

USER EXPERIENCE RESEARCH MODEL AS A FUNDAMENTAL IN SUSTAINABLE DIGITAL PLATFORM DEVELOPMENT

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Abstract

The increasing complexity of digital platforms requires systematic User Experience Research to support sustainable digital platform development and evidence-based design decision-making. However, existing user experience methodologies often treat research activities as separate processes, resulting in fragmented user insights and inconsistent research practices. This study aims to develop and apply an Integrated User Experience Research Framework that provides a structured and iterative approach to User Experience Research. A mixed-methods research design was employed through a literature review, user needs analysis, framework development, and an application and preliminary empirical evaluation using a Smart City digital platform. The proposed framework integrates nine interconnected stages into a unified User Experience Research lifecycle, linking strategic planning, user investigation, stakeholder collaboration, evidence-based evaluation, and creative ideation. The evaluation results demonstrate that the framework was practically implementable and was associated with a redesigned interface that measurably improved interaction efficiency and reduced errors, while multidisciplinary collaboration and consistency benefits are reported as qualitative observations rather than statistically confirmed effects; the comparative effectiveness of the framework itself, and its long-term contribution to platform sustainability, remain directions for future research. This study contributes to User Experience Research literature by providing a structured framework intended to support more consistent User Experience Research; consistent with the scope of the case study reported, this contribution should be read as an initial step toward supporting sustainable digital platform development rather than a demonstrated, generalizable outcome.

Keywords: Integrated user experience research framework, Mixed methods, Smart city, Sustainable digital platform, User experience research.

1. Introduction

Digital platforms have transformed communication, commerce, healthcare, education, and public services through cloud-based, mobile, and AI-enabled technologies [1-3]. However, technological investment alone does not secure adoption, retention, or sustained engagement when development overlooks user needs. User experience (UX) extends beyond interface aesthetics and efficiency to perceptions, emotions, motivations, trust, and behaviour [4]. Positive experiences support acceptance, satisfaction, and loyalty [5-7]. Systematic UX Research helps multidisciplinary teams identify needs, validate assumptions, and prioritize evidence-based improvements throughout product development [8].

Qualitative methods, including interviews, observation, and focus groups, explore motivations and pain points [9], while questionnaires, usability testing, and A/B experiments provide quantitative performance and perception measures [10, 11]. Human-Centred Design promotes continuous user involvement [12, 13]; Design Thinking emphasizes empathy, ideation, and experimentation [14]; Lean UX supports rapid collaborative validation [15]; and Double Diamond organizes discovery, definition, development, and delivery [16]. These approaches support iterative design, but the literature examined provides limited guidance for connecting research planning, participant selection, stakeholder involvement, empirical investigation, and ideation into one traceable research lifecycle [17-19]. Because the review was narrative rather than exhaustive, this gap is bounded by the sources examined and does not establish that no comparable framework exists.

The proposed framework addresses the organization of established techniques rather than a shortage of techniques themselves. It makes their selection, ordering, and interdependence explicit. Whereas Lean UX emphasizes build-measure-learn cycles within agile delivery, this framework foregrounds upstream planning and evidence traceability through Business Outcome, Key Questions, Recruitment Criteria, Stakeholders, and Research Statement. These artifacts document what should be investigated, with whom, and why before research findings are translated into design alternatives.

Sustainability is used here in a bounded sense: the capacity of a platform's UX Research process to capture and act on evolving user needs, creating conditions conducive to longer-term usability, engagement, and organizational value [20, 21]. Continuous research can reduce development uncertainty and inform adaptation [22], but demonstrating long-term sustainability requires longitudinal evidence beyond this study. The proposed nine-stage framework therefore integrates planning, investigation, stakeholder collaboration, empathy development, and ideation as an enabling research process; it does not establish sustained platform performance.

Building on the gaps identified above, this study addresses the following research questions: (RQ1) How can established UX Research activities be systematically organized into a coherent, traceable framework that supports digital platform development? (RQ2) To what extent is such a framework practically implementable within a real digital platform case study? (RQ3) What evidence does the application of the framework provide regarding its contribution to UX outcomes and to conditions relevant to sustainable digital platform development?

The objective is to develop, apply, and evaluate a nine-stage Integrated UX Research Framework in one Smart City platform. Its contribution is a traceable research lifecycle linking planning, empirical investigation, and design support [23]; cross-domain replicability and long-term effects remain untested.

2. Methods

A mixed-methods design combined qualitative analysis of user needs, research practices, and stakeholder perspectives with quantitative evaluation of the interface produced through the framework-guided process. Four stages structured the research (Fig. 1): Literature Review and Needs Analysis, Framework Development, Framework Implementation and Validation, and Framework Evaluation and Refinement. Qualitative and quantitative findings were compared for convergence or divergence through methodological triangulation before informing framework development and interpretation.

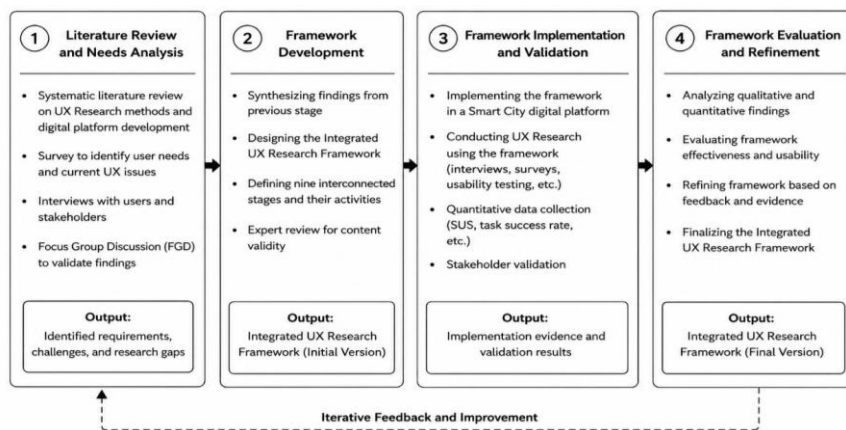


Fig. 1. The research comprises four sequential stages.

The four stages correspond, respectively, to identifying research practices and user needs (Section 2.1), synthesizing a framework (Section 2.2), applying it in a platform case study (Section 2.3), and evaluating and refining it using the evidence obtained (Section 2.4).

2.1. Literature review and needs analysis

The first stage combined a traditional narrative literature review with empirical needs analysis to establish requirements for the framework (RQ1). Following guidance on literature reviews [24], it examined UX Research, Human-Centred Design, Design Thinking, Lean UX, and related approaches for recurring activities, limitations, and integration opportunities. No preregistered strategy specified database list or search terms, or documented screening and inclusion/exclusion procedure was used; the findings must therefore be interpreted within these coverage limitations.

Needs analysis combined questionnaires ($n = 120$), interviews ($n = 15$), and two FGDs ($n = 16$) with Smart City users and stakeholders. These sources identified

expectations, usability problems, and organizational requirements; sampling and procedures appear in Section 2.5.

The synthesis identified recurring user problems, stakeholder requirements, and methodological gaps, providing theoretical and empirical inputs for framework development.

2.2. Framework development

Framework development integrated established UX activities [12-16] with empirical needs. The contribution is their selection, sequencing, and auditable interconnection rather than novelty in any individual technique.

The nine stages were derived through two thematic synthesis tracks. One coded the reviewed literature for recurring UX Research activities and the conditions in which they were effective or insufficient. The other independently applied the same coding procedure to questionnaire responses, interview transcripts, and FGD notes to identify practical requirements. Codes were cross-tabulated, retaining a candidate stage only when at least one literature-based code and one empirical code converged. Table 4 traces each retained stage to its findings, activity, and supporting literature.

The resulting sequence comprises Business Outcome, Key Questions, Interview Goals, Recruitment Criteria, Stakeholders, Research Statement, Timeline, Empathy Map, and Crazy 8's Ideation. Each stage has a defined objective and links to adjacent stages. Academics and practitioners with at least three years of UX/HCI experience reviewed the initial framework. Their feedback produced two revisions: Stakeholders was moved between Recruitment Criteria and Research Statement, and Research Statement became a fill-in-the-blank template to improve consistency. The framework was then applied in the Smart City case study.

Five experts used a 5-point scale (1 = very poor, 5 = excellent) to assess four criteria (Table 1), identify unclear or missing elements, and recommend revisions. Criterion means were calculated across experts. The overall mean of 4.4, reported in Section 3.2, includes their overall framework assessments alongside the four criterion ratings.

Table 1. Experts assessed the framework using four criteria.

Criterion	Review Question	Reported Mean (1–5 scale)
Clarity	Are the purpose, definition, expected output, and relationship of each framework stage clearly described and understandable?	4.4
Completeness	Does the framework include the essential activities required to plan, conduct, synthesize, and translate UX Research into design decisions?	4.2
Logical Consistency	Are the nine framework stages arranged in a coherent sequence, with clear and non-contradictory relationships between stages?	4.6
Practical Applicability	Can the framework and its associated outputs be realistically implemented by UX researchers and multidisciplinary digital-platform teams?	4.6

2.3. Framework implementation and evaluation

The framework was applied to a publicly used Smart City platform to assess implementability (RQ2). Its municipal service diversity, accessible user base, and existing usability concerns allowed all nine stages to be examined within the available timeframe; the case was not intended to represent digital platforms generally. Its four core functions service information/discovery, facility location/directions, public reporting/complaints, and service completion/confirmation correspond to the representative usability and A/B testing tasks.

Implementation progressed from objectives and research planning through recruitment, stakeholder identification, qualitative investigation, empathy mapping, and ideation. Questionnaires, interviews, FGDs, and usability observations captured both perceptions and behaviour to inform interface improvements.

Following usability testing, a seven-day between-subjects A/B test compared the existing interface (A) with the framework-informed redesign (B). Sixty participants were truly randomly assigned, independently of their characteristics, with 30 per variant. The pragmatic window enabled target recruitment while limiting cross-variant exposure; each participant used the platform once and saw only one variant. This reduced learning or novelty risks without eliminating possible novelty effects favouring B. All used comparable mobile devices under moderated conditions. The click metric was a task-relevant click ratio, not conventional advertising CTR: task-advancing clicks divided by all clicks from task initiation to completion or abandonment (0–1). A click meant a completed tap or mouse-click on an interactive element, including buttons, menus, links, cards, search results, form controls, or confirmation controls; scrolling, typing, and non-interactive contact were excluded. Moderators logged click sequence, target, and task relevance. No system-generated clickstream from a named analytics platform was retained. Because extra clicks can indicate exploration or confusion, efficiency was interpreted through convergence among this ratio, task time, errors, and completion rate (Section 3.2).

Qualitative and quantitative findings were triangulated to assess research planning, execution, and decision-making in practice. The evaluation examined implementability and whether the resulting interface improved selected outcomes; without an alternative-process control, it cannot isolate the framework's comparative causal effect. Findings informed the subsequent refinement stage.

2.4. Framework evaluation and refinement

The final stage evaluated the framework's logical consistency and practical application rather than only the platform interface. Interviews, observations, and FGDs identified strengths and implementation difficulties, while questionnaire and usability findings provided complementary evidence. The review examined whether stages formed a coherent workflow from planning to ideation.

Refinement addressed unclear relationships, redundant activities, and implementation challenges. The resulting framework is theoretically grounded and empirically informed, with preliminary applicability supported by one Smart City case rather than demonstrated generalizability. Table 2 summarizes the four research stages.

Table 2. Research stages link activities to expected outputs.

Research Stage	Main Activities	Expected Output
Literature Review and Needs Analysis	Review previous UX Research literature, identify research gaps, analyse user needs through questionnaires, interviews, and FGDs	Research gaps, UX requirements, and user needs
Framework Development	Synthesize theoretical findings and empirical evidence to construct the proposed framework	Preliminary Integrated UX Research Framework
Framework Implementation and Evaluation	Apply the framework in the Smart City platform using qualitative and quantitative UX Research methods	Framework application and evaluation findings
Framework Evaluation and Refinement	Evaluate implementation results, incorporate stakeholder feedback, and refine the framework	Final Integrated UX Research Framework

2.5. Participants and data collection procedures

This subsection reports the participants, sample sizes, and procedures used for each data collection method, as summarized in Table 3; corresponding findings and results are reported in Section 3. All participants were recruited using purposive sampling from prospective users, existing users, and relevant stakeholders of the Smart City digital platform, based on eligibility criteria requiring at least occasional prior exposure to municipal or public-service digital platforms. The participant samples for the questionnaire, in-depth interviews, Focus Group Discussions, usability testing, and A/B testing were independent (non-overlapping) groups; no individual participated in more than one data collection method. Data collection for the needs analysis and implementation stages was conducted between 6 and 30 May 2026.

The study involved anonymous, non-invasive UX research without medical or physical intervention, deception, or vulnerable populations. Data collection preceded a formal study-specific ethics protocol. A retrospective expedited review subsequently assessed a written summary of objectives, participants, procedures, consent, and data handling. The independent reviewer, Marsani Asfi, S.Si., M.Si., Dean of Universitas Catur Insan Cendekia, was neither an author nor a co-researcher. The determination dated 22 September 2026 found the protocol ethically acceptable, with no additional conditions beyond continued confidentiality and secure storage. During original collection, participants were informed of the study's purpose and voluntary nature and gave informal verbal consent. Responses were anonymized before analysis; no personally identifying information is reported.

The Google Form questionnaire was completed on 6–20 May 2026 by 120 respondents: 62 male and 58 female, aged 18–50 ($M = 34.8$). Self-reported digital literacy was High for 97 and Medium for 23; platform experience ranged from under one month (33 respondents) to over six months (31). Ten custom items (Appendix, Table A1) were informed by the UEQ dimensions Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty [25]. Ratings from 1 (strongly disagree) to 5 (strongly agree) were averaged into one UX index per respondent. This exploratory instrument is neither the validated UEQ nor a validated short form. Item-level data were not retained in a form permitting

reliability analysis such as Cronbach's alpha; no coefficient is reported. Formal content validation, piloting, and reliability testing remain necessary.

In-depth interviews were conducted with 15 participants (10 users, 3 stakeholders, and 2 practitioners; age range 20–50 years) using a semi-structured protocol. Each session lasted between 32 and 45 minutes (mean 39.1 minutes). Interview and FGD transcripts were thematically coded by two researchers working independently; codes were then compared, and disagreements were resolved through discussion to reach consensus on the final set of themes.

Two Focus Group Discussions (FGDs) were conducted with a total of 16 participants (8 per session; age range 20–47 years): the first session comprised prospective and existing users, and the second session comprised platform stakeholders and the internal platform team. Both sessions used the same semi-structured discussion guide and were coded using the same two-researcher procedure described above.

Usability testing was conducted with 20 participants under moderated, in-person conditions. Each participant completed the same set of six representative tasks (finding the main service, searching for public service information, locating a public facility, opening service details, using the reporting/complaint feature, and completing a process to confirmation), yielding 120 task observations in total.

A/B testing was conducted over a seven-day period with 60 participants randomly assigned to one of two interface variants (30 per variant): Variant A, the existing interface, and Variant B, the redesigned interface produced using the framework-guided UX Research process. Randomization, device conditions, and the operational definition of the task-relevant click ratio are described in Section 2.3.

In addition to the user- and stakeholder-facing methods above, five experts (two academics with a UX/HCI background and three practitioners, namely a UX researcher, a UI/UX designer, and a digital platform developer) participated in the expert review described in Section 2.2, conducted through discussion and a structured review instrument between 27 and 30 May 2026.

Table 3. Participants and procedures are summarized by method.

Method	Participants / Samples	Sampling / Grouping	Format	Period / Duration
Questionnaire	120	Purposive sampling	Online, Google Form	6–20 May 2026
In-depth Interview	15	Purposive sampling	Semi-structured, individual	May 2026 (32–45 min/session)
Focus Group Discussion	16	2 sessions × 8 participants	Group discussion	May 2026
Usability Testing	20	Purposive sampling	Moderated, in-person, 6 tasks	May 2026
A/B Testing	60	30 per variant (A vs. B), random assignment	Existing vs. redesigned interface	7 days
Expert Review	5	Expert/purposive selection (≥ 3 yrs experience)	Discussion + structured review	27–30 May 2026

3. Results and Discussion

The study produced a framework linking planning, user investigation, stakeholder collaboration, evaluation, and ideation. Results address framework derivation, empirical application, the final artifacts, theoretical positioning, and cross-method case synthesis.

Evidence is distinguished at three levels: practical implementation, outcomes of the resulting redesigned interface, and comparative framework effectiveness or long-term sustainability. The study directly addresses the first two; the third requires further research.

3.1. Development of the integrated UX research framework

The synthesis identified recurring requirements for objectives, questions, recruitment, stakeholders, protocols, scheduling, user understanding, and ideation. Although these activities were already established, the reviewed and empirical sources indicated insufficient integration into a traceable research lifecycle. Table 4 records the convergence supporting each stage.

Business Outcome, for example, combines literature on organizational alignment with evidence that Smart City stakeholders lacked shared objectives. Empathy Map combines human-centred design literature with observations that quantitative measures alone inadequately captured user pain points. Each stage was thus justified by both theoretical and empirical evidence. Expert feedback and implementation observations refined their sequence and connections, linking research objectives to stakeholder input, user insights, and design decisions.

Table 4. Convergent evidence supports the nine framework stages.

Empirical Finding (Needs Analysis)	Identified UX Research Activity	Framework Stage	Supporting Literature
Organizational objectives must be aligned with UX goals	Define business objectives	Business Outcome	[8, 17]
UX Research requires clear research questions	Formulate research questions	Key Questions	[9, 18]
User interviews require structured objectives	Define interview objectives	Interview Goals	[9]
Representative participants improve research validity	Establish participant selection criteria	Recruitment Criteria	[10, 18]
Collaboration among stakeholders is essential	Identify stakeholders	Stakeholders	[12, 13]
Research activities require formal documentation	Prepare research protocol	Research Statement	[19, 24]
UX Research requires systematic scheduling	Plan research timeline	Timeline	[19]
Understanding user perspectives improves design decisions	Analyse user experiences	Empathy Map	[12, 13]
User insights should be translated into design alternatives	Generate design ideas	Crazy 8's Ideation	[14, 16]

3.2. Framework application and empirical evaluation

The framework was implemented using interviews, observations, FGDs, questionnaires, usability testing, and A/B testing (RQ2, RQ3). Researchers reported more consistent planning, clearer links between objectives and evidence, and more systematic prioritization of usability issues.

These observations were not captured by a separate process-quality indicator and therefore do not demonstrate causal improvements in collaboration or decision-making. The evaluation distinguishes practical implementation and interface outcomes from the untested comparative effectiveness of the framework itself.

The usability evaluation of the redesigned interface, developed using the framework-guided UX Research process, was conducted with 20 participants across six representative tasks (120 task observations in total).

The evaluation yielded an overall task completion rate of 89.2% (SD not applicable at the aggregate level; see per-task detail below) and a mean completion time of 83.1 seconds per task (SD = 26.9 s), and a mean of 0.75 errors per task (SD = 0.75). Per-task completion rates ranged from 85.0% (Find main service; Find public facility/location) to 95.0% (Complete process until confirmation), indicating that navigation and facility-location tasks required further refinement despite the overall improvement in usability.

The seven-day A/B test compared A and B (30 participants each) using Section 2.3 procedures. B improved mean time (57.9 vs. 75.8 s), task-relevant click ratio (0.739 vs. 0.622), and errors (0.47 vs. 1.60/participant). Independent-samples tests, consistently reported as B–A, showed significant differences in time, $t(58) = -5.57$, $p < .001$, 95% CI [-24.18, -11.60] s, Cohen's $d = -1.44$; click ratio, $t(58) = 5.80$, $p < .001$, CI [0.077, 0.156], $d = 1.50$; and errors, $t(58) = -6.04$, $p < .001$, CI [-1.50, -0.77], $d = -1.56$ (Table 6). These large effects are consistent with research on interface micro-interactions [26].

Completion was 93.3% versus 86.7%, but the difference was not significant: $\chi^2(1) = 0.19$, $p = .667$, CI [-8.4, 21.8] percentage points, Cohen's $h = 0.23$. At $n = 30$ /group, power to detect this binary-outcome difference was limited; the result does not establish absence of an effect, and a larger sample is needed.

The questionnaire mean was 3.62/5 (SD = 0.50; $n = 120$) before redesign. Without a comparable post-redesign survey, it provides baseline context rather than independent corroboration of improvement. Nine interviewees described experience as moderate (5) or difficult (4); onboarding, accessibility/clarity, and service information informed Empathy Map and Crazy 8's priorities.

Experts rated Clarity 4.4, Completeness 4.2, Logical Consistency 4.6, and Practical Applicability 4.6, with overall mean 4.4. These findings support implementability and statistically supported interface efficiency/error improvements. Collaboration, consistency, and decision-making benefits remain qualitative observations without directly measured indicators. Neither comparative framework superiority nor long-term platform sustainability is established.

Table 5. Evaluation methods provide complementary evidence.

Evaluation Method	Purpose	Evidence Obtained	Contribution to Framework Evaluation
Literature Review	Establish theoretical foundation	UX Research theories and research gaps	Supported conceptual development
Questionnaires	Capture user perceptions	User expectations and requirements	Provided baseline user needs
In-depth Interviews	Explore user experiences	User pain points and qualitative insights	Refined framework stages
Focus Group Discussions	Obtain stakeholder perspectives	Stakeholder feedback and consensus	Improved framework structure
Usability Testing	Evaluate interface usability	Usability issues identified	Supported design improvements
A/B Testing	Compare alternative interface designs	Better-performing design alternative	Provided interface-level evidence

Note: All differences, confidence intervals, t-statistics, and effect sizes use B–A. Negative time/error values and positive click-ratio/completion values favour B.

Table 6. Usability and A/B testing quantify interface performance.

Metric	Usability Testing (<i>n</i> = 20)	A/B Test – A (<i>n</i> = 30)	A/B Test – B (<i>n</i> = 30)	95% CI of Difference (B–A)	Effect Size (B–A)	Significance
Task completion rate	89.2%	86.7%	93.3%	[–8.4, 21.8] pp	Cohen's <i>h</i> = 0.23	$\chi^2(1)=0.19$, $p=.667$ (ns)
Mean task time (s)	83.1 (SD 26.9)	75.8 (SD 13.1)	57.9 (SD 11.7)	[–24.18, –11.60]	$d = -1.44$	$t(58)=-5.57$, $p<.001$
Mean task-relevant click ratio	N/A	0.622 (SD .089)	0.739 (SD .065)	[0.077, 0.156]	$d = 1.50$	$t(58)=5.80$, $p<.001$
Mean errors/participant	0.75 (SD 0.75)	1.60 (SD 0.77)	0.47 (SD 0.68)	[–1.50, –0.77]	$d = -1.56$	$t(58)=-6.04$, $p<.001$

3.3. Integrated UX research framework

The final framework links strategic planning, user investigation, and ideation through nine connected artifacts (Fig. 2; Table 7). It is both a process guideline and an operational tool for translating research evidence into design alternatives. Its contribution lies in the selection, ordering, and traceable connection of established activities.

The sequence is iterative: evidence from Empathy Map or Crazy 8's Ideation can prompt revised business outcomes, research questions, or recruitment criteria. Teams should revisit earlier stages whenever new evidence changes the assumptions underlying them. Figure 3 presents the corresponding templates.

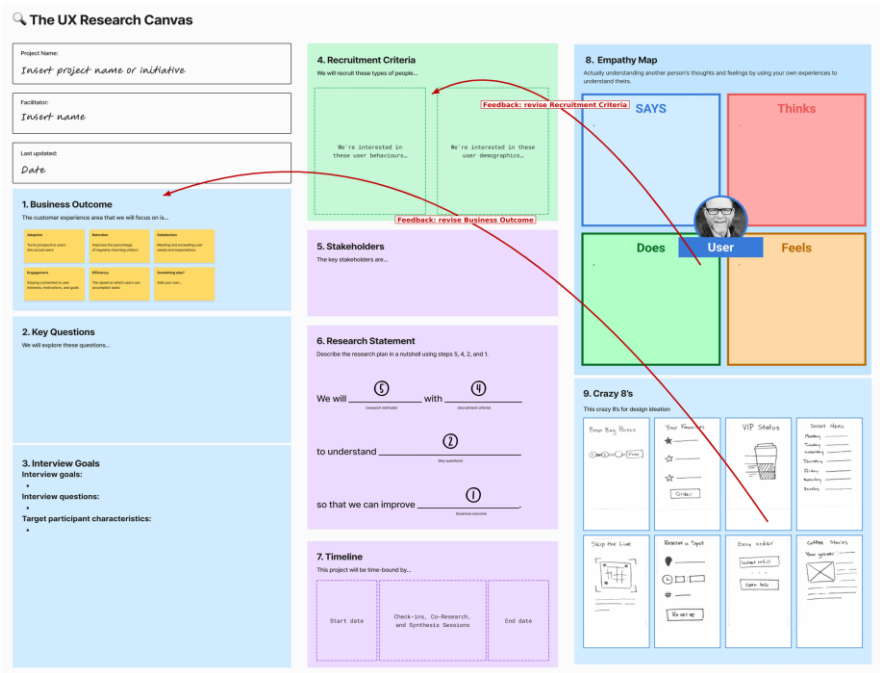


Fig. 2. Integrated UX Research Framework. Red arrows show how evidence from later stages can prompt revision of earlier planning stages.

Table 7. Each framework stage addresses a research objective.

Framework Stage	Primary Objective	Main Contribution
Business Outcome	Define strategic UX objectives	Align UX Research with organizational goals
Key Questions	Formulate research questions	Guide systematic evidence collection
Interview Goals	Define interview objectives	Improve qualitative data quality
Recruitment Criteria	Select representative participants	Increase research validity
Stakeholders	Identify key stakeholders	Strengthen multidisciplinary collaboration
Research Statement	Define research scope and protocol	Improve methodological consistency
Timeline	Organize research activities	Support effective project management
Empathy Map	Understand user perspectives	Enable human-centred decision-making
Crazy 8's Ideation	Generate design alternatives	Transform user insights into innovative solutions

1. Business Outcome
The customer experience area that we will focus on is...

Retention	Retention	Retention
Engagement	Engagement	Engagement
Satisfaction	Satisfaction	Satisfaction

(a) Business Outcome

2. Key Questions
We will explore these questions...

(b) Key Questions

3. Interview Goals
Interview goals:
•
Interview questions:
•
Target participant characteristics:
•

(c) Interview Goals

4. Recruitment Criteria
We will recruit these types of people...

We're interested in these user behaviours...

We're interested in these user demographics...

(d) Recruitment Criteria

5. Stakeholders
The key stakeholders are...

(e) Stakeholders

6. Research Statement
Describe the research plan in a nutshell using steps 5, 4, 2, and 1.

We will ^⑤ with ^④
(research method) (research context)

to understand ^②
(key question)

so that we can improve ^①
(research outcome)

(f) Research Statement

7. Timeline
This project will be time-bound by...

Start date

Check-ins, Co-Research, and Synthesis Sessions

End date

(g) Timeline

8. Empathy Map
Visualise understanding of what people think and feel to help you see experience in perspective.

SAYS

THINKS

DOES

FEELS

(h) Empathy Map

9. Crazy 8's Ideation
Use cheap 8's to ideate.

How many ideas?

8

1

2

3

4

5

6

7

8

(i) Crazy 8's Ideation

Fig. 3. Templates cover (a) Business Outcome, (b) Key Questions, (c) Interview Goals, (d) Recruitment Criteria, (e) Stakeholders, (f) Research Statement, (g) Timeline, (h) Empathy Map, and (i) Crazy 8's Ideation.

3.3.1. Business outcome

Business Outcome, as shown in Fig. 3(a), defines intended adoption, retention, satisfaction, engagement, or efficiency outcomes. In the case study, researchers associated explicit outcomes with less ambiguity in planning; this was a reflection rather than a directly measured effect.

3.3.2. Key questions

Key Questions, as shown in Fig. 3(b), translates intended outcomes into specific questions about behaviour, motivations, and frustrations, focusing field investigation and supporting relevant, consistent findings.

3.3.3. Interview goals

Interview Goals, as shown in Fig. 3(c), defines what conversations should reveal about motivations, recurring challenges, and behavioural assumptions, including questions and target participant characteristics, to support consistent interviews.

3.3.4. Recruitment criteria

Recruitment Criteria, as shown in Fig. 3(d), specifies demographic, psychographic, and behavioural attributes, such as age, profession, digital literacy, and usage frequency, to support appropriate participant selection and credible feedback.

3.3.5. Stakeholders

Stakeholders, as shown in Fig. 3(e), identifies developers, designers, managers, and external partners whose interests and constraints should inform research and multidisciplinary collaboration.

3.3.6. Research statement

Research Statement, as shown in Fig. 3(f), combines methods, participant criteria, and key questions into a shared declarative protocol before data collection, supporting consistent execution.

3.3.7. Timeline

Timeline, as shown in Fig. 3(g), sets start/end dates, allocates collection, analysis, and synthesis time, and schedules stakeholder check-ins to manage delays and scope.

3.3.8. Empathy map

Empathy Map, as shown in Fig. 3(h), synthesizes what users say, think, do, and feel. It integrates cognitive, behavioural, and emotional evidence to expose pain points and motivations that numerical measures alone may miss.

3.3.9. Crazy 8's ideation

Crazy 8's Ideation, as shown in Fig. 3(i), uses eight rapid sketches to translate validated insights into alternative solutions. Because this is a design activity rather than data collection, the framework structures UX research and its transition into ideation, not research wholly separate from design. This final stage connects empirical findings to actionable interface improvements.

3.4. Theoretical positioning and contribution

The framework differs from the reviewed approaches in research structure, planning emphasis, and stakeholder integration (Table 8). Human-Centred Design [12, 13] and Double Diamond [16] define broad design principles or phases, whereas the proposed framework specifies reusable research artifacts. Design Thinking [14] and Lean UX [15] emphasize ideation and iterative learning; here, Business Outcome, Key Questions, and Research Statement explicitly document the rationale for fieldwork. Stakeholders is a distinct stage before protocol finalization. Its association with improved collaboration in this case is based on qualitative observation, not a measured causal effect.

UEQ [25] is a standardized instrument covering Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty; it measures product experience rather than organizing a research process. Such an instrument could complement the framework's investigation and evaluation activities. ResearchOps

and evidence-based UX approaches emphasize organizational infrastructure, tools, and repositories [17], while the proposed artifacts guide an individual research/design cycle. These contributions are complementary.

The theoretical contribution is therefore an explicit artifact-based structure for research planning and execution that informs design, rather than a replacement for existing design frameworks or measurement instruments.

Table 8. The framework complements existing approaches and instruments.

Approach	Primary Focus	UX Research Structure	Key Distinction from Proposed Framework
Human-Centred Design [12, 13]	Continuous user involvement throughout system development	Implicit; user involvement is a guiding principle rather than a defined sequence of research artifacts	Proposed framework defines nine explicit, reusable UX Research artifacts rather than a general principle
Design Thinking [14]	Empathy, ideation, prototyping, and iterative experimentation	Research treated as part of the 'Empathize' phase, without detailed planning guidance	Proposed framework adds explicit strategic planning stages (Business Outcome, Key Questions) before fieldwork
Lean UX [15]	Rapid validated learning within agile development	Research embedded in build-measure-learn cycles; limited pre-research planning structure	Proposed framework separates and formalizes planning, investigation, and validation as distinct stages
Double Diamond [16]	Discovery, definition, development, and delivery of design solutions	Broad four-phase structure; does not prescribe specific UX Research artifacts	Proposed framework operationalizes research planning into nine concrete, sequential deliverables
UEQ [25]	Standardized quantitative measurement of UX outcomes	Not a process framework; a fixed post-hoc measurement instrument	Proposed framework structures the research process; UEQ could be embedded within it as a measurement tool
ResearchOps / evidence-based UX [17]	Organizational infrastructure and scaling of UX research	Organization-level operations, tooling, and repositories	Proposed framework operates at the level of a single research/design cycle rather than organizational infrastructure
Proposed Integrated UX Research Framework	Systematic planning, execution, and evaluation of UX Research itself	Explicit nine-stage lifecycle with defined artifacts, stakeholder integration, and iterative feedback	Complements the approaches above by structuring the UX Research process that precedes and informs design activity

3.5. Case study synthesis: Framework applicability in the smart city platform

This synthesis traces challenges across qualitative and quantitative methods to the framework stages that addressed them (Table 9). Given the sample sizes, it is descriptive cross-tabulation and should be interpreted as indicative rather than statistically confirmed evidence.

Find main service and Find public facility/location had the lowest completion rates (85.0% each), while Search public service information had the highest mean error count (1.10/attempt). Accessibility/clarity appeared in 3/15 interviews, with two of these participants rating their experience difficult, and in 5/8 user-FGD mentions. This convergence identified navigation and findability as recurring concerns, captured in Empathy Map and prioritized through Crazy 8's Ideation for the redesign evaluated in Table 6.

Stakeholder coordination led the stakeholder-FGD concerns (4/8 mentions); three interviewees contributed stakeholder perspectives. Their input informed Stakeholders and Research Statement and was consistent with qualitative collaboration observations. Onboarding was the most frequent interview theme (5/15). Although three of those five participants rated experience easy, its salience justified continued attention as a Business Outcome priority.

Together, these converging sources support practical applicability within the case, while the limits on causal and cross-domain interpretation remain.

Table 9. Case evidence links challenges to framework stages.

Identified Challenge (Qualitative Evidence)	Framework Stage Addressing It	Supporting Quantitative Evidence
Findability of main service and public facilities (accessibility/clarity: 3/15 interviews, 2 rated difficult; 5/8 FGD mentions)	Empathy Map; Crazy 8's Ideation	Lowest usability completion rates (85.0%) on related tasks; A/B task-time reduction 75.8s → 57.9s ($p < .001$)
Ambiguity in service information search (highest usability error count)	Key Questions; Empathy Map	Search public service information: 1.10 mean errors/attempt (highest of six tasks)
Need for cross-functional stakeholder coordination (4/8 stakeholder FGD mentions; 3/15 interviewees were stakeholders)	Stakeholders; Research Statement	Improved multidisciplinary collaboration reported during framework evaluation (Section 3.2)
Onboarding/first-time-use friction (most frequent interview theme, 5/15)	Business Outcome; Empathy Map	Overall questionnaire UX score 3.62/5 (SD = 0.50), pre-redesign baseline; prioritized for continued iteration
Reporting/complaint workflow usability (2/15 interview mentions)	Key Questions; Research Statement	Use reporting/complaint feature: 90.0% completion, 0.70 mean errors/attempt

4. Conclusions

This study developed and applied a nine-stage Integrated UX Research Framework connecting strategic planning, user investigation, stakeholder collaboration, and ideation. Its contribution is the traceable integration of established activities, supported by convergence-based derivation and explicit positioning relative to existing UX approaches. The Smart City case demonstrated practical implementation and a redesigned interface with statistically supported improvements in interaction efficiency and error reduction. It did not isolate the framework's comparative effectiveness or demonstrate long-term platform sustainability.

Practitioners may adopt Business Outcome, Key Questions, and Research Statement incrementally before implementing the full sequence. Standardizing Research Statement and Stakeholders across teams may support communication, although this association was qualitative and not directly measured.

Five limitations guide future research. First, a single platform requires replication across domains and by independent teams. Second, comparisons against alternative UX Research processes are needed to isolate framework effectiveness. Third, the seven-day A/B window cannot establish sustained engagement, retention, or organizational value; multi-month observation is required.

Fourth, the exploratory questionnaire requires content validation, piloting, and reliability assessment, or replacement with a validated instrument such as UEQ [25]. Fifth, A/B baseline demographics, literacy, and prior platform experience were not recorded, preventing assessment of group equivalence despite randomization. Moderator-recorded click data without retained system clickstreams also limit auditability. Future use of AI, predictive analytics, or continuous behavioural monitoring should be evaluated with comparable methodological rigor.

Declaration of Generative AI in Scientific Writing

During the preparation of this manuscript, the authors used generative artificial intelligence (AI) as a writing support tool to assist with language refinement, improvement of manuscript structure, and enhancement of academic writing clarity. The AI tool was not used to generate research data, conduct data analysis, develop the proposed framework independently, or draw scientific conclusions. All scientific content, methodological design, results, interpretations, and conclusions were developed, verified, and critically reviewed by the authors. The authors take full responsibility for the accuracy, originality, and integrity of the content presented in this manuscript.

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Nomenclature

Symbols	
d	Cohen’s standardized mean difference (dimensionless)
h	Cohen’s effect size for proportions (dimensionless)
M	Mean (units of the measured variable)
n	Sample size (count)
p	Probability under the null hypothesis (dimensionless)
t	Student’s t-statistic (dimensionless)
Greek symbols	
χ^2	Chi-square statistic (dimensionless)
Abbreviations	
AI	Artificial intelligence
CI	Confidence interval
FGD	Focus group discussion
SD	Standard deviation
UEQ	User Experience Questionnaire
UX	User experience

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Appendix A

Table A1 lists the ten questionnaire items used in Section 2.5, developed specifically for this study and informed by the six dimensions of the User Experience Questionnaire (UEQ) [25]. Respondents rated each item on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree); the UX index reported in Section 3.2 is the mean of all ten items per respondent. This is a custom, UEQ-informed instrument and not the validated UEQ itself; it has not undergone formal content validation, piloting, or reliability testing, and should be treated as exploratory.

Table A-1. Ten items measure exploratory perceptions of the platform.

Code	UEQ-Informed Dimension	Item
I1	Attractiveness	Overall, I am satisfied with my experience of using the Smart City platform.
I2	Attractiveness	The Smart City platform is pleasant to use.
I3	Perspiciuity	It was easy for me to learn how to use the Smart City platform.
I4	Perspiciuity	The information and menu labels on the platform are clear and understandable.
I5	Efficiency	I can find the public services or information I need quickly.
I6	Efficiency	I can complete my intended tasks with minimal unnecessary steps.
I7	Dependability	The platform behaves predictably when I select menus or commands.
I8	Dependability	I feel in control while navigating and completing tasks on the platform.
I9	Stimulation	Using the Smart City platform motivates me to access municipal digital services.
I10	Novelty	The Smart City platform presents municipal services in an innovative way.