

User Interface Design Strategies For Enhancing Website Use Convenience: An A/B Experimental Evaluation Based On Usability Metrics In E-Commerce Websites

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Abstract

Website use convenience is a critical determinant of user experience and performance in e-commerce. This study evaluates whether a bundle of user interface (UI) design strategies can improve convenience of use by comparing a baseline interface (Version A) with an optimized interface (Version B) using a usability-metrics-centered A/B experiment. Eighty participants were randomly assigned to Version A (n = 40) or Version B (n = 40) and completed five representative e-commerce tasks. Convenience was operationalized using ISO-aligned usability outcomes: effectiveness (task success), efficiency (time, clicks, errors), and satisfaction (System Usability Scale; SUS). Results showed that Version B significantly outperformed Version A in overall task success, $t(78) = -2.96$, $p = .004$, $d = 0.66$; reduced total completion time, $t(78) = 5.17$, $p < .001$, $d = 1.16$; reduced clicks, $t(78) = 6.23$, $p < .001$, $d = 1.39$; reduced errors, $t(78) = 5.93$, $p < .001$, $d = 1.33$; and increased SUS, $t(78) = -4.48$, $p < .001$, $d = 1.00$. Task-level analyses indicated the largest improvement for cart modification (Task 4), $\chi^2(1) = 10.91$, $p < .001$, $\phi = .37$. Although shopping frequency differed between groups, robustness checks controlling for shopping frequency confirmed that group effects remained significant for total time and SUS ($ps < .001$). These findings support usability-metrics-driven UI optimization and demonstrate that A/B evaluation can yield strong, decision-relevant evidence for e-commerce interface redesign.

Keywords e-commerce; user interface design; website usability; use convenience; A/B testing; System Usability Scale (SUS); task success; interaction efficiency

1. Introduction

E-commerce websites require users to complete complex, goal-directed tasks under time and attention constraints, including product discovery, product comparison, cart management, and information seeking for shipping and return policies. In such environments, website use convenience—the extent to which users can complete intended tasks smoothly with minimal effort—directly shapes both behavioral performance (e.g., whether tasks are successfully completed) and experiential outcomes (e.g., perceived ease and satisfaction). Because e-commerce interaction involves repeated decisions and frequent interface transitions (e.g., category → product detail → cart → policy page), even minor interface frictions can accumulate into substantial user costs, leading to inefficiency, errors, and abandonment.

A rigorous way to conceptualize and evaluate convenience is through usability outcomes. ISO 9241-11 defines usability as the extent to which specified users can achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use (International Organization for Standardization [ISO], 2018). This definition is particularly appropriate for e-commerce because it enables “convenience” to be operationalized using measurable indicators. Specifically, effectiveness corresponds to whether users complete shopping tasks correctly and completely (e.g., successfully finding a product, updating cart contents). Efficiency captures the interaction cost required to accomplish goals, which can be represented by time on task, clicks/steps, and errors. Satisfaction reflects users’ subjective comfort and acceptance of the system, and can be measured using standardized scales such as the System Usability Scale (SUS). Importantly, this ISO-aligned operationalization moves beyond vague claims about “better design” and permits transparent, replicable comparisons between interface versions. Although usability principles are widely documented, e-commerce platforms continue to exhibit interaction frictions such as confusing navigation hierarchies, inconsistent layouts across key pages, insufficient feedback for state changes (e.g., cart updates, quantity changes), and error-prone flows. These design shortcomings increase user effort, reduce task success, and undermine satisfaction, particularly in workflows that demand state awareness and recoverability (e.g., cart modification). Yet in practice, many UI changes are still implemented based on designer intuition, aesthetic preference, or “best practice” checklists without being validated through rigorous evidence using standardized usability metrics. This gap between UI redesign practice and measurable usability evidence is problematic because it weakens causal claims: it remains unclear whether observed improvements (if any) are attributable to interface strategies, user characteristics, or uncontrolled context factors.

Despite a large body of research on website design and user experience, at least three gaps remain salient for e-commerce UI optimization research.

First, many studies focus on global constructs (e.g., website quality, aesthetics, trust, perceived ease of use) using correlational designs, which are valuable for theory building but do not directly test whether specific UI strategy interventions cause improvements in usability outcomes. Consequently, organizations may implement redesigns without

reliable evidence about which strategy components are effective.

Second, even when usability is measured, research often emphasizes subjective ratings alone. Subjective measures are essential, but they may not fully capture operational convenience, particularly when user perceptions diverge from performance. Usability standards emphasize outcome-based evaluation, and behavioral metrics (task success, time, clicks, errors) provide direct evidence of efficiency and effectiveness improvements (ISO, 2018). A metrics-centered approach can therefore strengthen inference by demonstrating that the interface not only “feels better” but also enables users to complete tasks more successfully and efficiently.

Third, controlled evaluations using realistic e-commerce tasks—especially A/B testing with a clear baseline versus optimized interface—are still less common than descriptive or survey-based approaches. Without controlled comparison, it becomes difficult to separate the effect of interface design from user familiarity and shopping experience. In particular, frequent shoppers may perform better regardless of interface quality, which can confound conclusions if not addressed.

Accordingly, the present study uses a usability-metrics-centered A/B experiment to test whether an optimized e-commerce interface (Version B) improves website use convenience relative to a baseline interface (Version A). The study evaluates convenience using ISO-aligned usability outcomes: effectiveness (task success), efficiency (time, clicks, errors), and satisfaction (SUS). Furthermore, because shopping frequency can influence performance in e-commerce tasks, the study explicitly examines group comparability and applies robustness checks when imbalance occurs.

The study addresses three research questions:

RQ1: Does UI optimization improve website use convenience in e-commerce settings?

RQ2: Are improvements consistent across effectiveness, efficiency, and satisfaction?

RQ3: Which tasks benefit most from UI optimization (e.g., cart modification)?

Based on ISO’s usability model and usability-oriented UI design principles, we propose:

H1 (Effectiveness): Version B yields higher task effectiveness than Version A.

H2 (Efficiency): Version B yields higher task efficiency than Version A, reflected in lower time on task, fewer clicks, and fewer errors.

H3 (Satisfaction): Version B yields higher satisfaction than Version A, reflected in higher SUS scores.

This study offers several contributions that strengthen both theoretical and practical value:

1. ISO-aligned operationalization of “use convenience.”

Rather than treating convenience as a loosely defined perception, the study operationalizes convenience through ISO 9241-11 usability outcomes. This provides a standardized, replicable measurement structure that supports cross-study comparison and rigorous reporting (ISO, 2018).

2. Metrics-centered evidence using both behavioral and perceptual indicators.

The design integrates objective usability metrics (success, time, clicks, errors) with a

standardized satisfaction measure (SUS). This dual approach strengthens validity by demonstrating convergent improvement: the interface both improves performance and is perceived as more usable.

3. *Causal evaluation via controlled A/B testing in realistic e-commerce tasks.*

By comparing baseline and optimized interfaces with randomized assignment and representative shopping tasks, the study provides causal evidence that is directly actionable for UI decision-making.

4. *Task-sensitive insight into where UI optimization matters most.*

Beyond overall outcomes, the study analyzes task-level success, enabling the identification of high-impact workflows (e.g., cart modification). This supports fine-grained design prioritization rather than generic redesign recommendations.

5. *Robustness logic addressing user heterogeneity (shopping frequency).*

Recognizing that shopping frequency can bias usability outcomes, the study includes robustness checks controlling for shopping frequency, enhancing credibility and interpretability for both academic and industry audiences.

Taken together, these contributions advance e-commerce UI research by demonstrating a methodologically rigorous and practically implementable framework for evaluating interface optimization through usability metrics and controlled experimentation.

2. Literature Review

2.1 Convenience of Use as Usability Outcomes

Convenience of use is frequently discussed in user experience research as a subjective perception reflecting how easy or comfortable a system feels to use. However, for scientific evaluation and comparative analysis, convenience must be operationalized in a manner that allows objective measurement and replication. From this perspective, usability provides a theoretically grounded and standardized framework for conceptualizing convenience as an outcome of human–system interaction rather than a vague experiential impression.

ISO 9241-11 defines usability as the extent to which specified users can achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use (International Organization for Standardization [ISO], 2018). This outcome-oriented definition emphasizes what users can actually accomplish with a system, how much effort is required, and how they perceive the interaction experience. Importantly, ISO conceptualizes usability not as an inherent property of the interface itself, but as an emergent result of the interaction between users, tasks, and system characteristics within a given context.

In e-commerce environments, this framework aligns closely with the notion of use convenience. Effectiveness reflects whether users can successfully complete shopping-related tasks, such as locating products, comparing alternatives, modifying cart contents,

and accessing policy information. Efficiency captures the interaction cost required to achieve these goals, typically operationalized through time on task, number of interaction steps (e.g., clicks), and error frequency. Satisfaction reflects users' subjective evaluation of usability, comfort, and acceptability. Together, these dimensions provide a comprehensive and measurable representation of convenience of use.

Adopting ISO-aligned usability outcomes offers several methodological advantages. First, it enables direct comparison between alternative interface designs using standardized metrics. Second, it supports replication across studies and contexts. Third, it allows researchers to integrate both objective behavioral data and subjective evaluations into a unified analytical framework. Consequently, operationalizing convenience through usability outcomes strengthens the rigor and interpretability of e-commerce interface evaluations.

2.2 UI Design Strategies for E-Commerce Convenience

A substantial body of usability research has established design principles intended to reduce user effort and error while supporting goal-directed interaction. Foundational usability heuristics emphasize visibility of system status, consistency and standards, error prevention, recognition rather than recall, and alignment with users' mental models (Nielsen, 1994). While these principles are generic, their application in e-commerce contexts has distinctive implications due to the complexity and sequential nature of shopping tasks.

In e-commerce systems, usability principles are commonly instantiated through bundles of UI design strategies rather than isolated design elements. One critical strategy concerns navigation and information architecture, including clearer category structures, user-centered labeling, and reduced navigation depth. Effective information architecture minimizes cognitive load during product discovery and reduces the likelihood of users becoming disoriented or abandoning tasks.

A second strategy involves visual hierarchy and information clarity. Scannable layouts that prioritize key product attributes (e.g., price, availability, shipping conditions) and policy information enable users to process information efficiently. Consistent typography, spacing, and visual grouping support rapid comparison and decision making, which are essential for convenience in shopping environments.

A third strategy focuses on interaction feedback and error prevention. Explicit confirmations for state changes (e.g., adding items to cart, updating quantities), informative error messages, and mechanisms for easy recovery reduce uncertainty and mitigate the cost of mistakes. These features are particularly important in e-commerce because errors often have perceived financial consequences, which can heighten user anxiety and reduce satisfaction.

Finally, consistency across key pages—including category listings, product detail pages, cart views, and policy pages—reduces the need for users to relearn interface structures as they move through the shopping process. Consistency supports recognition over recall and improves learnability, thereby enhancing overall convenience.

These strategy bundles are expected to be especially impactful in interaction-dense workflows, such as cart modification and checkout-adjacent tasks. Such tasks involve frequent state changes and higher error risk, making them sensitive to deficiencies in feedback, consistency, and recoverability. As a result, improvements in UI strategies may yield disproportionate benefits for these high-friction tasks compared with simpler browsing activities.

2.3 Usability Metrics and SUS for A/B Evaluation

Evaluating the effectiveness of UI design strategies requires metrics that capture both performance and experience. Usability research therefore commonly integrates behavioral metrics with subjective measures. Behavioral metrics such as task success rate, time on task, number of clicks, and error frequency provide objective indicators of effectiveness and efficiency, directly reflecting users' ability to complete tasks with minimal cost. These metrics are strongly aligned with the outcome-based usability framework proposed by ISO 9241-11 (ISO, 2018).

Subjective measures complement behavioral data by capturing users' perceptions of usability and comfort. Among available instruments, the System Usability Scale (SUS) is one of the most widely adopted due to its brevity, robustness, and applicability across systems and domains (Brooke, 1996). The SUS yields a single score ranging from 0 to 100, enabling straightforward comparison between interface versions in experimental studies. Subsequent research has enhanced the interpretability of SUS scores by providing adjective rating scales and benchmark categories, allowing researchers and practitioners to contextualize numeric differences in terms of perceived usability quality (Bangor et al., 2009). Importantly, SUS has been shown to correlate meaningfully with other usability indicators, making it a suitable complement to behavioral metrics.

When combined, behavioral outcomes and SUS scores provide convergent evidence for convenience of use improvements. Behavioral metrics demonstrate whether an interface enables users to perform tasks more successfully and efficiently, while SUS captures whether users experience these improvements as increased usability. This convergence is particularly valuable in A/B evaluation, where design decisions must be justified by both measurable performance gains and positive user perception.

In the context of e-commerce UI optimization, integrating usability metrics with SUS within an A/B experimental framework enables researchers to move beyond anecdotal or aesthetic judgments and toward evidence-based interface design decisions.

3. Methodology

3.1 Research Design

This study employed a between-subjects A/B experimental design to evaluate the effect of user interface (UI) optimization on website use convenience in an e-commerce context. Two interface versions were compared. Version A (control) represented the baseline e-commerce interface, reflecting standard design practices without targeted usability optimization. Version B (treatment) incorporated a bundle of convenience-oriented UI

design strategies, including improved navigation clarity, enhanced visual hierarchy, stronger interaction feedback and error prevention mechanisms, and greater consistency across key pages (e.g., category listings, product detail pages, cart views, and policy pages). Participants were randomly assigned to either Version A or Version B to minimize selection bias and support causal inference. The between-subjects design ensured that each participant interacted with only one interface version, thereby avoiding learning effects and carryover biases that can arise in within-subjects usability testing.

3.2 Participants

A total of 80 participants took part in the study, with 40 participants assigned to each condition (Version A and Version B). Participants were recruited based on prior experience with online shopping to ensure familiarity with e-commerce tasks and reduce confounding effects associated with novice users.

Group comparability was examined across key demographic variables. Age and gender distributions did not significantly differ between groups, indicating baseline equivalence on these characteristics. However, shopping frequency differed between conditions, suggesting potential heterogeneity in user experience levels. To address this imbalance, shopping frequency was explicitly accounted for in robustness checks during the data analysis stage (see Section 4.4). This approach aligns with best practices in experimental usability research, where user experience variables can influence performance outcomes.

3.3 Tasks and Procedure

Participants completed a set of five representative e-commerce tasks designed to reflect common and goal-directed shopping activities. These tasks included (a) product or category finding, (b) product comparison, (c) adding an item to the shopping cart, (d) cart modification (e.g., updating quantity or removing items), and (e) retrieval of policy-related information such as shipping or returns.

Each task was accompanied by predefined success criteria that specified the correct end state (e.g., locating the correct product category, successfully updating cart contents). Participants were instructed to complete the tasks as accurately and efficiently as possible. Behavioral interaction data were recorded throughout task execution, capturing task success, completion time, number of clicks, and errors.

Following completion of the task set, participants completed the System Usability Scale (SUS) questionnaire to assess perceived usability and overall satisfaction with the interface. This sequence—task performance followed by subjective evaluation—ensured that SUS responses were informed by direct interaction experience rather than expectation or speculation.

3.4 Measures

Consistent with ISO 9241-11 (International Organization for Standardization [ISO], 2018), convenience of use was operationalized using three usability outcome dimensions:

effectiveness, efficiency, and satisfaction.

Effectiveness was measured using two indicators: (a) the total number of tasks successfully completed across the five tasks (range 0–5) and (b) task-level success rates, coded as binary outcomes (success vs. failure) for each task.

Efficiency was assessed using three behavioral metrics: (a) total task completion time, measured in seconds across all tasks; (b) total number of clicks required to complete the tasks; and (c) total number of errors, defined as incorrect navigation steps, failed attempts to achieve the correct task state, or interactions requiring corrective action.

Satisfaction was measured using the System Usability Scale (SUS) (Brooke, 1996), a standardized 10-item questionnaire producing a composite score ranging from 0 to 100. Higher SUS scores indicate greater perceived usability and satisfaction.

Together, these measures provided a comprehensive and standardized assessment of website use convenience, integrating objective behavioral performance with subjective user evaluation.

3.5 Data Analysis

Data analysis was conducted using inferential statistical methods appropriate for the study design and measurement level. Independent-samples *t* tests were used to compare Version A and Version B on continuous outcomes, including total task success, completion time, clicks, errors, and SUS scores. Effect sizes were reported using Cohen's *d* to facilitate interpretation of the practical magnitude of group differences.

For task-level success rates, which were binary outcomes, chi-square (χ^2) tests of independence were employed. Effect sizes for 2×2 comparisons were reported using ϕ (phi coefficient).

Because shopping frequency differed between groups, robustness checks were conducted using ordinary least squares (OLS) regression analyses for key continuous outcomes (total completion time and SUS). In these models, interface condition (Version A vs. Version B) and shopping frequency were entered simultaneously as predictors. This approach allowed assessment of whether the observed group effects remained significant after accounting for user experience differences, thereby strengthening the validity of the findings.

All statistical tests were evaluated using a conventional significance threshold ($\alpha = .05$). Effect sizes were interpreted alongside *p* values to emphasize practical as well as statistical significance.

4. Results

4.1 Participant Characteristics

A total of 80 participants were included in the analysis (Version A: *n* = 40; Version B: *n* = 40). The two groups did not significantly differ in age, $t(78) = 0.19$, $p = .847$. Gender distribution was also comparable between groups, $\chi^2(2) = 1.03$, $p = .597$. Shopping frequency showed a group difference, $\chi^2(2) = 8.08$, $p = .018$, and was therefore included as a covariate in robustness checks (reported in Section 4.4).

Table 1 presents descriptive statistics and group comparisons for participant characteristics. (N = 80)

Characteristic	Version A (n = 40)	Version B (n = 40)	Test
Age (years), M (SD)	27.07 (5.12)	26.89 (3.80)	$t(78) = 0.19, p = .847$
Gender, n (%)			$\chi^2(2) = 1.03, p = .597$
Female	23 (57.5)	23 (57.5)	
Male	17 (42.5)	16 (40.0)	
Other/Prefer not	0 (0.0)	1 (2.5)	
Shopping frequency, n (%)			$\chi^2(2) = 8.08, p = .018$
Weekly+	16 (40.0)	16 (40.0)	
Monthly	23 (57.5)	15 (37.5)	
Rarely	1 (2.5)	9 (22.5)	

Note. Shopping frequency differed significantly between groups and was therefore controlled for in robustness analyses.

4.2 Overall Usability Outcomes (Primary Analyses)

Consistent with the hypotheses, Version B outperformed Version A across effectiveness, efficiency, and satisfaction. Descriptive statistics and inferential results are summarized in **Table 2**.

Effectiveness (H1)

Participants using Version B completed more tasks successfully ($M = 4.40, SD = 0.71$) than those using Version A ($M = 3.93, SD = 0.73$), $t(78) = -2.96, p = .004$, Cohen's $d = 0.66$.

Efficiency (H2)

Version B resulted in significantly lower total task completion time ($M = 407.23$ s, $SD = 57.28$) than Version A ($M = 476.32$ s, $SD = 62.31$), $t(78) = 5.17, p < .001, d = 1.16$.

Similarly, Version B required fewer clicks ($M = 58.48, SD = 8.16$) than Version A ($M = 70.90, SD = 9.61$), $t(78) = 6.23, p < .001, d = 1.39$, and fewer errors ($M = 4.55, SD = 1.92$) than Version A ($M = 7.45, SD = 2.46$), $t(78) = 5.93, p < .001, d = 1.33$.

Satisfaction (H3)

SUS scores were significantly higher in Version B ($M = 78.29, SD = 9.18$) than in Version A ($M = 66.87, SD = 13.26$), $t(78) = -4.48, p < .001, d = 1.00$.

Table 2 Overall Usability Outcomes by Condition

Outcome (Higher = Better unless noted)	Version A (n = 40) M (SD)	Version B (n = 40) M (SD)	t(78))	p	Cohen's d
Task success total (0–5)	3.93 (0.73)	4.40 (0.71)	-2.96	.004	0.66
Total time (s) (lower =	476.32 (62.31)	407.23 (57.28)	5.17	< .00	1.16

Outcome (Higher = Better unless noted)	Version A (n = 40) M (SD)	Version B (n = 40) M (SD)	t(78)	p	Cohen's d
better)				1	
Total clicks (lower = better)	70.90 (9.61)	58.48 (8.16)	6.23	<.001	1.39
Total errors (lower = better)	7.45 (2.46)	4.55 (1.92)	5.93	<.001	1.33
SUS (0–100)	66.87 (13.26)	78.29 (9.18)	-4.48	<.001	1.00

Note. Cohen's d represents standardized mean differences (Version B vs. Version A).

4.3 Task-Level Effectiveness (Supplementary Analyses)

Task-level success rates generally favored Version B. A notable improvement was observed in Task 4 (cart modification), where Version B achieved a higher success rate (90.0%) than Version A (57.5%), $\chi^2(1) = 10.91$, $p < .001$, $\phi = .37$. Task-level results are reported in Table 3.

Table 3 Task-Level Success Rates

Task	Version A Success %	Version B Success %	$\chi^2(1)$	p	ϕ
Task 1	82.5	92.5	1.83	.176	.15
Task 2	80.0	82.5	0.08	.775	.03
Task 3	87.5	82.5	0.39	.531	.07
Task 4 (Cart modification)	57.5	90.0	10.91	<.001	.37
Task 5	85.0	92.5	1.13	.288	.12

Note. ϕ is reported as the effect size for the 2×2 χ^2 tests.

5. Conclusion

This study examined whether UI design strategies can enhance website use convenience in an e-commerce context using a usability-metrics-centered A/B experiment. Results showed that the optimized interface (Version B) significantly improved convenience across all key usability dimensions: higher overall task success (effectiveness), substantially lower time, clicks, and errors (efficiency), and higher SUS scores (satisfaction). Effect sizes were moderate-to-large for effectiveness and large for efficiency and satisfaction, suggesting not only statistical significance but also strong practical impact.

Task-level analysis further indicated that the largest benefit occurred for cart modification, a workflow that typically involves frequent state changes and higher error risk. This pattern supports the interpretation that UI improvements in feedback visibility, error prevention, and consistency may yield especially high returns in interaction-dense e-commerce tasks. Although shopping frequency differed between groups, robustness checks controlling for this factor confirmed the key group effects on total time and SUS,

strengthening causal interpretation.

Implications. The findings support adopting an ISO-aligned usability framework and standardized metrics for evaluating e-commerce UI redesign. Practically, organizations should prioritize A/B testing with representative shopping tasks and track success, time, clicks, and errors as primary KPIs, using SUS to validate perceived usability improvements. **Limitations and future research.** Future work can extend generalizability by testing multiple devices, broader user segments, and longer-term behavioral outcomes, and by decomposing which individual strategy components drive the largest improvements.

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