, co-creation, design thinking and human-computer interaction/AI. Prior work treats users as partners in configuring socio-technical systems (Tinker-Perrault *et al.*, 2015; Delgado *et al.*, 2023); systematic mappings document participatory design evolution (Wacnik *et al.*, 2025), design-thinking perspectives (Bhandari, 2022) and the centrality of usability testing (Baghini *et al.*, 2024; Mahdie *et al.*, 2024), including the risk that participation narrows to interface-level consultation (Delgado *et al.*, 2023; Stappers and Sanders, 2008; Liu, 2025). In sum, prior reviews hold that user partnership should span the design lifecycle, that plural co-creative methods are needed and that participation should shape scope beyond interface consultation.

In content analysis, this lens supplies vocabulary for the methods dimension (workshops, co-design, co-creation, usability testing) and for timing when cases describe design lifecycles or early versus late user entry (Waidelich *et al.*, 2018); co-creation is coded here as a design method, not as citizen-science co-production and engagement levels in consultative-to-collaborative modes draw on Delgado *et al.* (2023) when cases describe user influence on design scope.

The second lens draws on research-driven participatory practices (citizen science, crowdsourcing and cultural-heritage participation literature), framing co-production, fieldwork communication and impact (Turnhout *et al.*, 2020; Vohland *et al.*, 2021; Xu *et al.*, 2024), complemented by policy and practitioner frameworks on participation models and intensities (European Commission, 2015; Haklay *et al.*, 2020; Gómez-Ferri, 2014). In sum, citizen science and co-production literature require differentiated participation models, open treatment of power in co-production and accountable science–society engagement.

In content analysis, it codes methods when participation appears as crowdsourcing, annotation, contributory infrastructures or knowledge co-production rather than workshop co-creation and informs engagement when reports use citizen science or co-production scales distinct from design-consultation wording; inclusion screening also retained cases with traceable research-driven procedures (Ridge *et al.*, 2021). These two lenses support multidisciplinary in how users are integrated into design and research processes in the databases, while requiring terminological distinction between design-driven and research-driven participation.

The third lens addresses the semantic web and NeSy AI: structured reviews describe architectures combining symbolic and neural components (Hamilton *et al.*, 2022) and evaluation stressing human control and lifecycle inclusion (Calvano, 2024, 2025) and bibliometric synthesis on semantic technologies for cultural heritage shows adoption of knowledge graphs, linked data and ontologies (Desul *et al.*, 2023) without comparatively mapping participative practices across technology types. In sum, reviewed NeSy and semantic technology literature argues that trustworthy information systems require human control, transparency and lifecycle-wide user inclusion.

In content analysis, it classifies each practice into a technology profile (knowledge graph, NeSy AI, linked open data/semantic portals, ontology/semantic search) used in the findings and tables, shapes search and appraisal axes and supports interpretation of whether participation is reported differently by infrastructure type.

The fourth lens concerns cultural heritage, digital libraries and other GLAM contexts, describing socio-technical infrastructures for discovery, metadata, collections and public engagement (Fox and Chandrasekar, 2021; Ranjgar *et al.*, 2024; Patti *et al.*, 2015), process-driven patterns, participatory indexing tensions (Leblanc, 2020) and multi-actor workflows.

In sum, digital-library and GLAM scholarship requires multi-actor workflows and evidence that participation improves discovery, metadata work and public engagement in heritage infrastructures. In content analysis, it bounds the corpus to library, archive, museum or heritage information systems, informs timing when cases describe deployment, discovery, curation or monitoring typical of heritage infrastructures and directs synthesis toward how participation supports collection access, metadata quality and public-facing discovery.

The fifth final lens constitutes conceptual work on epistemic justice, representation and inclusion (Fricker, 2007; Stengers and Despret, 2014; Ferran-Ferrer *et al.*, 2023; Haraway, 1991), linking bias, provenance and governance to accountable human-centered AI design (Capel and Brereton, 2023; Fox and Chandrasekar, 2021). In sum, epistemic-justice and human centered AI literatures require explicit attention to representation, bias, provenance and community governance in the design of information systems. In content analysis, it defines the ownership dimension – bias, representation, gender, multivocality, provenance, community governance and rights-oriented safeguards – coding from practice descriptions and stakeholder implications when justice terms are not named literally, with interpreted claims distinguished from explicitly reported safeguards in the findings; inclusion required at least one traceable inclusion or governance element per analyzable practice (Calvano, 2025; Fricker, 2007).

Methodology

This scoping review adopts a qualitative-dominant mixed-methods approach (see Figure 1). It combines bibliometric mapping techniques (Cobo *et al.*, 2011) with content analysis (Cardoso *et al.*, 2021) within the SALSA framework (Search, Appraisal, Synthesis, Analysis) (Grant and Booth, 2009). The objective is to map participation in the design process of semantic or NeSy AI systems for digital libraries and cultural heritage in scholarly database literature, complemented by examining documented timing, methods, engagement and ownership in such literature. The study analyses how participation is

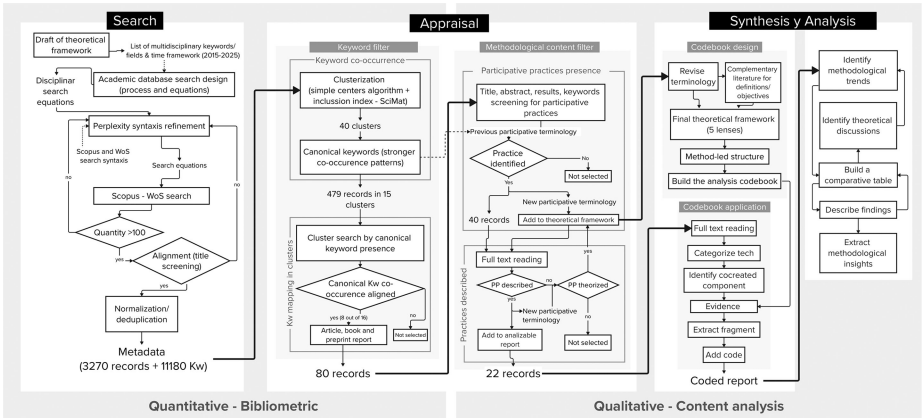


Figure 1. Scoping review workflow (SALSA): bibliometric mapping in SciMAT (Search–Appraisal) and four-dimension content analysis (Synthesis–Analysis). Record flow after deduplication: 3,270 → 479 (bibliometric filter) → 80 (≥8 / 16 canonical keywords) → 40 (title/abstract screen) → 22 analyzable practices (full-text appraisal)

Source: Authors' diagram; metadata extraction and coding completed August 2025

reported in peer-reviewed and preprint publications; it does not evaluate deployed systems in operational digital-library settings.

In Search, the first phase, structured queries were executed in Scopus and Web of Science during 2024–2025 (iterative runs), with publication years limited to 2014–2025, including books, articles and preprints. Exports were processed with SciMAT (Cobo *et al.*, 2011), deduplicated to 3,270 records, bibliometrically filtered to 479 records, then screened to 80, 40 and 22 analyzable practices after full-text appraisal (Figure 1; Appraisal below). Four-dimension content analysis of those 22 practices was completed in August 2025. A set of search equations was designed by combining multidisciplinary terms for semantic and NeSy AI technologies (what is designed) with UCD, participatory design, design thinking, co-creation and citizen-science approaches (how participation is intended). These terms are within the fields of computer science, library and information science, digital humanities, human-computer interaction/AI and design studies. The following Boolean strategies illustrate how participation-oriented and semantic-technology axes were combined:

Example 1 (Scopus – participatory design × knowledge infrastructure):

```
TITLE-ABS-KEY(
  ("participatory design" OR "co-creation*" OR "user centered design"
   OR "human centered interaction" OR "social innovation")
  AND
  ("knowledge graph*" OR "CK theory" OR "interaction patterns"
   OR "usability testing" OR "cognitive load")
)
AND SUBJAREA(COMP OR SOCI OR ARTS)
AND PUBYEAR > 2014
```

Example 2 (Web of Science – same intersection):

```
TS = (
  ("participatory design" OR "co-creation*" OR "user centered design"
   OR "human centered interaction" OR "social innovation")
  AND
  ("knowledge graph*" OR "CK theory" OR "interaction patterns"
   OR "usability testing" OR "cognitive load")
)
AND PY = 2014–2025
```

Example 3 (Scopus – semantic web proximity to knowledge graphs):

```
TITLE-ABS-KEY(
  ("semantic web" OR "linked data" OR "RDF mapping" OR "FAIR data" OR
   "ontology engineering")
  W/5
  ("knowledge graph*" OR "frame semantics" OR "polyvocality" OR "multimodal
   data" OR "bias reduction")
)
AND PUBYEAR > 2014
```

Parallel segmented strategies also targeted digital humanities and GLAM/cultural-heritage metadata. Search terms used in equations and in the bibliometric filter: knowledge graph, linked open data, semantic technologies, ontology, knowledge organization systems, metadata, digital cultural heritage, digital humanities, UCD, participatory design, co-creation, usability, human-computer interaction, crowdsourcing, semantic annotation, visualization, archives, participatory archives.

Preprints were included as a recognized form of academic dissemination within these domains; excluding them would have disregarded relevant practices. A search engine/agent (Perplexity AI) allowed direct injection of Scopus and Web of Science syntax rules by official uniform resource locator and was used iteratively as a syntax corrector for the Boolean strategies to obtain results of adequate quantity and quality. In the appraisal phase, two filters were applied. First, a bibliometric keyword co-occurrence filter took the 3,270 deduplicated records from the search phase, built 40 keyword co-occurrence clusters and identified 16 canonical keywords across the four thematic axes (cultural heritage; semantic web and NeSy AI; representational gaps; and UCD, citizen science and HCI), using SciMAT's default co-occurrence threshold (Cobo *et al.*, 2011). This yielded 479 metadata records with relevant co-occurrence signals. Second, records with at least eight of those 16 keywords (50% coverage) were retained – 80 records – to require overlap across axes rather than peripheral mention of a single theme; lower cutoffs inflated records where participation appeared only as background context, not as a reported method. The second filter then assessed titles, abstracts, results and keywords and manually selected documents that described participative practices.

Inclusion criteria for the second filter (80–40 records) were: explicit reporting of participatory methodology in the title/abstract/results/keywords, clear description of when users enter the process (conceptualization, design, development, deployment, evaluation or monitoring) (Waidelich *et al.*, 2018; Calvano, 2025); identification of participatory procedures (e.g. workshops, co-design/co-creation, usability testing, crowdsourcing, annotation or curation) (Delgado *et al.*, 2023; Stappers and Sanders, 2008; Baghini *et al.*, 2024; European Commission, 2015; Ridge *et al.*, 2021); and sufficient evidence of participation engagement (from consultation to co-ownership/agency). Also, the inclusion concerns (bias, representation, gender, epistemic justice, governance) (Delgado *et al.*, 2023; Vohland *et al.*, 2021; Fricker, 2007; Ferran-Ferrer *et al.*, 2023; Escobar, 2016; Fox and Chandrasekar, 2021). Exclusion criteria: papers without participatory process detail (19); conceptual/editorial pieces without a describable method (1); cases with labels (e.g. “user-centered” or “participatory”) but no concrete actions, actors, phase or tool (4); or reports that did not allow extraction of analyzable methodological fragments for cross-case comparison (16). Although 40 records showed signs of such information, after reading the full text, only 22 provided sufficient methodological description to support the content-analysis phase. Several of the 40 records were also used to build the codebook and the theoretical framework and additional references were added to provide conceptual support (e.g. citizen science and epistemic-justice variables).

Sufficient methodological description was defined as minimum traceable evidence of four elements in the same case report: process timing of participation (early/late/continuous), concrete methods or tools used, stated form/intensity of participation and at least one explicit treatment (or clear absence) of inclusion/representation safeguards. This threshold follows the definitions of participatory design and co-design (Delgado *et al.*, 2023; Stappers and Sanders, 2008), usability testing as a method (Baghini *et al.*, 2024), citizen-science participation forms (European Commission, 2015; Gómez-Ferri, 2014) and governance/bias concerns in human-centered AI and digital-library workflows (Calvano, 2025; Fox and Chandrasekar, 2021). Records lacking one or more of these elements were retained as contextual literature.

In the Synthesis phase, the four-dimension analytical codebook was applied at the level of each practice to aggregate codes across the documents. At this stage, codes were organized to identify patterns and gaps across four analytically distinct methodological dimensions.

The user integration phases and process-driven patterns (timing) identify when participation happens in a project trajectory, from conceptualization to monitoring. This captures temporal/process evidence (early, late, ongoing) and relies on explicit workflow

descriptions such as “study design, data collection, data analysis, data visualization and interpretation” (Baghini *et al.*, 2024, p. 10). From the design perspective, iterations of conceptualization/design and feedback are common ways to describe these patterns (Waidelich *et al.*, 2018). Other terms appear in descriptions of life-cycle inclusion of users, such as participation “from the definition of requirements to their evaluation” (Calvano, 2025, p. 234). Terms vary because studies label the design/research lifecycle differently depending on the lens. See Table 1 with cross-technology synthesis of participatory patterns.

Participatory approaches and methodological tools (Methods), by contrast, identify how participation is operationalized: workshops, co-design, co-creation, usability testing, crowdsourcing, annotation and related procedures (Stappers and Sanders, 2008; Delgado *et al.*, 2023; European Commission, 2015; Gómez-Ferri, 2014). For example, if “co-creation [...] (as an) act of collective creativity” (Stappers and Sanders, 2008) is found in the Lens 1 context, it is treated as the unit of analysis. If a case instead refers to “knowledge co-production,” it is treated in the Lens 2 context as an activity, rather than as a marker of when participation occurs. Levels of participation and agency (engagement) classify how much agency participants hold, not when they enter or which tool is used. It distinguishes consultative from collaborative and co-ownership forms (Delgado *et al.*, 2023) on a scale (consult, include, elaborate, and, at the deepest level, own) and incorporates citizen-science participation orientations and agency domains – scientific, inspirational, educational, social, economic, environmental and political community agency (Vohland *et al.*, 2021; European Commission, 2015) – as levels of engagement. A threshold here is related to meaningful participation, since “many participatory techniques fail to truly empower stakeholders” (Delgado *et al.*, 2023, p. 3). Finally, Inclusion, representational gaps and epistemic-justice

Table 1. Cross-technology synthesis of information services and their participatory patterns

Technology type	Timing	Methodological dimensions		Ownership
		Method	Engagement	
Knowledge graphs (6 practices found)	Mostly design-led early/late; One constant research-driven and One not-explicit research-design case	Co-construction, PD workshops, mixed-method usability/ interviews, annotation workflows, UCD refinement	Consult to collaborate/ empower; One scientific-participation profile	Interpreted ownership in yanyuwa; mostly under-explicit in other KG cases
Neurosymbolic systems (3)	Early/late or constant across development/ evaluation	Collaborative storytelling + AI, requirement workshops/ user testing, user-controlled narrative generation	Involve/consult to collaborate -empower	Mostly not explicit, with preliminary community-agency framing in narrative-generation work
Linked open data platforms (5)	Not explicit or evaluation for first lens; constant/ongoing for second lens.	User-oriented portals, collaborative editing, crowdsourced contribution models	Inform/involve to community curation and citizen participation	Mostly not explicit in justice safeguards
Other ontology/ semantic search systems (8)	Early, late, ongoing and mixed early + constant patterns	Ontology engineering (NeOn), semantic search UX iterations, participatory indexing, provenance co-design, community co-design, implicit crowdsourcing	Inform/consult to collaborate/ empower; includes community-agency profiles	Strongest ownership signals in inuvaluit, HyperReal, ProvKOS/ GTDOnto; others remain under-explicit

Source(s): Author’s own data

considerations (ownership) assess whose knowledge counts and under which safeguards: gender and representation asymmetries, knowledge diversity, power dynamics and whether technical protections are specified (Fricker, 2007; Ferran-Ferrer *et al.*, 2023; Escobar, 2016; Fox and Chandrasekar, 2021; Calvano, 2025). These concepts are unlikely to appear literally in every case report; where justice terms are absent, the ownership dimension is inferred from practice descriptions and stakeholder implications, as reported in the Findings.

To support traceability, the research process systematically read full papers and extracted relevant fragments following a two-step protocol (see Figure 1): first, code assignment; second, code aggregation. This connected the reported findings to specific analytical categories from the codebook into a comparison grid. This is how methodological information in the literature is translated into comparative results. In the analysis phase, the aggregated coded patterns were interpreted through the five lenses, linking what prior literature already theorizes with what the 22 documented practices in this corpus actually report. This enables a structured link between methodological choices and analytical outcomes of this study, including user integration, agency and epistemic-justice-related implications in the examined systems for digital libraries.

Findings about methodological user integration

The findings are organized around when participation happens, how it happens, the level at which participation occurs and the ownership reported in the digital-library context. These issues bear on how libraries build trust, representation and accountability in AI-augmented infrastructures. They synthesize how participative practices are documented in semantic and NeSy AI systems that support digital library and GLAM work (collections, discovery, metadata and public engagement).

Prior reviews argue that participation should span system lifecycles, combine diverse methods and embed justice and governance safeguards; the 22-practice corpus (Table 2) shows that such integration is reported across all analyzable cases, but unevenly in timing, depth of documentation and explicit ownership language. The corpus therefore confirms the presence of participative practices in the indexed literature while narrowing the normative claims of prior syntheses to what is actually traceable in case reports.

Regarding the first research question, all 22 practices report participative integration in the design and/or evaluation of semantic or NeSy systems for digital libraries or cultural heritage, with sufficient methodological detail for comparative analysis (timing, methods, engagement and inclusion-related elements). Participation is integrated and documented throughout the analyzable set; differences lie in how that integration is described. Seven practices document early user involvement in design or co-construction; the remaining cases emphasize late-stage evaluation, iterative NeSy feedback loops or continuous contributory models (especially linked open data and crowdsourcing). Engagement is predominantly consultative or collaborative; explicit epistemic-justice safeguards are reported in selected cases but remain thin across much of the set.

Regarding the second research question, the literature describes who participates, how participation is done, how much agency is reported and how owned outcomes are framed in the following patterned way. Who participates and at what engagement level are detailed in the Engagement subsection and Table 2 (Engagement column)? When (timing): user entry is early in seven practices; more often late in evaluation, in iterative NeSy cycles or in continuous contributory maintenance. How (methods): workshops, co-design, usability testing, crowdsourcing and annotation predominate; NeSy cases add interaction testing and configurable outputs. How much (engagement): consultative and collaborative modes dominate; deeper co-ownership appears mainly in ontology/semantic search and selected NeSy practices. How owned: explicit justice and governance language are strongest in

Table 2. Comparative analysis of participative practices (22 cases)

Practice – source (user)	Technology type	Timing	Method	Engagement + user	Ownership
Yanyuwa Comic Project (Liang et al., 2024)	Knowledge graphs	Development-early	Co-construction workshops; data storytelling/data comics	Include (language teachers)	Community agency; recognition of diverse knowledge systems
World literature knowledge graph (Stranisci et al., 2017)	Knowledge graphs	Evaluation usability testing (late)	Reader community integration; expert usability validation	Consult (teachers, researchers, publishing professionals)	Addresses non-western representation (implicit)
PhD students' information-Sharing knowledge Graph (Gardasevic and Gazan, 2023 ; Gardasevic and Lamba, 2024)	Knowledge graphs	Design/evaluation (late)	Participatory design workshop; interviews + sentiment analysis	Include (PhD students)	Not explicit
KnowEdu (Chen et al., 2018)	Knowledge graphs	Development (UCD)	User-centered design with experts/learners; automated KG	Elaborate (experts, learners)	Not explicit
Research knowledge Graphs for participatory archives (Hocker et al., 2022)	Knowledge graphs	Research/Ongoing	Participatory approach; annotation	Scientific (archivists, researchers)	Not explicit
ATLAS (Giacomini et al., 2025)	Knowledge graphs	Research design/analysis - constant	Participatory research support; collaborative data entry	Scientific (researchers, practitioners)	Not explicit
Polariscope collaborative storytelling Platform (Almeida et al., 2024)	Neurosymbolic AI systems	Design: Development/evaluation (constant)	Collaborative storytelling with AI-generated stories	Involve/collaborate (citizens, cultural institutions)	Not explicit
InTaVia (Mayr et al., 2022)	Neurosymbolic AI systems	Design/evaluation (constant)	Requirement workshops; user testing; empirical validation	Consult (historians, cultural scientists, GLAM practitioners, technicians)	Not explicit
Neurosymbolic narrative generation for cultural heritage (Palma, 2023)	Neurosymbolic AI systems	Development (constant)	Neurosymbolic ASG pipeline; user parameter control	Consult, include, elaborate (not defined)	Community agency framing (preliminary)
DigiNUMA (Hocker et al., 2022)	LOD platforms	Design (participatory heritage) not explicit timing	Participatory heritage component; lightweight KG	Educational (school archivists and researchers)	Not explicit
SAMPO model projects (Hyvönen, 2023)	LOD platforms	Design (not explicit timing)	Configurable semantic portals; faceted exploration	Consult (researchers, practitioners)	Not explicit
Wikibase for cultural heritage (Kesäniemi et al., 2022)	LOD platforms	Ongoing enrichment – constant	Collaborative editing	Social (non-expert users)	Not explicit
Cultural leaf semantic portal (Dorobăţ et al., 2024)	LOD platforms	Evaluation – late	Usability-focused semantic portal	Consult (researchers, general public)	Not explicit
European cultural gems (Consoli et al., 2023)	LOD platforms	Information gathering/ constant	Crowdsourced platform; citizen contributions	Social (citizens)	Not explicit
Archive dynamics ontology – ArDO (Vsesviatska et al., 2021)	Ontology/semantic search systems	Design (expert-driven) late	Ontology engineering	Inform/consult (not reported)	Not explicit
GTDOnto (Al-Fayez et al., 2023)	Ontology/semantic search systems	Design (NeOn) – early	NeOn methodology; expert review + competency questions	Consult	Sensitive domain; bias mitigation noted

(continued)

Table 2. Continued

Practice – source (user)	Technology type	Timing	Method	Engagement + user	Ownership
ARCA (Bernasconi <i>et al.</i> , 2022)	Ontology/semantic search systems	Development/evaluation (late)	User-centered design; iterative releases; comparative usability testing	Consult (publishers, researchers, interested individuals)	Not explicit
ArsEmotica (Patti <i>et al.</i> , 2015)	Ontology/semantic search systems	Information gathering/constant	Emotion-driven exploration with implicit crowdsourcing	Political community agency (social media users)	Not explicit
Participatory indexing for academic digital libraries (Leblanc, 2020)	Ontology/semantic search systems	Design (early)	Co-design workshops; prototyping	Scientific (potential library users)	Not explicit
ProvKOS (Choi and Cheng, 2024)	Ontology/semantic search systems	Design (early)	Five-step participatory process; participatory design	Consult, include, elaborate (editorial managers, information professionals, researchers)	Bias mitigation (controversial classification tracking)
Inuvialuit digital library (Famel and Shiri, 2019)	Ontology/semantic search systems	Design/ongoing (early)	Community-driven co-design; interviews/ focus groups/user testing/surveys	Political community agency (community members, students, language instructors, ICC staff, archivists, librarians, researchers)	Community agency; diverse knowledge systems; culturally grounded access rules
HyperReal (Sartini and Shoilee, 2025)	Ontology/semantic search systems	Ongoing	Participatory exhibition design; co-curation tools	Consult, include, elaborate (not profiled)	Community agency (multivocal approach)
Rhizomer (García <i>et al.</i> , 2022)	Ontology/semantic search systems	Evaluation/ongoing (late/monitoring)	Human-centered interface for KG exploration	Consult and elaborate (researchers, practitioners, lay users)	Not explicit

Source(s): Authors’ content analysis

ontology/semantic search and sensitive-domain cases; in other profiles, ownership is frequently inferred from practice descriptions rather than reported as formal safeguards.

The sample comprises 22 participative practices distributed across four technology profiles. Knowledge graph (6 practices) and NeSy AI systems (3) concentrate on collaborative knowledge construction, semantic integration and human-centered evaluation in domains such as educational guidance, interdisciplinary research support, archival enrichment and AI-assisted cultural storytelling. Across these groups, participation appears in design and evaluation cycles, with some cases extending into continuous research-driven monitoring (Table 1).

Linked open data and semantic portal systems (5) focus on interoperability and public-facing discovery infrastructures. Their participatory themes are non-expert contribution, collaborative editing and exploratory access to distributed cultural data sets, often through crowdsourcing and ongoing curation models rather than intensive early co-design documentation.

The ontology/semantic search systems (8) bring together ontology engineering, semantic retrieval/exploration, indexing workflows, provenance/governance modeling and community-led cultural infrastructures. This group shows the widest thematic spread: sensitive-domain modeling, multivocal interpretation, affective metadata capture and culturally grounded governance. It also contains the clearest ownership-oriented cases, although justice and governance mechanisms remain unevenly specified across the group.

These types of information services, grouped by technological similarities, are examined for how participation is integrated, revealing methodological trends in timing, methods, engagement and ownership as follows:

Timing: user integration phases and process-driven patterns. As Table 2 shows, for knowledge graphs, timing is mostly design-led and split between early co-construction and late validation, with a smaller research-driven subset organized around constant enrichment. This profile reflects workflows where participatory input supports both model formation and iterative evaluation. For NeSy AI systems, timing is explicit and iterative, combining early requirement work, development-stage interaction and evaluation loops. Participation is not only post hoc testing; it is often embedded in system shaping through repeated feedback cycles. In linked open data platforms, timing divides between design-led portal evaluation and research-driven continuous contribution models. Participation is frequently tied to maintenance and updating of shared records, rather than to strongly documented early co-design phases. For ontology/semantic search systems, timing is the most heterogeneous, spanning early design, late evaluation, ongoing co-curation and mixed early-plus-constant patterns. This variation aligns with the breadth of this dimension, where governance-oriented and retrieval-oriented systems require different moments and intensities of participation.

Method: participatory approaches and methodological tools. Methodological tools are treated here as operational devices that structure participation across process phases and technology contexts (see column 2 in Table 2). The distribution of these by technology profile is as follows. In a knowledge graph, methods combine co-construction, participatory workshops, usability-oriented assessment, annotation/enrichment workflows and user-centered refinement. The methodological pattern is relatively rich and mixed, often linking design decisions to practical model-use scenarios. For NeSy AI systems, methods combine collaborative design practices with interaction testing and user-controlled configuration mechanisms. Participation is frequently operationalized as iterative negotiation between model behavior, narrative production and interface usability. In linked open data platforms, methods split between exploration-oriented portal architectures and contribution infrastructures built around collaborative editing and crowdsourcing. Method descriptions are generally functional and implementation-oriented, with less frequent reporting of deeper participatory design protocols. For ontology/semantic search systems, methodological diversity is highest: ontology engineering, participatory provenance modeling, iterative retrieval UX, co-curation, indexing co-design, community-led mixed-method processes and implicit crowdsourcing all coexist. This group concentrates the broadest range of participation devices and methodological vocabularies.

Overall, participation in this corpus is terminologically diverse, but concrete descriptions of the tools used remain uneven. A more detailed description of participation strategies in practice would contribute to a clearer, more concrete toolkit, which is still being defined in reviews and policy documents.

Engagement: levels of user participation and engagement. Participation levels concentrate in consultative, include and collaborative modes, but agency differs by task ownership and by who is named as a participant (Table 2, Engagement column). In knowledge graph practices, engagement ranges from consult and include (reader communities, PhD students, language teachers) to scientific participation (archivists, researchers) and elaborate work with experts and learners. In NeSy AI systems, engagement spans involve/collaborate and consult–include–elaborate combinations (citizens, cultural institutions, GLAM practitioners, technicians); narrative-generation work reports configurable interaction but often leaves users undefined. In linked open data platforms, social and educational engagement labels align with non-expert users, citizens and school-based heritage contributors. In ontology/semantic search systems, engagement is the most heterogeneous: consult and consult–include–elaborate

pairings with publishers, experts and information professionals sit alongside political community-agency and scientific labels in community-led, crowdsourced and indexing cases.

Across the 22 practices, reported user communities fall into four overlapping groups: professional and research actors (archivists, researchers, GLAM practitioners, publishers, editorial managers, information professionals); learners and specialist publics (PhD students, experts, learners, language teachers); non-expert and citizen contributors (citizens, general public, social media participants, non-expert editors, potential library users); and community- or place-based coalitions (language communities, multistakeholder heritage groups, co-curators). Papers rarely use a single digital-library user model; instead, participation is distributed across roles tied to curation, discovery, indexing and narrative tasks. Consult and include levels are most frequent; scientific, educational and social labels appear in research-driven archival and crowdsourced workflows; political community-agency framings are clearest in community-led digital library and multivocal exhibition work. Three cases note actors as not defined or not profiled, which limits comparability even where methods are richly described.

According to the literature descriptions, engagement could be accomplished by identifying aspects that are meaningful to stakeholders rather than only attending to system coherence. Although many cases remain at consultative levels, several ontology/semantic search systems document exploratory narrative-making and sustained governance-oriented community work.

Ownership: inclusion, representational gaps and epistemic justice considerations. Explicit justice-oriented reporting remains uneven and often implicit (see column 4 in [Table 2](#)). In a knowledge graph, ownership language is clearest when projects address language preservation or representational coverage, but most cases document participation procedures more than explicit justice safeguards. In NeSy AI systems, ownership is stronger where users influence meaning production and narrative outputs; however, formalized protocols for representational risk and bias mitigation remain sparsely documented. In linked open data platforms, contribution mechanisms are visible and operational, but ownership safeguards are rarely formalized as explicit inclusion, bias or representational-audit frameworks. In ontology/semantic search systems, ownership language is strongest in sensitive-domain governance, provenance/accountability modeling, multivocal curation and community-led authority over metadata and access norms. Even so, formal epistemic-justice instrumentation remains uneven across the dimension.

[Table 2](#) is the case-level inventory for all 22 analyzable practices: each row is one reported practice, with source, technology profile and coded timing, methods, engagement (including named user communities) and ownership.

Limitations

Methodologically, reporting quality is uneven across the literature: many studies do not describe participation phases, methods or outcomes with sufficient precision, which reduces comparability, weakens replicability and limits the strength of cross-case conclusions. Although the review started from a large corpus (80), only 22 practices offered enough methodological detail for full analysis, which constrains representativeness. In addition, these information systems are often highly specialized and infrastructure-oriented and the integration of participative practices remains difficult to report in several domains; likewise, the bibliometric component relied on metadata- and keyword-based techniques, so more specialized retrieval strategies might capture a broader and more representative sample. A further limitation concerns epistemic justice: concepts such as bias, representation, gender or knowledge diversity are not always named literally in case reports, so this study necessarily interprets their presence (or absence) from practice descriptions and stakeholder implications. Findings distinguish explicitly reported safeguards from interpreted ownership claims, as

noted in Table 2 where applicable. Geographic and linguistic coverage remain uneven: the search corpus is English-indexed, cases cluster in Europe and the Global North and several papers do not report site geography explicitly, limiting transferability to other sociocultural contexts. The temporal focus (2014–2025) captures current developments but may underrepresent longer trajectories and still-maturing trends. Many cases are hybrid, combining multiple technologies and participatory approaches, which complicates categorization and introduces unavoidable analytical simplifications. Finally, the lack of standardized metrics for participation quality, trust-building, social impact and epistemic justice outcomes, together with the scarcity of longitudinal and comparative designs, limits deeper evaluation. Taken together, these constraints suggest that participation in semantic and NeSy-related fields is active but still methodologically uneven and not yet fully mature as a consolidated, systematically comparable research process across disciplines.

Discussion

The critical perspective on the current state of human-centered semantic and NeSy AI practices in digital libraries is part of a broader cultural and socio-technical system. Compared with participatory reviews, such as the studies summarized in Wacnik *et al.* (2025), many projects describe participation at multiple stages, while others confine it to specific moments (Wacnik *et al.*, 2025). Aligned with Delgado’s analysis of participatory AI design, the examined practices implement participation through consultative modes, in which preferences and values are elicited but scope and purpose remain in expert hands (Delgado *et al.*, 2023). Accordingly, participation in digital libraries replicates the literature pattern in which it is distributed unevenly across phases, reducing influence on system co-governance and limiting the capacity to transform how cultural-heritage infrastructures are conceived and steered.

The corpus also shows that participation is not enacted by a generic end user. Table 2 links engagement levels to named communities – research and GLAM professionals, students and domain learners, citizens and non-expert contributors and place-based heritage coalitions – yet role labels remain inconsistent across papers. Consult and include modes predominate where publishers, experts or interface testers validate semantic systems; scientific and educational participation appears in archival enrichment and school heritage workflows; social and political community-agency framings cluster in crowdsourced linked data, affective collection exploration and community-led metadata design. That distribution suggests digital libraries mobilize different publics for different infrastructural tasks, but reporting seldom specifies how engagement quality or representativeness is evaluated for each community. Strengthening practice, therefore, requires naming who participates, at what level and with what authority over metadata, narratives and governance – not only documenting workshops or usability scores.

Furthermore, the tool repertoire shows a similar combination of ambition and constraint when compared with the reviews. Methodologically, the widespread use of Co.-design workshops, collaborative activities and community-oriented processes “echoes the twin desire diagnosed in participatory-design literature to remedy inequitable design by engaging directly with stakeholders and users” (Wacnik *et al.*, 2025, p. 2). However, the strong emphasis on user testing and interface evaluation within this corpus mirrors the bibliometric finding that usability testing “has become a central methodological focus across multiple fields, including information science and library science” (Mahdie *et al.*, 2024, p. 11). As Delgado’s team study argues, many participatory AI projects “focus exclusively on informing selected aspects of the user interface, thereby restricting what is on the table in design negotiations” (Delgado *et al.*, 2023, p. 6). The semantic and NeSy participative

practices in digital libraries show the use of a diverse toolkit, although their evaluation was not fully documented; they mainly assess system performance and usability, which suggests that participation functions more as a technique embedded in expert-driven workflows than as a fully theorized and measured methodological object.

Finally, the implications for trust and resilience derived from this study align with human-centered AI critiques ([Hamilton et al., 2022](#); [Capel and Brereton, 2023](#)) and with work on community-driven knowledge organization and science communication. Semantic and NeSy AI systems that integrate users primarily at late evaluation stages risk reproducing expert-centric assumptions and opaque knowledge representations; trust is thus framed not as a purely technical property but as a socio-technical outcome dependent on meaningful participation, transparency of design choices and accountability for representational decisions ([Stappers and Sanders, 2008](#); [Fox and Chandrasekar, 2021](#)). Human-centered AI surveys underscore that problems such as inscrutable models, embedded bias, privacy risks and illusions of meaning cannot be resolved solely through technical fixes when AI systems act on personal and trace data without accountable co-design ([Capel and Brereton, 2023](#)). Community-driven heritage and science-communication perspectives emphasize that resilient cultural-heritage infrastructures depend on sustained social relationships, shared authority and culturally grounded practices ([Escobar, 2016](#); [Farnel and Shiri, 2019](#); [Davis and Horst, 2016](#)) and that embedding community governance and long-term engagement helps address cultural sensitivities, contested knowledge and evolving community needs ([Farnel and Shiri, 2019](#); [Stengers and Despret, 2014](#)). Resilience in digital libraries is not only a matter of infrastructural robustness but also of sustained social relationships and distributed responsibility. Against this backdrop, the practices documented in this article point to a possible agenda for digital libraries: aligning participatory strategies with domain sensitivity, pairing participatory methods with explicit evaluations of engagement and governance outcomes and embedding provenance mechanisms, bias checks and community-centered governance from the outset are advisable steps to move from consultative to genuinely co-produced semantic and NeSy AI infrastructures in cultural-heritage contexts.

These patterns point to a broader challenge for transdisciplinary collaboration. Although the analyzed corpus draws from diverse fields, the integration of these perspectives often remains partial. Technical development and participatory design are frequently decoupled, rather than co-evolving through shared conceptual frameworks and evaluation criteria ([Delgado et al., 2023](#); [Capel and Brereton, 2023](#)) and good practices may miss opportunities for transfer, undermining the adaptive, user-driven exploration envisioned for future digital libraries. Transdisciplinary collaboration can be expanded through the multi-actor workflow integration advocated by Fox and Chandrasekar – explicitly linking UX researchers, subject-matter experts and developers in extensible knowledge-graph-driven workflows ([Fox and Chandrasekar, 2021](#)) – while processes contribute perspectives and lessons from their own limitations to strengthen the relationship between knowledge and societal relevance ([Davis and Horst, 2016](#)).

The practice implications and recommendations below bridge the synthesis above with work in libraries, archives, museums and heritage-facing information services. They are intended for digital library and GLAM teams planning or governing semantic and NeSy systems – not as universal prescriptions for every sociocultural context, but as actionable directions consistent with what this corpus reports.

Recommendations and practice implications for participatory artificial intelligence in digital libraries

The recommendations that follow are organized into three practice areas that emerged from the review. The first concerns when participation takes place in the design lifecycle (lenses 1

and 3 -lifecycle integration and trustworthy NeSy design). The second concerns how participation is connected to governance, transparency, and epistemic-justice safeguards (lenses 2 and 5). The third concerns how participatory processes are documented and evaluated (lenses 1, 2 and 4). Together, these areas translate the patterns found in the 22 documented practices into practical guidance for digital library and GLAM teams working with semantic and neurosymbolic AI systems.

Meaningful integration in design lifecycle

This recommendation responds to a recurring pattern in the corpus: participation is often documented as late-stage evaluation, usability testing, or narrowly scoped contribution. It also builds on participatory design and human-centered AI literature, which argues that users should influence not only interfaces, but also the scope, purpose, and development of systems.

For discovery and public-facing services, digital library teams can involve cataloguers, subject specialists, and community partners when defining retrieval tasks, narrative labels, and exploratory interfaces—not only when testing finished portals (Table 1; Table 2). Early workshops can help identify what users need to discover, how they interpret semantic links, and how errors in semantic search affect trust.

For participatory indexing and vocabulary work, the corpus includes co-design of indexing services in academic digital libraries (Leblanc, 2020) and ontology-oriented cases with multivocal or contested terminology (Table 2). Institutions can treat index construction and vocabulary alignment as participatory design problems. This means surfacing tensions between expert metadata and community language before subject schemes are fixed in semantic or NeSy-assisted retrieval systems.

In practice, teams should:

- Apply human-centered methods from the start and across the full lifecycle: users “must be included in all the phases of the creation process” and systems should remain “reliable, safe, trustworthy and fully in human control” (Calvano, 2025).
- Avoid narrow interface-only participation, it should shape scope, purpose and design decisions since many projects otherwise “focus exclusively on [...] the user interface” (Delgado *et al.*, 2023, p. 6).
- Use integrated co-creation approaches because “a single design approach cannot address the scale or the complexity of the challenges” (Stappers and Sanders, 2008).

Make governance, transparency, and epistemic safeguards explicit

This recommendation addresses a second gap in the corpus: many cases describe participatory procedures, but fewer explain how bias, provenance, community authority, or representational risks are governed. It draws on citizen science, co-production, epistemic justice, and human-centered AI literature, where participation is understood as a question of power and accountability, not only user input.

For metadata and knowledge-graph governance, knowledge-graph and NeSy cases digital libraries teams should make responsibility for entity choices, provenance fields, classification decisions, and public releases visible in project documentation. Where linked data or knowledge graphs feed public collections, governance should specify who may correct records, under what authority, and with what audit trail (Fox and Chandrasekar, 2021).

For community-led or culturally sensitive collections, participation should also define how contested labels, multilingual terms, culturally grounded access rules, and community

knowledge are represented. These issues should be treated as part of the infrastructure itself, not as secondary ethical concerns after system design.

In practice, teams should:

- Include explicit governance safeguards from the design phase, including bias reduction, transparency, provenance documentation and rights-oriented compliance, because users must be able to understand and contest system decisions (Calvano, 2025).
- Treat power and representation as explicit design objects: co-production should ensure inclusivity/representativeness and acknowledge that power “should be discussed openly” (Turnhout *et al.*, 2020).
- Operationalize epistemic justice through concrete checks including representation, gender and intersectionality, provenance of contested labels, community governance and mechanisms for correcting or challenging metadata decisions (Fox and Chandrasekar, 2021; Calvano, 2025).

Documented processes, evaluation, evidence quality and research infrastructure

This recommendation responds to the uneven reporting found across the reviewed practices. Participatory methods are often mentioned, but their quality, impact, and governance outcomes are not consistently evaluated. The recommendation therefore builds on user studies, usability evaluation, citizen-science reporting, and GLAM workflow literature.

For digital library programmes, evaluation should go beyond information retrieval performance and usability (Mahdie *et al.*, 2024). Teams can add indicators for participation quality: whether communities can influence scope of the system, whether governance decisions were recorded, whether representational risks were reviewed, and whether participants had authority over metadata, narratives, or access rules.

For research infrastructure, documentation should also become more standardized. Reporting who participated, when they entered the process, what methods were used, what authority they had, and what changed as a result would make future studies easier to compare and would give practitioners clearer models to follow.

In practice, teams should:

- Pair participatory methods with explicit evaluation of engagement and governance outcomes, not only usability/performance (Fox and Chandrasekar, 2021; Calvano, 2025).
- Develop clearer criteria and best-practice protocols for usability and participatory evaluation, as highlighted in future-research recommendations (Mahdie *et al.*, 2024).
- Improve evidence coverage and comparability by extending linguistic/database scope in reviews and by strengthening science-society-policy coordination around public engagement and trust (Mahdie *et al.*, 2024; European Commission, 2015).

Overall, these recommendations suggest a shift from treating participation as a methodological add-on to treating it as a structural and governing principle in digital library infrastructures. The review shows that participative practices are already present in semantic and neurosymbolic AI systems for digital libraries and cultural heritage, but that they remain uneven in timing, depth, documentation, and epistemic-justice safeguards. Aligning participative practices with lifecycle integration, explicit governance, and stronger evaluation frameworks can support the development of more inclusive, accountable and trustworthy AI systems in cultural heritage contexts.

Conclusions

By combining a scoping review of the scholarly literature with a content analysis of the 22 practices described in the papers, this study addressed whether participative practices are integrated and documented in semantic and NeSy systems for digital libraries and cultural heritage (first research question) and how the literature describes timing, method, engagement and ownership (second research question). The analysis is documentary: it codes reported practices in publications, not live system deployments.

For the first question, participative practices are integrated and documented in all 22 analyzable cases, with traceable phases, tools and participation levels; unevenness appears in lifecycle timing (seven practices with early integration; others late or continuous contributory models), technology profile (six knowledge-graph, three NeSy AI, five linked open data/semantic portal, eight ontology/semantic search) and thin reporting of epistemic-justice safeguards in many papers. For the second question, the literature describes timing and methods as above and engagement as consultative-to-collaborative in most cases, with scientific, educational and social or political community-agency labels in research-driven, crowdsourced and community-led work (Table 2). Reported participants include research and GLAM professionals, learners, citizens and non-expert contributors and heritage coalitions; no unified digital-library user type spans the corpus. Ownership language remains strongest in ontology/semantic search and selected NeSy cases but is often implicit elsewhere.

Across the analyzed cases, participation is present but uneven in depth and timing. A limited number of initiatives document early co-design, while a larger share situates users in late-stage evaluation or in continuous yet narrowly scoped contribution models, especially in crowdsourcing-oriented practices. Methodological repertoires are active and diverse, but evaluation remains concentrated on usability and information-retrieval performance, with less systematic evidence on trust, social impact, inclusion and community empowerment. In parallel, explicit epistemic-justice safeguards are visible in selected cases, particularly where community governance or provenance/bias concerns are central but remain implicit or underdeveloped in much of the corpus.

These conclusions should be read in light of the study's limits. The reduced analyzable corpus (22 cases) does not indicate low relevance of the topic; rather, it reflects the high specialization of semantic and NeSy AI information systems and the practical difficulty of locating literature that reports participatory processes with sufficient methodological detail for comparative assessment. This challenge is reinforced by abstract theoretical conceptualizations, uneven reporting standards, hybrid system architectures that resist strict categorization, limited longitudinal/comparative evidence and a sample still skewed toward English-language Global North publications.

The study contributes an empirically grounded map of participative practices and a replicable analytical framework that links process timing, methodological tools, participation levels and epistemic justice. For digital library practice, the implications above specify how findings on discovery, participatory indexing, metadata and knowledge-graph governance and evaluation beyond retrieval performance can be applied within the limits of this corpus. The recommendations trace explicitly to that framework literature and to the documented practices gathered in this corpus, with priority on early and sustained participation, evaluation beyond usability and epistemic-justice safeguards in system design.

A reasonable next step is to consolidate field-oriented research agendas: domain-specific comparative studies, longitudinal tracking of participation effects and shared evaluation protocols that combine technical performance with indicators of governance quality, representational fairness and community authority. In this sense, the current findings are less

a final diagnosis than a structured baseline for a growing research area that remains methodologically promising and conceptually consequential.

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