

## Integrated Behavioral Perceptual Evaluation for Comparative E-Commerce Web Usability: Evidence from Shopee and Tokopedia

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### Abstract

The growth of e-commerce has intensified competition among digital platforms, making usability a crucial factor in user engagement and convenience. However, many usability studies rely on single-method evaluation approaches, rarely conduct cross-platform comparisons, and seldom examine the relationship between perceived usability and behavioral interaction efficiency. This study compared the web usability of Shopee and Tokopedia by combining subjective usability assessment with eye-tracking analysis. Thirty-nine participants completed search, filter, and cart tasks on both platforms while gaze data were recorded and then completed the USE Questionnaire. The data were analyzed using non-parametric tests and AOI-based eye-tracking metrics. The results showed that both platforms achieved comparable perceived usability and received a “Good” classification. However, eye-tracking findings revealed task-dependent differences in visual attention, particularly during search activities. These findings demonstrate that perceived usability equivalence does not necessarily indicate behavioral interaction efficiency. This study contributes methodologically by proposing an integrated evaluation framework that combines biometric and psychometric measures, and theoretically by providing empirical evidence of the divergence between subjective perceptions and objective behavioral efficiency, with implications for improving visual hierarchy and navigation in e-commerce interfaces.

**Keywords:** e-commerce usability; eye-tracking; integrated usability evaluation; perceived usability; visual attention analysis

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### INTRODUCTION

The expansion of internet connectivity has accelerated digital commerce, transforming how consumers search, evaluate, and purchase products. In emerging economies such as Indonesia, the growth of digital infrastructure has reshaped competitive dynamics (Nurcahyo & Putra, 2021; Sandu et al., 2025), with Shopee and Tokopedia dominating web traffic. Although mobile transactions prevail, web-based platforms remain essential for complex decision-making and detailed product comparison (Mateja, 2023).

Digital platforms operate within a competitive ecosystem where user experience becomes a key differentiator influencing user retention and platform choice. In two-sided markets, platforms compete not only through price and product variety but also through interaction quality, making usability a strategic factor for competitive advantage (Panico &



Cennamo, 2022; Suuronen et al., 2024). In this context, usability should not be treated as an absolute attribute of a single system, but as a relative construct that emerges through comparison across competing platforms. Modern e-commerce interfaces often present dense information and promotional content, increasing complexity and potential information overload (Lv & Liu, 2022; Qiu et al., 2025). Therefore, effective visual hierarchy and intuitive interface structures are critical to guide user attention and support efficient interaction (Gleichauf et al., 2025; Ma, 2025). From a cognitive perspective, this phenomenon can be primarily explained through Cognitive Load Theory, which posits that increased interface complexity elevates users' cognitive processing demands and influences interaction efficiency (Sweller, 1988; Xie et al., 2025). In parallel, studies on visual attention and load theory suggest that interface design directly shapes how users allocate attention, which can be objectively captured through eye-tracking metrics (Wang et al., 2014). Importantly, cognitive load is not always consciously perceived by users (Sweller, 1988), meaning that subjective evaluations may not fully reflect actual interaction efficiency.

Usability plays a critical role in determining the quality of user interaction with digital platforms. According to ISO 9241-11, usability refers to the extent to which a system enables users to achieve goals effectively, efficiently, and with satisfaction (Ahmad et al., 2021; Standardization, 2018). Higher usability improves engagement, satisfaction, and continued usage, influencing conversion outcomes (Guo et al., 2023).

The use of multiple platforms necessitates cross-platform usability evaluation, as user interaction varies across systems (Harrison et al., 2013). UX benchmarking enables systematic comparison of usability across platforms to identify relative strengths and weaknesses (Abuaddous et al., 2022). Usability assessment itself can be conducted through both subjective and objective approaches. Subjective methods use standardized questionnaires such as USE (Usefulness, Ease of Use, Ease of Learning, and Satisfaction) to capture perceived usability (Shanklin et al., 2022). Objective methods such as eye-tracking capture visual attention and interaction behavior (Chavan et al., 2025; Novák et al., 2024). While subjective instruments reflect perceived usability, eye-tracking captures behavioral interaction patterns, indicating that these approaches measure complementary dimensions of usability (Falkowska et al., 2025). However, treating these approaches as merely complementary overlooks a deeper conceptual issue regarding whether usability reflects perception, performance, or both.

Previous studies have applied these approaches in digital platforms. Prior studies show that combining questionnaires and eye-tracking reveals usability issues not captured by subjective measures alone (Albaghli et al., 2025; Lim et al., 2025; Sidhawara, 2022; Szekely et al., 2023). However, these findings remain conceptually fragmented. Some report high perceived usability despite inefficient behavior, while others analyze gaze without linking it to perception. This inconsistency reveals a deeper theoretical tension: usability is often implicitly treated as a perceptual construct, assuming that user satisfaction reflects interaction efficiency. However, empirical evidence increasingly contradicts this assumption, showing that users may report high usability despite inefficient visual behavior. This raises an unresolved conceptual question of whether usability should be understood as a subjective perception, an objective performance construct, or a multidimensional construct that integrates both.

This paradox may be theoretically elucidated by recognizing that users do not always consciously register increases in processing demands, even when their visual attention patterns reveal inefficient information search behaviors. Consequently, prevailing usability frameworks exhibit conceptual limitations, as they fail to sufficiently account for the discrepancy between perceived ease of use and actual attentional efficiency within complex digital environments. Moreover, much of the existing literature tends to assess usability within isolated systems rather than through cross-platform comparisons, thereby constraining the interpretation of usability as a relative and competitive construct in contemporary digital ecosystems.

The persistence of this issue highlights a fundamental limitation in usability research, particularly the absence of integrated and comparative frameworks capable of simultaneously examining subjective perceptions and objective behavioral efficiency across competing platforms. More critically, it underscores a conceptual insufficiency in explicating the relationship between perceptual evaluations and the underlying cognitive as well as behavioral processes that occur during user interaction. In the absence of such integrative approaches, it remains uncertain whether platforms exhibiting comparable levels of perceived usability genuinely deliver equivalent interaction efficiency, or whether latent behavioral discrepancies persist that may ultimately shape user performance and decision-making.

This study proposes an integrated behavioral perceptual evaluation framework that systematically combines psychometric assessment with eye tracking metrics within a cross-platform comparative design. The contribution of this study is twofold. At the conceptual level, it advances the understanding that perceived usability and behavioral efficiency constitute distinct, non-equivalent dimensions of user experience. At the methodological level, it introduces a unified analytical approach that establishes a direct linkage between subjective evaluations and objective attentional data, thereby enabling a more comprehensive explanation of usability differences across competing platforms. Through its application to Shopee and Tokopedia, the study offers empirical evidence demonstrating how interface design shapes both perceived user experience and actual interaction performance within a competitive digital context.

## **METHOD**

This study employed a quantitative comparative within-subject design to evaluate and compare the web usability of Shopee and Tokopedia. In this design, the same participants interacted with both platforms under identical task conditions. The within-subject approach was chosen to reduce variability between participants and improve comparison accuracy. The study integrated objective behavioral measurement using eye-tracking and subjective usability assessment using questionnaires to capture both visual attention patterns and user perceptions.

Participants were recruited using purposive sampling. Eligible participants were between 18 and 45 years old, representing the primary demographic of active e-commerce users with sufficient digital literacy for website navigation. Participants were active online marketplace users with prior experience on both Shopee and Tokopedia to ensure familiarity. Participants were screened prior to the experiment to confirm this familiarity. Individuals with color vision deficiency were excluded to ensure reliable visual attention measurement. A total of 39 participants were included in the analysis. This sample size is considered adequate for eye-tracking usability research to obtain stable gaze pattern representations (Dicya & Tranggono, 2024; Pernice & Nielsen, 2009). All sessions were conducted using laptops to maintain interface consistency.

Eye-tracking data were recorded using GazeRecorder software to capture gaze coordinates during task execution. Subjective usability perception was measured using a 22-item USE Questionnaire (USE-Lite) derived from the original USE instrument. The USE questionnaire was selected because it provides broader usability coverage than single-index instruments such as SUS or experience-focused tools such as UEQ. The USE-Lite version has been psychometrically validated in previous research to maintain reliability while reducing respondent burden (Shanklin et al., 2022). All items were rated on a 7-point Likert scale.

Participants completed three usability tasks representing common e-commerce interactions. Tasks included searching for a product, filtering by location, and adding a raincoat priced Rp100,000–Rp150,000 to the cart without logging in. Before the experiment began, participants completed a short practice session. To ensure procedural consistency, all participants completed the tasks on Shopee first, followed by Tokopedia. This fixed sequence

may introduce order bias and learning effects due to repeated task exposure across platforms. As no counterbalancing was applied, the findings should be interpreted with caution. However, the tasks were designed to be simple and representative of common e-commerce interactions, which may have reduced the extent of cognitive transfer between platforms.

Areas of Interest (AOIs) were defined based on task-critical interface elements, namely the search bar, filter options, and cart button, as these components directly supported task completion. Eye-tracking heatmaps were processed using a Python pipeline with OpenCV to extract gaze density within each AOI and compute three visual attention metrics: Relevant Ratio, Distraction Intensity, and Coverage Percentage. USE Questionnaire scores were converted into percentage values relative to the maximum possible score to facilitate comparison across participants. Statistical analysis included validity, reliability, and normality testing, followed by comparative analysis using the Wilcoxon Signed-Rank Test for non-normal data. All procedures followed ethical research standards, and participants provided informed consent prior to participation.

## RESULTS AND DISCUSSION

### Results

Data collection was conducted over one month from October 20 to November 26, 2025. A total of 45 participants were initially recruited. During data quality screening, six datasets were excluded due to unsuccessful eye-tracking calibration. A dataset was considered invalid when the calibration process resulted in unstable gaze detection or low tracking accuracy, leading to insufficient gaze samples and incomplete heatmap generation required for reliable visual attention analysis. Consequently, 39 valid datasets were retained for further analysis.

Prior to hypothesis testing, construct validity and reliability analyses were conducted. Construct validity was assessed at the item level using Pearson correlation analysis, where all 22 USE Questionnaire items met the validity criterion ( $r\text{-count} > r\text{-table} = 0.316$ ). These results indicate that each item adequately represents the intended usability construct, ensuring the suitability of the instrument for further analysis. The detailed validity results are presented in Table 1.

**Table 1.** Construct validity results

Platform	Lowest r-count	Highest r-count	Mean r-count	r-table	Category
Shopee	0.544	0.911	0.776	0.316	Valid
Tokopedia	0.610	0.867	0.746	0.316	Valid

As shown in Table 1, all questionnaire items exceeded the minimum validity threshold. The lowest correlation value was 0.544, which is substantially higher than the required r-table value (0.316). In addition, the mean correlations for Shopee (0.776) and Tokopedia (0.746) indicate strong relationships between the items and the measured constructs, confirming the instrument's validity for measuring perceived usability. Complementing these validity results, reliability testing also showed high internal consistency for both platforms, with Cronbach's Alpha values detailed in Table 2.

**Table 2.** Reliability results

Platform	Cronbach's Alpha	Criteria	Status
Shopee	0.9670	>0.60	Reliable
Tokopedia	0.9615	>0.60	Reliable

Both platforms demonstrated excellent reliability, with values substantially exceeding the recommended threshold of 0.60. These results indicate that the questionnaire items

consistently measure perceived usability across the evaluated platforms. Subjective usability percentages were calculated from the USE questionnaire scores. The results across four USE dimensions are presented in Table 3.

**Table 3.** Usability percentage scores by dimension

Dimension	Shopee (%)	Standard Deviation	Tokopedia (%)	Standard Deviation
Usefulness	75.6	15.6	74.6	13.6
Ease of Use	78.9	16.3	78.6	14.2
Ease of Learning	86.4	14.5	82.5	12.5
Satisfaction	77.4	17.4	76.5	14.4
Overall	78.6	15.0	77.4	12.4

Based on the usability classification framework and the percentage scores presented in Table 3, both platforms achieved an overall “Good” usability rating. Shopee demonstrated slightly higher usability scores across most dimensions than Tokopedia. As also shown in Table 3, Ease of Learning obtained the highest scores on both platforms, indicating that participants were able to quickly understand how to operate the interface during the experimental tasks. This may reflect users’ familiarity with common e-commerce interaction patterns such as product search, filtering options, and cart navigation. The standard deviation values in Table 3 indicate moderate variability in user perceptions across usability dimensions, suggesting that participants generally provided consistent usability evaluations for both platforms.

Before inferential testing, data normality was assessed using the Shapiro–Wilk test ( $N = 39$ ). The majority of variables did not meet the normality assumption ( $p < 0.05$ ), with only one variable demonstrating normal distribution ( $p = 0.086$ ). Therefore, the Wilcoxon Signed-Rank Test was applied for paired comparisons. The Wilcoxon results are presented in Table 4. The mean values in Table 4 are presented as raw dimension scores because the Wilcoxon Signed-Rank Test was conducted on the original participant-level Likert-scale data rather than on percentage-transformed values. Reporting raw scores preserves consistency with the inferential non-parametric analysis, whereas the percentage values in Table 3 are presented for descriptive comparison across usability dimensions. Thus, the difference in scale reflects the distinct analytical purposes of the two tables.

**Table 4.** Wilcoxon signed-rank test results

Dimension	Platform	Mean	Standard Deviation	Z	p-value	Effect size (r)
Usefulness	Shopee	37.05	7.63	-1.119	0.263	0.18
	Tokopedia	36.56	6.68			
Ease of Use	Shopee	38.69	7.99	-0.748	0.455	0.12
	Tokopedia	38.51	6.96			
Ease of Learning	Shopee	18.15	3.05	-2.115	0.034	0.34
	Tokopedia	17.33	2.62			
Satisfaction	Shopee	27.10	6.07	-1.277	0.202	0.20
	Tokopedia	26.79	5.05			
Overall	Shopee	121.00	23.04	-1.424	0.154	0.23
	Tokopedia	119.21	19.15			

Statistical analysis indicated no significant difference in overall usability between Shopee and Tokopedia ( $p = 0.154$ ). Similarly, Usefulness, Ease of Use, and Satisfaction did not show significant differences. Although Ease of Learning showed  $p = 0.034$  with a medium

effect size ( $r = 0.34$ ), this value did not remain statistically significant after applying the Bonferroni-adjusted significance threshold ( $\alpha = 0.017$ ). Based on common interpretation guidelines (small  $\approx 0.10$ , medium  $\approx 0.30$ , large  $\geq 0.50$ ), the observed effect sizes indicate small to moderate practical differences, suggesting comparable perceived usability performance between the two platforms.

Eye-tracking data were further analyzed to examine behavioral attention patterns during task execution. Three Areas of Interest (AOIs) were predefined based on key functional task elements, namely Search, Filter, and Cart, to align with the standardized task scenarios. These AOIs represent interface components directly involved in the experimental task scenarios and were used to distinguish attention directed toward task goals from non-task-related exploration during user interaction. The same AOI structure was applied to both platforms to ensure a consistent comparison of visual attention patterns between Shopee and Tokopedia. Figures 1 and 2 illustrate the predefined AOI configurations for both platforms.

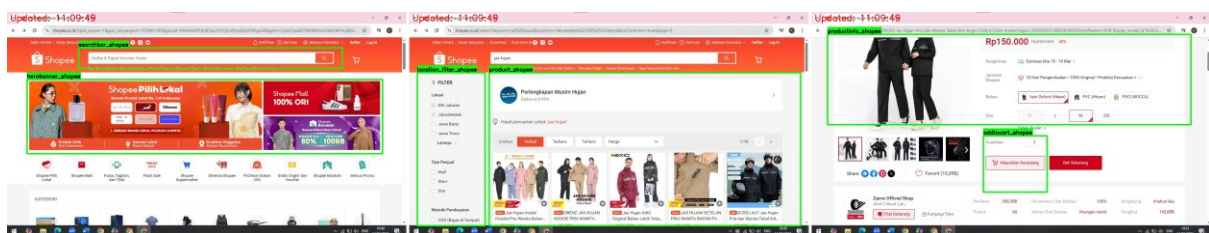


Figure 1. Predefined AOIs on the Shopee interface used in the experimental tasks

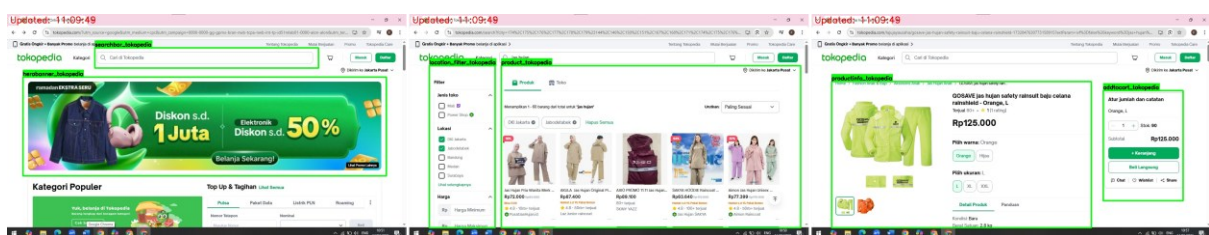


Figure 2. Predefined AOIs on Tokopedia interface used in the experimental tasks

Eye-tracking results were quantified using three behavioral indicators: Relevant Ratio, Distraction Intensity, and Coverage. Relevant Ratio reflects the proportion of visual attention directed toward task-relevant elements, while Distraction Intensity indicates attention allocated to non-relevant areas. For readability and cross-platform comparison, Distraction Intensity values were rescaled by dividing the raw values by 100,000. Coverage represents the proportion of the interface area visually explored during task completion and was converted into a percentage of the total screen area ( $1366 \times 768$  pixels) to facilitate interpretation and comparison across platforms. Table 5 presents the mean and standard deviation of these metrics across task scenarios.

Higher Relevant Ratio values indicate more efficient goal-directed attention toward task-critical interface elements, whereas higher Distraction Intensity reflects greater allocation of attention to non-relevant areas, suggesting reduced attentional efficiency. Coverage represents the extent of visual exploration required to locate relevant interface components. During the Search task, Tokopedia demonstrated a higher Relevant Ratio, indicating more concentrated attention on task-critical elements. In contrast, Shopee exhibited higher Distraction Intensity and Coverage values, suggesting broader visual exploration of the interface. From a visual search perspective, these differences suggest that interface elements with clearer visual hierarchy can facilitate faster target identification, whereas more visually dense layouts may require broader exploratory scanning. This pattern indicates that Tokopedia provides more efficient visual guidance during search tasks, while Shopee encourages broader exploratory

behavior. For the Filter and Cart tasks, the smaller differences between platforms indicate that both interfaces provide sufficient visual cues to support task completion, reducing the need for extensive visual search. It should be noted that the eye-tracking metrics presented are descriptive and were not subjected to inferential statistical testing due to the exploratory nature of the eye-tracking metrics and variability in gaze data. Therefore, the observed differences represent behavioral patterns rather than statistically significant differences.

**Table 5.** Eye-tracking metric comparison

Platform	Task	Relevant Ratio		Distraction Intensity		Coverage (%)	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Shopee	Search	0.089	0.101	1.416	0.921	8.39%	4.57
	Filter	0.389	0.365	0.227	0.317	3.49%	2.41
	Cart	0.291	0.259	0.229	0.327	4.62%	3.09
Tokopedia	Search	0.198	0.201	0.279	0.302	3.75%	2.44
	Filter	0.337	0.293	0.339	0.352	4.93%	3.91
	Cart	0.309	0.296	0.332	0.278	5.27%	3.15

## Discussion

The findings indicate that Shopee and Tokopedia provide comparable perceived usability performance, with no significant differences in overall subjective usability scores. However, eye-tracking analysis revealed task-dependent differences in visual attention, particularly during search tasks, indicating that subjective usability does not fully capture interaction efficiency. This divergence suggests that subjective ratings may not reflect underlying cognitive effort during task execution.

Within the framework of Cognitive Load Theory, variations in interface design impose differential cognitive demands that directly influence user attention and interaction efficiency. Interfaces characterized by a well-defined visual hierarchy tend to minimize cognitive burden and facilitate more rapid target detection (Glechauf et al., 2025). Empirical observations indicate that Tokopedia elicits more concentrated attentional patterns during search tasks, reflecting lower cognitive load and more efficient allocation of focus toward task-relevant elements. Conversely, the broader visual exploration observed on Shopee suggests elevated cognitive load and increased attentional demands, aligning with the dynamics of information overload (Qiu et al., 2025).

These findings highlight usability as a multidimensional construct combining perceptual and behavioral dimensions (Falkowska et al., 2025). Eye-tracking metrics reflect attentional efficiency, where higher Relevant Ratio indicates efficient focus and higher Distraction Intensity indicates increased cognitive load. In contrast, questionnaires capture perceived satisfaction and ease. Behavioral efficiency does not necessarily translate into higher perceived usability. User evaluations may instead be influenced by familiarity and trust cues (Guo et al., 2023), which can overshadow perceived effort.

These findings align with prior studies showing that combining eye-tracking and questionnaires reveals complementary insights into usability (Albaghli et al., 2025; Dicya & Tranggono, 2024). This study extends prior work by explaining the discrepancy through differences in cognitive load reflected in attention patterns. Perceived usability is also influenced by visual design and trust-related cues (Guo et al., 2023), explaining why Shopee maintained high satisfaction despite broader visual exploration. From a Cognitive Load

perspective, users may rely on heuristic judgments rather than accurately assessing mental effort. Thus, perceived usability may mask underlying cognitive processing differences.

In the Ease of Learning dimension, no significant differences were found despite slight descriptive variations. This may be explained by user familiarity with common e-commerce patterns. Users may not consciously perceive reduced cognitive effort when tasks are successfully completed. This study positions usability as a multidimensional construct integrating perception and cognitive behavioral performance. Questionnaires capture perception, while eye-tracking captures behavioral efficiency. By linking these two dimensions through Cognitive Load Theory, this study explains why they may diverge, highlighting that subjective perception does not always reflect actual cognitive effort. Methodologically, this study demonstrates the value of integrating psychometric and biometric measures in comparative design.

The findings also provide practical insights for interface design in web-based e-commerce platforms. However, the eye-tracking findings suggest opportunities for interface refinement. For example, increasing the visual prominence of the search bar, improving the salience of filter controls, and strengthening navigational cues may help guide user attention more efficiently toward task-relevant areas. Grounded in Cognitive Load Theory, improvements in visual hierarchy can reduce extraneous cognitive load by minimizing unnecessary visual search and enabling more direct access to task-relevant information. Such improvements may also facilitate faster visual target identification, allowing users to locate relevant products with less cognitive effort during search activities. This finding challenges the common assumption that subjective usability alone is sufficient to evaluate interaction quality.

This study is subject to several limitations that should be carefully considered. First, although the sample size ( $N = 39$ ) is acceptable for controlled eye-tracking experiments, a more diverse demographic composition would enhance the external validity and allow for broader generalization across different user populations. Second, the experimental design was confined to desktop-based interactions due to the calibration constraints of webcam-based eye-tracking technology. However, given that contemporary e-commerce activities are predominantly conducted on mobile devices, the observed visual interaction patterns may not fully capture user attention behaviors in mobile browsing contexts.

In addition, the use of a fixed task sequence (Shopee followed by Tokopedia) may introduce potential order and learning effects, where experience gained from the first platform could influence performance on the subsequent platform. This may have affected visual attention patterns and task efficiency, particularly in later tasks. Third, behavioral metrics were derived from AOI heatmap intensity rather than detailed fixation-sequence modeling, which may limit the depth of cognitive process interpretation. Future research should therefore incorporate mobile interaction contexts, larger and more diverse samples, and advanced gaze-sequence analysis techniques to better capture cognitive load dynamics and further investigate the relationship between perceived usability and behavioral interaction efficiency across broader stages of the online shopping process. Despite these limitations, the findings provide evidence that challenges the assumption that perceived usability is a reliable proxy for interaction efficiency.

## CONCLUSION

This study compared the web usability of Shopee and Tokopedia by integrating subjective usability assessment and eye-tracking analysis. The results show that both platforms achieved comparable perceived usability, with no significant differences across USE dimensions. However, eye-tracking findings revealed task-dependent differences in visual attention patterns, particularly during search activities. These results indicate that perceived usability does not always reflect behavioral interaction efficiency. This study highlights the

value of combining subjective and objective evaluation methods to obtain a more comprehensive understanding of usability and contributes empirical evidence to comparative e-commerce usability research. The findings also provide practical insights for improving visual hierarchy and navigation in e-commerce interfaces. However, limitations related to sample characteristics, desktop-based testing, and fixed task sequence may affect generalizability, suggesting the need for further research in more diverse and mobile-based contexts.

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