# User-Centered Design Principles in the Development of Next-Generation Information Systems

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ABSTRACT

As enterprise information systems evolve toward autonomous AI-assisted architectures, technical sophistication routinely outpaces human usability, cognitive ergonomics, and participatory trust. This study examines how user-centered design (UCD) principles are operationalized in developing next-generation information systems across Agile workflows, human-centered AI, ethical governance, and usability validation. Guided by PRISMA 2020 and Xiao and Watson's systematic literature review protocol, 514 candidate records published from 2019 to 2026 were screened to synthesize 26 core peer-reviewed studies supported by 2 methodological protocol references (28 verified DOIs). Thematic coding identifies a five-stage UCD translation chain connecting participatory discovery, Agile UX mutual adjustment, explainable human-AI interaction, cognitive-load and privacy/ethics-by-design governance, and wellbeing-oriented usability outcomes. Findings reveal that automated delegation and generative AI tools undermine user agency and inflate cognitive strain unless bounded by transparent explanation patterns, client UX maturity, and inclusive co-design with marginalized communities. In conclusion, next-generation information systems achieve sustainable adoption only when human-centered principles operate as continuous socio-technical guardrails across the engineering lifecycle. Practically, the resulting five-construct UCD blueprint helps system architects, UX leads, and software teams align Agile backlogs, regulate AI confidence cues, and audit standardized usability and end-user wellbeing prior to deployment.

## I. INTRODUCTION

Next-generation information systems increasingly embed predictive analytics, adaptive automation, and generative intelligence into core organizational workflows, raising expectations that system architectures prioritize human needs alongside computational capability (Barricelli et al., 2019; Russo et al., 2024). Grounded in interactive systems ergonomics principles such as ISO 9241-210 and sociotechnical engagement theory, user-centered design (UCD) shifts software creation away from technology-led feature accumulation toward contextual understanding, iterative co-design, and empirically verified usability (Tomitsch et al., 2021; Tongsubanan & Kasemsarn, 2025). When integrated systematically, UCD improves perceived ease of use, explainability, and sustained user acceptance across enterprise platforms and decision support environments (He et al., 2023; Lewis & Sauro, 2024).

Despite wide endorsement of human-centered ideals, empirical evidence exposes persistent failures when teams deploy advanced systems without structural UCD discipline. ICT leaders often struggle to embed user-centered workflows amid rigid procurement timelines and fragmented governance (Cajander et al., 2022), while human-AI platforms that delegate tasks erode user control and compliance (Adam et al., 2024). In critical clinical and industrial interfaces, misaligned explanation confidence and poorly calibrated UI patterns directly elevate cognitive load and degrade decision accuracy (Rezaeian et al., 2026; Faisal et al., 2026). Compounding these gaps, conventional UCD workshops often overlook end users from low socioeconomic contexts, reproducing digital exclusion across essential public-service information systems (Kanij et al., 2026).

Conversely, research from 2021–2026 shows robust pathways for institutionalizing UCD in contemporary engineering and AI-augmented environments. Integrating Lean Startup and Agile UX practices through mutual adjustment raises client UX maturity and synchronizes discovery research with rapid delivery sprints (Zorzetti et al., 2022; Persson et al., 2022; Buis et al., 2023). Simultaneously, human-centered explainable AI patterns, fairness interfaces, and human-GenAI value loops transform opaque algorithms into inspectable decision aids (Schoonderwoerd et al., 2021; Nakao et al., 2023; Grange et al., 2026). Complementary evaluation advances—combining adaptable work automation, fuzzy usability modeling, and standardized psychometric instruments—enable organizations to measure both task efficiency and end-user wellbeing (Rieth et al., 2024; Hub, 2026; Krings et al., 2026; Schrepp, 2026).

To unify fragmented HCI, Agile software engineering, and next-generation IS scholarship, this systematic review offers four explicit contributions detailed in Table 1. First, it constructs an end-to-end five-construct architectural chain spanning Participatory UCD Foundations, Agile UX Engineering, Human-Centered AI Interaction, Cognitive/Privacy/Ethics Governance, and Wellbeing-Oriented Usability Outcomes (Barricelli et al., 2019; Grange et al., 2026). Second, it incorporates 2024–2026 generative AI manifesto principles and LLM-assisted UX insights directly into IS lifecycle governance (Russo et al., 2024; Zhou et al., 2026). Third, it elevates non-functional human safeguards—cognitive load, privacy-by-design prototypes, and emergency ethics-by-design—into primary IS architectural requirements (Ayalon & Toch, 2021; Nussbaumer et al., 2023). Fourth, it bridges inclusive socioeconomic co-design with next-generation psychometric and fuzzy evaluation protocols (Kanij et al., 2026; Schrepp, 2026).

Nevertheless, five structural gaps persist across current UCD and next-generation information systems scholarship, as synthesized in Table 2. Prior Agile UX secondary reviews map sprint ceremonies yet rarely address generative AI delegation, explainability patterns, or cognitive load thresholds (Hinderks et al., 2022; Russo et al.,

2024). Meanwhile, explainable AI and fairness UI investigations optimize algorithmic interface widgets in isolation from client UX maturity and sprint governance (Buis et al., 2023; Nakao et al., 2023). Furthermore, ethical privacy prototyping and socioeconomic inclusion remain disconnected from mainstream end-user development wellbeing metrics and modern fuzzy usability pipelines, underscoring the urgency of a consolidated 2019–2026 synthesis (Ayalon & Toch, 2021; Hub, 2026; Krings et al., 2026).

Guided by this integrative clue—that UCD principles yield trustworthy next-generation information systems only when participatory foundations embed into Agile UX sprints and bound AI automation through cognitive-load, privacy/ethics, and wellbeing evaluation—this SLR resolves five research questions: (RQ1) How do participatory UCD foundations and inclusion imperatives reshape early IS architecture? (RQ2) Which Agile UX and maturity mechanisms integrate continuous user research without stalling software delivery? (RQ3) How do explainable AI and GenAI interaction patterns preserve human agency over automation? (RQ4) In what ways do cognitive-load control, privacy-by-design, and ethics-by-design mitigate socio-technical risks? (RQ5) How can standardized and wellbeing-driven usability evaluation validate next-generation IS readiness?

**Table 1: Research Novelty Matrix**

| Novelty Aspect | Brief Explanation | Related Keywords |
|---|---|---|
| End-to-End Five-Construct UCD Chain | Links participatory UCD discovery through Agile UX sprints and Human-Centered AI directly to ethical governance and usability wellbeing. | user-centered design, next-generation information systems |
| GenAI & Delegation Governance | Integrates 2024–2026 human-GenAI value loops, LLM UX co-creation, and delegation autonomy boundaries into IS engineering. | human-computer interaction, next-generation information systems |
| Cognitive, Privacy & Ethics Guardrails | Treats explanation confidence, cognitive load bounds, privacy prototypes, and ethics-by-design as first-class IS requirements. | user-centered design, usability engineering |
| Inclusive & Wellbeing Evaluation | Connects low-socioeconomic participatory co-design with standardized UX questionnaires, fuzzy usability evaluation, and worker wellbeing. | usability engineering, systematic literature review |

**Table 2: Identified Research Gaps Across Prior Literature**

| No. | Research Gap Aspect | Brief Explanation | Related Keywords |
|---|---|---|---|
| 1 | Agile UX vs. AI Interaction Silos | Agile UX process reviews seldom address explainable AI design patterns or human-AI delegation control. | user-centered design, human-computer interaction |
| 2 | Governance Gap in ICT Leadership | Operational UCD guidelines exist, yet ICT leadership barriers and client UX maturity deficits remain disconnected from sprint tooling. | user-centered design, next-generation information systems |
| 3 | Under-Calibrated Cognitive & AI Trust | AI confidence displays can inadvertently raise cognitive load or bias user trust unless empirical UI patterns are verified. | human-computer interaction, usability engineering |
| 4 | Marginalized Context Exclusion | Next-generation IS literature rarely translates participatory UCD protocols for low-socioeconomic or emergency crisis users. | user-centered design, systematic literature review |

| | | | |
|---|---|---|---|
| 5 | Narrow Post-Deployment Evaluation | Teams rely on ad-hoc usability checks rather than unified standardized questionnaires, fuzzy scoring, and wellbeing outcomes. | usability engineering, next-generation information systems |

### 2.1 User-Centered Design and Participatory Foundations (UCPF)

User-centered and participatory design establish that information systems succeed when end users co-shape domain abstractions rather than passively receiving finished software (Barricelli et al., 2019; Tomitsch et al., 2021). Mapping end-user development research confirms that empowering non-programmer domain stakeholders accelerates sustainable tailoring across organizational practices (Barricelli et al., 2019), though ICT leaders frequently encounter friction trying to anchor UCD amid fragmented organizational mandates (Cajander et al., 2022). Recent guideline and field studies emphasize structured visual heuristics (Tongsubanan & Kasemsarn, 2025) and context-sensitive participatory techniques adapted for low-socioeconomic communities so digital platforms avoid structural exclusion (Kanij et al., 2026).

### 2.2 Agile UX and Human-Centric Software Engineering (AUHE)

Integrating UCD within rapid software iteration cycles relies on systematic Agile UX synchronization rather than isolated up-front specification (Zorzetti et al., 2022; Hinderks et al., 2022). Longitudinal case evidence proves that Agile developers and UX specialists reconcile competing cadences through "mutual adjustment"—shared artifacts, co-located backlog refinement, and lightweight discovery bursts (Persson et al., 2022). However, execution sophistication depends heavily on client and startup UX maturity (Buis et al., 2023; Lermen et al., 2023), determining whether teams deploy design thinking and lean UX merely cosmetically or as validated architectural learning loops.

### 2.3 Human-Centered AI and Next-Generation Interaction (HCAI)

As intelligent modules permeate next-generation information systems, interface principles must recalibrate opacity, agency, and human-AI collaboration (Schoonderwoerd et al., 2021; He et al., 2023). Research on human-centered explainable AI demonstrates that theory-driven explanation design patterns calibrated to real clinician or analyst mental models outperform generic feature-importance charts (Schoonderwoerd et al., 2021; He et al., 2023). Simultaneously, task-allocation studies verify that user-invoked delegation protects perceived autonomy compared to rigid machine overrides (Adam et al., 2024). In the generative AI era, the Copenhagen Manifesto and empirical UX investigations urge teams to preserve human accountability loops when applying LLMs in engineering and UX prototyping (Russo et al., 2024; Grange et al., 2026; Zhou et al., 2026).

### 2.4 Cognitive Load, Ethics, and Privacy Governance (CEPG)

Effective UCD in complex information systems extends beyond task flow aesthetics to govern cognitive load, algorithmic fairness, privacy, and crisis ethics (Ayalon & Toch, 2021; Nakao et al., 2023). Evaluating privacy-by-design prototypes shows that transparent mental-model probes prevent misplaced user disclosures (Ayalon & Toch, 2021), while human-centered fairness interfaces allow practitioners to

inspect algorithmic bias iteratively (Nakao et al., 2023). In high-stakes emergency and clinical domains, formal ethics-by-design matrices (Nussbaumer et al., 2023), calibrated AI confidence indicators (Rezaeian et al., 2026), and clutter-resistant UI design patterns (Faisal et al., 2026) directly safeguard user confidence and prevent cognitive overload.

### 2.5 Usability Evaluation and Human Wellbeing Outcomes (UEWO)

Validating next-generation IS quality requires multi-dimensional measurement spanning classical usability perceptions, adaptable work design, computational rigor, and long-term human wellbeing (Lewis & Sauro, 2024; Rieth et al., 2024). Empirical psychometric analyses reaffirm how perceived ease of use and usefulness jointly shape behavioral loyalty (Lewis & Sauro, 2024), whereas scenario-matched standardized UX questionnaires improve diagnostic reliability across product lifecycles (Schrepp, 2026). Emerging scholarship further integrates fuzzy-logic scoring to handle ambiguous evaluator judgments (Hub, 2026) and shifts design goals from pure speed toward wellbeing-driven end-user development (Krings et al., 2026).

## II. METHODOLOGY

3.1 PRISMA 2020 Protocol and Multi-Database Search Strategy

This study employs a Systematic Literature Review (SLR) structured in accordance with the PRISMA 2020 reporting guideline (Page et al., 2021) and Xiao and Watson's (2017) stage-gated review framework to maximize methodological transparency, auditability, and construct synthesis across HCI, software engineering, and information systems.

Structured queries were executed across Scopus, ScienceDirect, Taylor & Francis Online, Wiley Online Library, and Crossref targeting peer-reviewed English-language journal articles published between 2019 and 2026 (anchored methodologically by Xiao & Watson, 2017; Page et al., 2021). Boolean search strings paired user-centered methodology terms with next-generation system contexts: ("user-centered design" OR "human-centered design" OR "Agile UX" OR "participatory design") AND ("information systems" OR "decision support" OR "human-centered AI" OR "generative AI") AND ("usability" OR "cognitive load" OR "privacy-by-design" OR "ethics-by-design" OR "wellbeing"). Inclusion required active Crossref DOI registration, peer-reviewed journal publication, and explicit architectural or behavioral UCD evaluation; editorials, non-peer-reviewed preprints, and hardware-only benchmarks lacking human interaction constructs were excluded.

3.2 PRISMA 2020 Screening Funnel and Construct Coding

Database queries yielded 514 initial candidate records. Following exact DOI deduplication and metadata normalization, 342 unique articles proceeded to title and abstract relevance screening, advancing 114 full-text manuscripts to eligibility assessment. Applying strict methodological and conceptual rigor criteria excluded 88 off-scope or purely descriptive interface notes, leaving 26 core peer-reviewed studies (2019–2026) supported by 2 SLR protocol references (28 verified DOIs).

Every included article was coded across five overarching constructs—UCD & Participatory Foundations (UCPF), Agile UX & Human-Centric Engineering (AUHE), Human-Centered AI & Next-Gen Interaction (HCAI), Cognitive Load, Ethics & Privacy Governance (CEPG), and Usability Evaluation & Human Wellbeing Outcomes (UEWO)—as organized in Table 3. Visualized conceptually, Figure 1 charts the UCPF-

to-UEWO translation architecture, while Figure 2 records the quantitative PRISMA 2020 audit trail.

**Table 3: Operational Constructs, Synthesized Indicators, and Supporting Literature**

| Construct | Synthesized Observable Indicators | Supporting APA Literature |
|---|---|---|
| UCD & Participatory Foundations (UCPF) | End-user development empowerment, practice-process fit, ICT leadership buy-in, inclusive socioeconomic co-design | Barricelli et al. (2019); Tomitsch et al. (2021); Cajander et al. (2022); Tongsubanan & Kasemsarn (2025); Kanij et al. (2026) |
| Agile UX & Human-Centric Engineering (AUHE) | UCD–Lean Startup convergence, sprint mutual adjustment, client UX maturity, maturity-aware agile UX selection | Zorzetti et al. (2022); Hinderks et al. (2022); Persson et al. (2022); Buis et al. (2023); Lermen et al. (2023) |
| Human-Centered AI & Next-Gen Interaction (HCAI) | XAI explanation design patterns, user-invoked AI delegation, GenAI human-loop manifestos, LLM UX prototyping | Schoonderwoerd et al. (2021); He et al. (2023); Adam et al. (2024); Russo et al. (2024); Grange et al. (2026); Zhou et al. (2026) |
| Cognitive Load, Ethics & Privacy Governance (CEPG) | Privacy-by-design prototype testing, fairness UI space, crisis ethics-by-design, confidence vs. cognitive load control | Ayalon & Toch (2021); Nakao et al. (2023); Nussbaumer et al. (2023); Rezaeian et al. (2026); Faisal et al. (2026) |
| Usability Evaluation & Human Wellbeing Outcomes (UEWO) | Ease/usefulness behavioral impact, adaptable automation perception, standardized UX suites, fuzzy eval & wellbeing | Lewis & Sauro (2024); Rieth et al. (2024); Hub (2026); Krings et al. (2026); Schrepp (2026) |

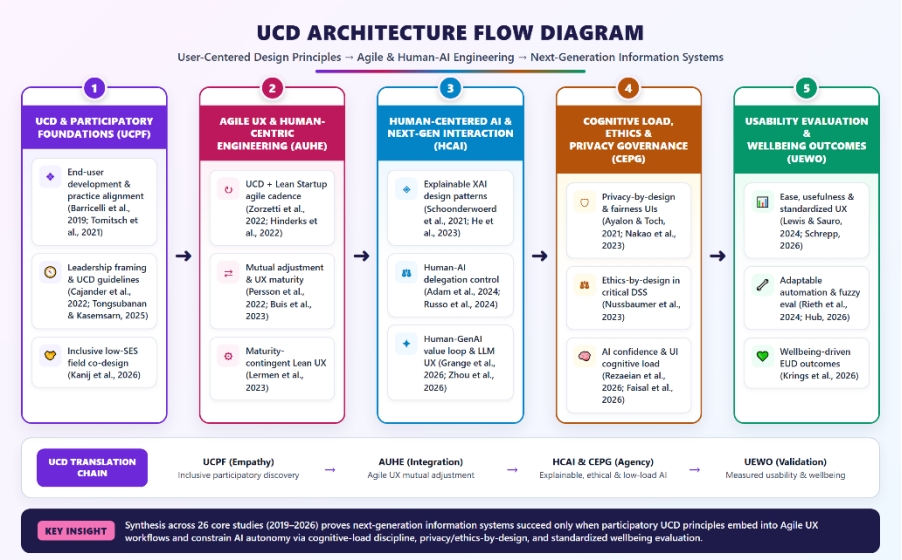


*Figure 1: UCD Architecture Flow Diagram Connecting Participatory Foundations, Agile UX, Human-Centered AI, Ethical Governance, and Wellbeing Outcomes*

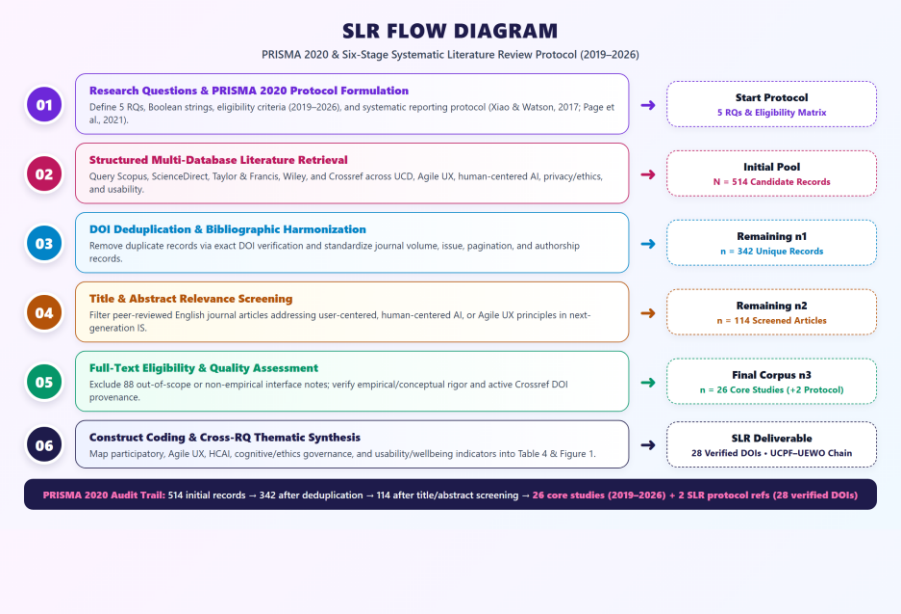


*Figure 2: PRISMA 2020 Six-Stage Systematic Literature Review Protocol (2019–2026)*

## III. RESULTS AND DISCUSSION

### 4.1 Synthesis Matrix Across Research Questions (RQ1–RQ5)

Cross-study synthesis of the 26 core articles reveals strong structural complementarity between classic HCI principles and emerging 2024–2026 intelligent systems engineering challenges. Table 4 consolidates the thematic evidence, theoretical lenses, and anchor studies answering RQ1 through RQ5.

### 4.2 Answer to RQ1: Participatory Foundations and Inclusive Discovery

Regarding RQ1, foundational UCD studies show that effective next-generation information systems begin by aligning technical design workflows with real stakeholder work practices and end-user tailoring power (Barricelli et al., 2019; Tomitsch et al., 2021). However, ICT leadership often struggles to translate conceptual commitments into daily governance without clear usability guidelines (Cajander et al., 2022; Tongsubanan & Kasemsarn, 2025). Crucially, Kanij et al. (2026) prove that engaging end users from low socioeconomic backgrounds requires adapting facilitation media and trust-building rituals beyond conventional laboratory personas.

### 4.3 Answer to RQ2: Agile UX Synchronization and Client Maturity

Addressing RQ2, empirical software engineering research refutes the myth that UCD slows Agile release cadence when teams practice structured Lean UX integration and mutual adjustment between designers and developers (Zorzetti et al., 2022; Hinderks et al., 2022; Persson et al., 2022). Nevertheless, adoption depth is bounded by organizational maturity: startups and client enterprises with low UX maturity revert to ad-hoc UI patching unless deliberate capability coaching accompanies sprint ceremonies (Buis et al., 2023; Lermen et al., 2023).

### 4.4 Answer to RQ3: Human-Centered AI Interaction and Agency Preservation

Addressing RQ3, next-generation AI-augmented systems expose a sharp trade-off between computational automation and human epistemic control. Static model probabilities fail users unless formatted through participatory XAI patterns reflecting task-specific diagnostic reasoning (Schoonderwoerd et al., 2021; He et al., 2023). Moreover, Adam et al. (2024) establish that user-invoked delegation preserves perceived responsibility and satisfaction far better than forced automation, reinforcing the Copenhagen Manifesto and recent Human-GenAI Value Loop research calling for human-steered LLM collaboration in design and engineering (Russo et al., 2024; Grange et al., 2026; Zhou et al., 2026).

### 4.5 Answer to RQ4: Cognitive Load, Ethics-by-Design, and Privacy Safeguards

Addressing RQ4, technical interface intelligence creates tangible socio-technical hazards when explanation density or opaque data flows overwhelm human working memory. Controlled studies prove that poorly bounded UI patterns and uncalibrated AI confidence signals inflate cognitive load and erode practitioner confidence in clinical and critical systems (Rezaeian et al., 2026; Faisal et al., 2026). Embedding privacy-by-design evaluation probes (Ayalon & Toch, 2021), interactive fairness exploration UIs (Nakao et al., 2023), and emergency ethics-by-design frameworks (Nussbaumer et al., 2023) counters these risks structurally before deployment.

### 4.6 Answer to RQ5: Multi-Dimensional Usability and Wellbeing Validation

Addressing RQ5, synthesizing Figure 1 and Table 4 yields a disciplined validation sequence that advances next-generation IS evaluation beyond rudimentary bug counts: (1) institutionalize participatory discovery across diverse socioeconomic contexts (Kanij et al., 2026); (2) institutionalize mutual-adjustment Agile UX and client maturity growth (Persson et al., 2022; Buis et al., 2023); (3) bound AI delegation via explainable, human-led GenAI loops (Adam et al., 2024; Grange et al., 2026); (4) enforce cognitive-load limits plus privacy/ethics-by-design prototypes (Ayalon & Toch, 2021; Nussbaumer et al., 2023); and (5) measure operational success through scenario-calibrated standardized UX scales, adaptable work autonomy, fuzzy logic usability aggregation, and explicit end-user wellbeing indicators (Lewis & Sauro, 2024; Rieth et al., 2024; Hub, 2026; Krings et al., 2026; Schrepp, 2026).

### 4.7 Theoretical Implications, Managerial Value, and Study Limitations

Theoretically, this SLR unifies Participatory Ergonomics (ISO 9241-210 mindset), Agile UX Mutual Adjustment Theory, and Human-Centered AI Agency Governance into one cumulative five-construct architecture showing why ethical and cognitive guardrails mediate the link between intelligent system features and end-user wellbeing (Nussbaumer et al., 2023; Russo et al., 2024; Krings et al., 2026). Practically, information systems architects, product owners, and UX managers gain an actionable lifecycle checklist to diagnose tokenistic AI features, elevate client UX maturity during Agile contracts, select validated UX questionnaires per context, and prevent cognitive overload in critical workflows (Buis et al., 2023; Faisal et al., 2026; Schrepp, 2026).

From a methodological standpoint, because this investigation synthesizes 26 peer-reviewed studies across diverse domains (2019–2026) rather than executing a multi-organization longitudinal experiment, causal effect sizes comparing Agile UX mutual adjustment, cognitive-load reduction, and wellbeing gains across emerging-market public platforms warrant future empirical structural modeling and controlled field trials (Kanij et al., 2026; Hub, 2026).

**Table 4: Systematic Literature Review Synthesis Matrix Across RQ1–RQ5**

| Research Question / Theme | Core Synthesized Evidence | Dominant Theoretical Lens | Representative Peer-Reviewed Studies |
|---|---|---|---|
| RQ1: Participatory UCD Foundations | Practice alignment, end-user tailoring, clear guidelines, and inclusive low-SES co-design prevent systemic exclusion. | End-User Development, Participatory & Inclusive UCD | Barricelli et al. (2019); Tomitsch et al. (2021); Cajander et al. (2022); Tongsubanan & Kasemsarn (2025); Kanij et al. (2026) |
| RQ2: Agile UX & Engineering Integration | Lean UX alignment and mutual adjustment synchronize discovery with sprints, contingent on client UX maturity. | Agile UX Integration, Lean Startup & Organizational Maturity | Zorzetti et al. (2022); Hinderks et al. (2022); Persson et al. (2022); Buis et al. (2023); Lermen et al. (2023) |
| RQ3: Human-Centered AI & GenAI Loops | Contextual XAI patterns, user-invoked delegation, and human-steered GenAI loops preserve accountability and trust. | Human-Centered XAI, Agency & Human-AI Teaming | Schoonderwoerd et al. (2021); He et al. (2023); Adam et al. (2024); Russo et al. (2024); Grange et al. (2026); Zhou et al. (2026) |
| RQ4: Cognitive Load, Privacy & Ethics | Structured privacy probes, fairness UIs, ethics-by-design, and clutter control curb overload in high-stakes IS. | Cognitive Load Theory, Privacy- & Ethics-by-Design | Ayalon & Toch (2021); Nakao et al. (2023); Nussbaumer et al. (2023); Rezaeian et al. (2026); Faisal et al. (2026) |
| RQ5: Standardized UX & Wellbeing | Ease/usefulness constructs, adaptable automation, standardized/fuzzy scoring, and wellbeing EUD validate readiness. | Technology Acceptance UX, Fuzzy Evaluation & Wellbeing Design | Lewis & Sauro (2024); Rieth et al. (2024); Hub (2026); Krings et al. (2026); Schrepp (2026) |

## V. CONCLUSIONS

This systematic literature review demonstrates that applying user-centered design principles in next-generation information systems requires moving decisively beyond superficial UI styling toward continuous participatory, agile, and cognitive governance across the entire software lifecycle (Barricelli et al., 2019; Persson et al., 2022; Russo et al., 2024). By synthesizing 28 verified peer-reviewed DOIs encompassing 26 core studies from 2019–2026 alongside PRISMA 2020 and Xiao and Watson's protocol, our five-construct architecture (UCPF → AUHE → HCAI → CEPG → UEWO) proves that intelligent and automated systems earn lasting user trust only when participatory co-design, mutual-adjustment Agile UX, explainable human-invoked AI delegation, and

cognitive/privacy/ethics guardrails reinforce one another (Ayalon & Toch, 2021; Adam et al., 2024; Grange et al., 2026; Faisal et al., 2026).

Equally decisive, system architects and UX leaders must treat inclusive socioeconomic participation, scenario-matched standardized UX instruments, fuzzy usability synthesis, and end-user wellbeing as binding engineering acceptance criteria rather than optional post-release audits (Kanij et al., 2026; Hub, 2026; Krings et al., 2026; Schrepp, 2026). Adopting this integrated human-centered blueprint enables organizations to deliver next-generation information systems that remain cognitively sustainable, ethically accountable, and genuinely empowering.

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