SafeRoutes – Be Free and Safe in Istanbul Mobile Application Project
Final Report

CS 549 – Human Computer Interaction

Sabancı University

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Date of Submission:
10 January 2026

SafeRoutes

GitHub Repository Link: https://github.com/Aise0/SafeRoutes-Prototype/tree/main

1. User-Interface Requirements

SafeRoutes is a mobile navigation interface that aims to reduce the feelings of insecurity and uncertainty experienced by users when choosing routes, especially when moving around the city at night. By making routes visible not only in terms of time and distance but also in terms of perceived safety, SafeRoutes aims to support users in making more informed, comfortable, and safer decisions. The interface allows the user to see three different route options after entering their starting and ending points. These options are categorized as “safest”, “balanced”, and “shortest”, and safety-related information is presented to the user in a calm, explanatory, and non-alarmist language. Thus, SafeRoutes aims to address the emotional and perceptual needs arising in the context of nighttime mobility while maintaining the functionality offered by classic navigation systems. In this section, we justify why the interface is necessary and what users expect from this system by explaining SafeRoutes' target users, the problem it addresses, and the context in which the interaction takes place.

SafeRoutes' target users are individuals walking alone in urban areas, especially at night. Within this group, women in particular experience heightened safety concerns in public spaces, leading to greater limitations on their movements (Erkan & Topcu, 2021). However, SafeRoutes is designed to encompass all urban users who experience safety concerns at night. For these users, safety isn't simply an objective risk assessment. How they perceive their surroundings, how much control they feel over their environment, and how they interpret uncertainty directly influences their route choice. Therefore, users often choose the route that makes them feel more comfortable and secure, rather than the shortest one.

Current navigation systems mostly rank routes based on objective criteria such as time, distance, and traffic (Kaur et al., 2021). However, for users moving around the city, especially at night, one of the most important factors determining route selection is perceived safety (Şenol, 2022). Dark streets, deserted areas, negative past experiences, and feelings of uncertainty about the environment deeply affect users' spatial behavior and shape their movement decisions not only based on efficiency but also on emotional and perceptual evaluations (Hamedanian & Ghadermazi, 2022). Despite this, current systems do not present this safety concern to the user as a visible, understandable, and manageable dimension. This leads to a two-way problem. On the one hand, users excessively restrict their movements by avoiding areas where they feel unsafe. On the other hand, because they lack sufficient and meaningful information about safety, they may unintentionally choose uncomfortable or stressful routes. SafeRoutes steps in precisely at this point, aiming to provide an interface that centers the user's perception of safety, makes safety-related information visible and explainable, and thus supports the user in making their own decisions more consciously, comfortably, and with greater control.

Therefore, the context in which interaction takes place in SafeRoutes should be considered differently than ordinary navigation use. Users often choose routes on their mobile devices, often while anxious to get somewhere on time, alone outdoors, or knowing they will soon be alone. This moment is not only about accessing information, but also about making decisions while trying to manage uncertainty. The user tries to anticipate their surroundings, intuitively weigh risks, and act quickly. Therefore, a quick and understandable interface becomes a critical requirement. Similarly, the amount of information presented must be balanced. Insufficient information creates distrust, while excessive information can cognitively exhaust the user, making decision-making impossible. User expectations are concentrated precisely between these two extremes, at a point of balance where they feel sufficiently informed but not overwhelmed.

To make these requirements more concrete, we structured the study around a single core use case. We assumed the user needed to travel from one point to another in the evening, for example, from Kadıköy to Beşiktaş. After entering the starting and ending points, the user is presented with three route options. These options are presented not only with efficiency metrics such as time and distance, but also with information that supports the perception of safety. If the user wishes, they can report any situation they anticipate encountering during the journey and express their experience with a brief evaluation at the end of the trip. This flow allowed us to integrate the safety dimension into the experience without disrupting basic navigation behavior such as route selection, and to transform safety from a passive score into a process where the user can contribute and feel more like an agent.

Beyond core route selection, SafeRoutes also offers several supportive safety features. An SOS Activation function enables women to contact emergency services instantly in high-risk situations; an Emergency Contacts module allows users to pre-define trusted people and automatically share their live location and trip details with a single tap; a Walking Together option lets users coordinate shared routes with friends and mutually track each other's progress; and a configurable Safety Preferences panel allows each user to customise how strongly safety is prioritised over travel time and what types of safety alerts and notifications they want to receive.

In conclusion, the fundamental element that necessitates SafeRoutes is that the perceptual and emotional burden users experience during nighttime mobility remains invisible in current navigation experiences. Users make decisions not only about where they are going, but also about how they will feel and how much control they will have during the journey. What people expect from SafeRoutes is that they can choose a route where they feel safer, understand the reasons behind that choice, and not be left alone when making a decision. We position this section as a foundation that connects the design principles and evaluation approach we use in subsequent stages to these requirements.

2. Guidelines, Documents, and/or Process

SafeRoutes' design is built upon fundamental theoretical principles from the human-computer interaction literature, aiming to support users' decision-making processes shaped by uncertainty, anxiety, and the need for trust. These principles guided not only how the interface looked, but also how the user interacted with the system, what they understood, and what they trusted. In this section, we explain the four core principles that guided our design process and how these principles were reflected in SafeRoutes' concrete design decisions.

We considered Norman's Gulf of Evaluation as one of the most critical points of disconnect between the user and the system. In the context of SafeRoutes, this gap arises when the "safety-related output" provided by the system is not correctly understood by the user. The user may see that a route is safer, but if they cannot understand what this safety is based on, this information does not become meaningful in the decision-making process. Therefore, instead of presenting the safety score in isolation in SafeRoutes, we made the factors behind this score visible. Indicators such as lighting, crowd density, reported incidents, and the like are presented to the user as components that form the context of the safety score. This approach aims to narrow the Gulf of Evaluation by making the system output "interpretable" for the user (Norman, 2013). Thus, the user becomes an actor who not only accepts the system's suggestion but also interprets and evaluates it.

In SafeRoutes, we not only referenced the Gulf of Evaluation approach, but also directly translated Norman's design principles into interface decisions. In particular, we addressed the visibility principle, ensuring that safety-related information is not a "background" detail but is visible at the moment of route selection. Therefore, the safety score is not presented in isolation; indicators such as lighting, crowd density, and reported incidents are all included on the same decision screen. This allows the user not only to see the system's recommendation but also to read which signals support that recommendation (Norman, 2013). Secondly, we used the feedback principle in a way that clearly conveyed to the user that every critical action they take is being perceived and processed by the system (Norman, 2013). Providing instant feedback to the user during steps such as route selection, report submission, or task completion makes the interaction “predictable.” This was particularly important for maintaining a sense of control for users making decisions under uncertainty. We deliberately kept the feedback design visible and clear, as the system remaining unresponsive when a user makes a choice could raise concerns in a security context.

We based our interface design on the principle of mapping. We aimed to keep the organization of screens and the placement of actions close to the mental models users are familiar with from mobile navigation applications (Norman, 2013). Presenting route options in card format, naturally positioning the reporting action within the task flow, and guiding the user through a flow that hints at "what they need to do" are all part of this approach. Instead of forcing the user to learn a new interaction logic, we adapted familiar patterns to the security context. Finally, we approached the constraints principle not as a "restriction" but as a structuring tool used to manage decision burden (Norman, 2013). We did not stop offering options to the user; however, we avoided creating cognitive load by highlighting unnecessary options at every step. Reducing route options to three main categories and dividing the reporting flow into a few clear steps was designed with a limiting logic that guides the user without overwhelming them. The aim of this approach was not to make the user passive, but to make the decision-making process more sustainable.

Ensuring the user-manageable decision-making process has been a fundamental goal in our design. Especially in contexts involving uncertainty and emotional burden, encountering numerous options can prolong decision-making time and increase user anxiety (Hick, 1952; Hyman, 1953). Therefore, we approached Hick's Law not merely as a principle that reduces the number of options, but as a tool for structuring the decision-making space. By grouping routes into three conceptual categories -Safest, Balanced, and Shortest- we presented the user with a meaningful mental framework instead of a numerical list. This allows the user to choose a strategy that aligns with their current priority, rather than getting lost among dozens of routes. This approach aims to make the decision-making process faster and safer by transforming the question "Which route should I choose?" into "Which priority is more important to me?".

The physical dimension of interaction is directly related to this cognitive load. Physical strain on the user during interface use increases mental fatigue and can lead to distraction. Therefore, we considered Fitts' Law not only as an ergonomic requirement but also as a design principle supporting attention and load management (Drewes, 2023). Route cards, reporting buttons, and approval areas are large, easily accessible, and visually clearly separated. This reduces the physical effort expected from the user, aims to prevent interaction errors, and allows the user to focus their attention on evaluating safety information rather than using the interface (Drewes, 2023). When these two principles are considered together, the aim of the design is not only to increase usability but also to reduce both mental and physical friction in decision-making and interaction processes. Thus, the user can act in a more controlled, comfortable, and conscious manner, even in a context involving uncertainty and anxiety.

At SafeRoutes, we've placed the most contextually relevant aspects of Shneiderman's Eight Golden Rules at the heart of the design. Chief among these is the principle of striving for consistency. Color codes, icon language, and labeling are maintained consistently across the entire interface. For example, presenting safety and risk signs with the same visual logic on every screen prevents the user from having to relearn each new screen. This consistency contributes to the interface being perceived as reliable and "settled," especially in the context of nighttime mobility where quick decisions are crucial (Shneiderman, 2010). Secondly, we actively used the principle of offering informative feedback to ensure user actions don't go unrewarded. When a user selects a route, submits a report, or completes a trip, the interface changes state, and this change is clearly noticeable, acting as a mechanism to validate interaction. This strengthens not only usability but also the trust relationship, as the user can monitor "what the system is doing" and "what its status is" (Shneiderman, 2010).

In SafeRoutes' security-focused context, one of the most critical principles for us was supporting the internal locus of control. The interface doesn't force the user onto a single route. The user can always go back and change their choice, and suggestions are presented not as commands, but as alternatives open to consideration. This way, the user feels they are in control, especially in a sensitive area like security. This sense of control was particularly important because we believe that the perception of security is related not only to information but also to a sense of agency and decision-making. We also applied the "reduce short-term memory load" rule, ensuring the user doesn't need to constantly track information between screens. Having critical safety cues and route differences visible on the same screen reduces the user's need to remember what was written on the previous screen. This aims to both shorten decision-making time and reduce cognitive fatigue, which can increase anxiety (Shneiderman, 2010). Finally, we used the "design dialogs to yield closure" rule to give user flows a sense of completeness. Providing a clear closing screen with sentiment ratings and a short comment section after the journey is complete makes the user feel that the process is finished and their interaction is complete (Shneiderman, 2010). This seemingly small detail makes the user experience more holistic and complete, especially in a safety-focused scenario.

Taken together, these principles have shaped SafeRoutes' design not as a system that guides the user, but as a decision-support system that provides the necessary framework for the user to make their own decisions. The aim is not to make decisions for the user, but to support the user in making decisions in a context involving uncertainty and anxiety, feeling more informed, more comfortable, and more secure.

3. User-Interface Software Tools (Implementation)

The implementation work for SafeRoutes focused on realising our interaction ideas as a coherent, testable user interface rather than as a fully coded mobile application. For this purpose, our primary environment was Figma, which we used both as a layout tool and as an interactive prototyping environment. After completing the paper and tablet sketches, we systematically rebuilt the same flows in Figma so that every screen, transition, and interaction could be experienced as a continuous journey instead of separate drawings.

We began by defining a small design system inside Figma. This included typographic styles (for titles, subtitles, body text, and captions), colour tokens for safety levels (e.g., "Safest", "Balanced", "Shortest" routes and different alert states), and reusable components such as navigation bars, buttons, route cards, alert cards, chips, and bottom sheets. Using Auto Layout and component instances, we ensured that these elements behaved consistently across screens and were easy to update. For example, when we refined the appearance of the route cards or changed the visual emphasis on the "Safest" tag, those adjustments automatically propagated throughout all relevant screens, reducing manual work and preventing inconsistencies.

On top of this component library, we built an interactive mid to high-fidelity prototype. The prototype connects the full core flow: entering origin and destination, viewing and comparing the three route options, starting navigation, seeing alerts along the route, opening detailed alert information, reporting a new alert through a two-step flow, and finally completing and rating the route. Additional flows include accessing the Profile and More Options menus, as well as browsing the Forum feed and creating new posts. Figma's prototyping features allowed us to define tap targets, transitions, and bottom-sheet animations so that the prototype feels like a real mobile application during usability testing, even though no underlying backend exists yet.

In a few places, we experimented with Figma's AI-assisted layout suggestions to quickly explore variants for screens such as onboarding or forum lists. However, these outputs were always treated as drafts: we manually adapted them to conform to our existing design system, to our three-route structure, and to our safety-oriented interaction logic. In this way, AI support helped us speed up routine layout work without compromising the conceptual integrity of the interface.

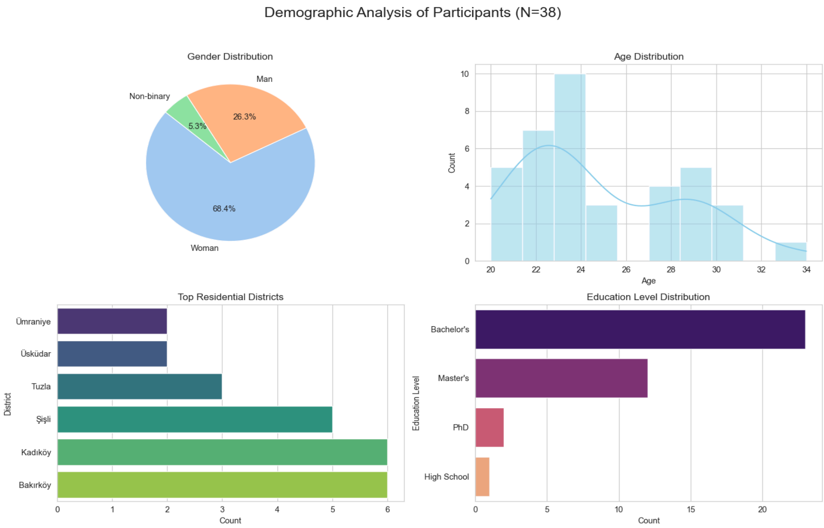
Thus, the Figma prototype functions both as a research artefact for our planned usability studies and as a practical specification for potential future implementation of the SafeRoutes mobile application.

4. Usability Testing (Evaluation)

For usability testing, we adopted a quantitative approach with N=38 participants to allow for systematic statistical analysis. We conducted a user study with Figma and Google Forms survey tools. The participants answered questions related to demographical information, perceived safety in the city during different times and routes and also completed a realistic route selection task through our interactive mid to high-fidelity prototype on Figma. The prototype has global coverage presenting all features, operational in terms of durability and has interactive usage capabilities.

Our independent variables are gender, tech proficiency, history of harassment and some time/region context variables such as night/day or city/district. The dependent variables are perceived safety, usability, trust and emotional assurance. The data is cleaned and mistakes are corrected such as writing "İstabnul", instead of "İstanbul" or writing the university name, together with the district.

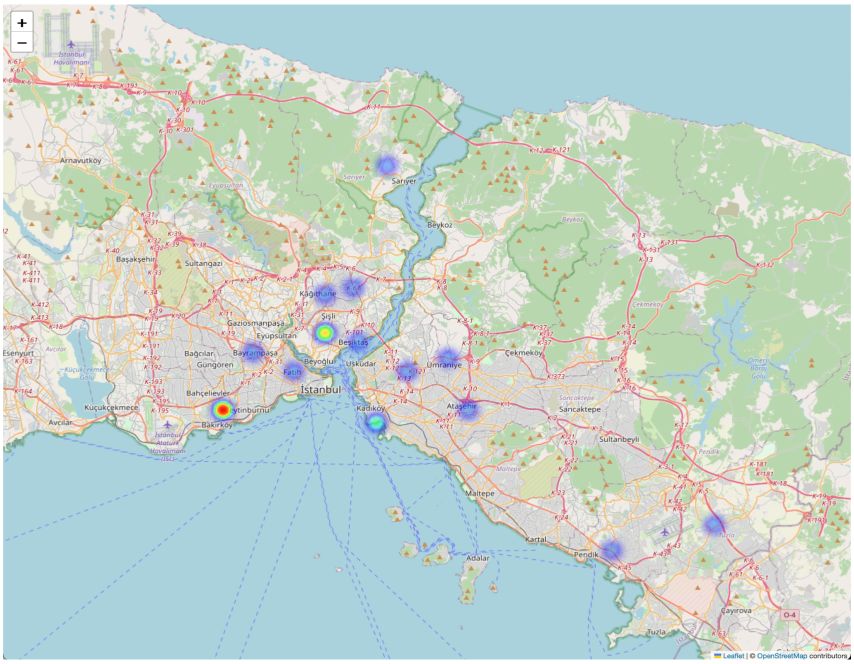
The total participants are 38 people living in Istanbul, studying or working, predominantly young women. In quantitative research studies, a sample size of N>=30 is needed to be considered statistically valid and it is possible to apply t-test (Lazar et al., 2017). Since our target group is young women with high urban mobility in Istanbul, and the participants should represent target user populations (Lazar et al. 2017), our sample group consists of mostly women who live and work/study in Istanbul.



68.4% (26 people) of the participants are female, 26.3% (10) are male and 5.3% (2) are non-binary. The participant group consisted of young adults, primarily generation Z and millennials with mean age 24-25 years, standard deviation is 3.65 and the whole range is from 20 to 34. The group is highly educated with the majority holding or pursuing university degrees. 21 participants have bachelor's degree, 7 participants have master’s degree and one participant has a PhD, while 9 participants are undergraduate students.

The participants are concentrated in central districts in Istanbul, correlated with high student populations and urban mobility such as Kadıköy, Şişli and Bakırköy. Tuzla is also a high popularity district because of the density of Sabancı University students in the study. Participants self-reported their proficiency with technology, which is a critical variable for assessing "Ease of Use" without bias from digital illiteracy. 57.9% (22) of the participants reported being “good” at, while 23.7% (9) reported being “very good” at using technology, 15.8% (6) and only one participant (2.6%) reported poor usage of technology in general. This means over 80% of the participants have a good or advanced level of technology adaptation and it minimizes the friction caused by smartphone usage issues.

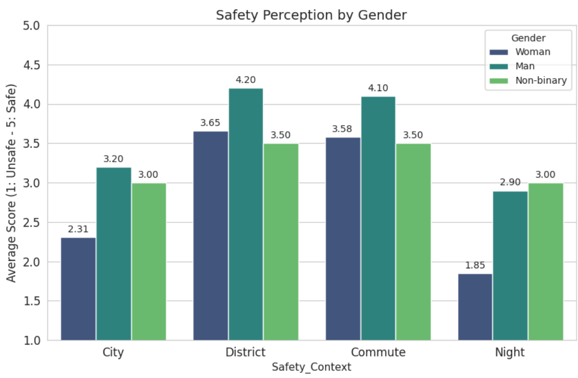
The sample showed a wide variety of mobility behaviors, with users regularly using public transportation like buses, trains, and the subway. This evaluation's main goals were to examine user acceptability of the suggested "crowdsourced safety" features and to empirically test the notion that safety perception in urban areas is highly gendered.

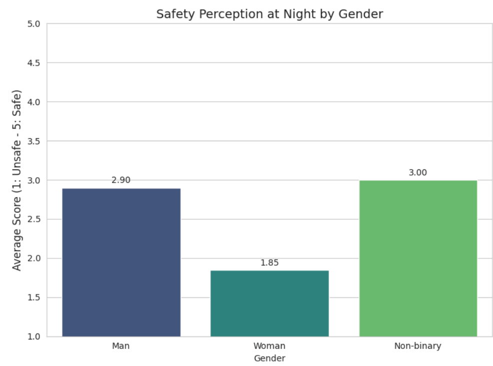


Heatmap of the districts where participants live in Istanbul

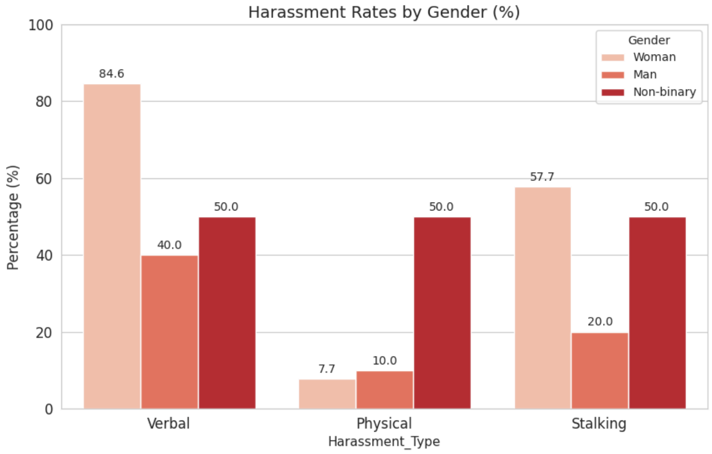
4.1 Statistical Validation of the Problem Context

Our research provides reliable statistical support for the application's fundamental value proposition by confirming a statistically significant gender-based difference in safety perceptions. Female participants felt substantially less safe at night than male participants, according to an independent sample T-test ($p=0.024$, $p<0.05$). On a 5-point scale, men's mean safety score was 2.90, while women's mean was significantly lower at 1.85.





The concrete history of harassment creates the crucial problem context for our intervention, going beyond perception. A harsh reality is revealed by our user study: More than twice as many female participants (84.6%) as male participants (40%) reported verbal harassment in public places, and 57.7% reported being stalked. For women, urban transportation becomes a complicated risk management challenge rather than a straightforward navigational task due to their disproportionate exposure to aggressiveness. SafeRoutes is therefore intended as a digital defense against this systematic gendered threat. The app tackles the underlying cause of the users' worry by making these frequently invisible hazards evident through community reporting, confirming the particular need for a navigation system that takes social safety threats into account.

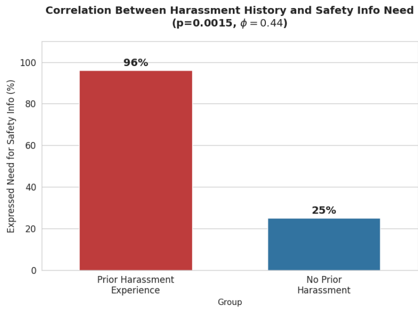


The importance of the "Safest Route" algorithm over conventional navigation aids, which usually put speed ahead of security, is quantitatively validated by this large "safety gap". Additionally, gender is a strong predictor of safety perception, according to multivariate correlation analysis ($r=-0.47$), demonstrating that the target user base (women) is disproportionately impacted by the issue SafeRoutes seeks to address.

No significant correlation between age, education level and perceived safety or usability has been detected.

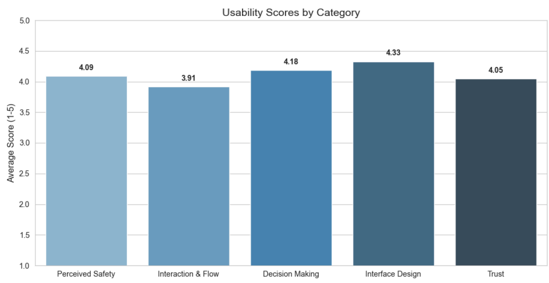
4.2 Feature Validation and User Needs

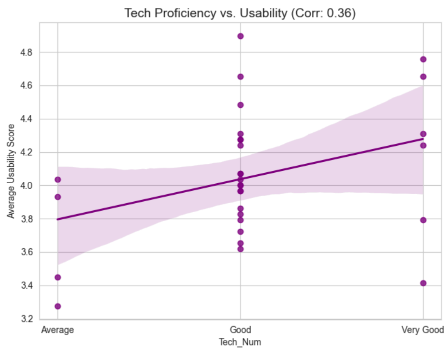
We used a Chi-Square Test of Independence to examine the relationship between prior harassment experiences and the need for safety information in order to determine whether the suggested features addressed real-world concerns. 96% of users who had previously encountered verbal or physical harassment stated a clear need for an app that offers safety-specific route information, according to the very significant results ($p=0.0015$, $p<0.01$). In contrast, only 25**%** of users without harassment experience felt this need. Because the users who are most susceptible to harassment are statistically more likely to interact with and gain from these tools, this conclusion supports the inclusion of the "Community Alert" and "Reporting" features.



4.3 Usability and Prototype Acceptance

Consequently, a standardized Likert scale was used to assess the SafeRoutes Figma prototype's usability and perceived impact.The findings show extremely high user acceptability. Remarkably, 92.1% of respondents agreed or strongly agreed that "using this interface made me believe that my personal safety was being regarded." Furthermore, 94.7% of users said they felt the app provided them with options to better control their personal safety. These metrics indicate that the safety objectives of the project are successfully translated into a user experience that reduces anxiety and empowers the user through to the suggested user-centered design, particularly the distinct differentiation between "Fastest" and "Safest" routes.





This high degree of digital literacy and the perceived usability of interface features are strongly positively correlated, according to our findings. In particular, users with better proficiency demonstrated a greater ability to navigate through the interface, such as multilayered safety filtering and detailed event reporting.

4.4 Ethical Considerations and Limitations

For ethical considerations, the users' anonymity is established, no identifiable data has been collected. In order to prevent any possible discomfort related to harassment-focused questions, a separate section is created through a conditional question asking if the participant feels comfortable to answer questions related to disturbing events while traveling in the city.

The demographic homogeneity of the sample (N=38) is the main limitation of this study since it mainly consisted of university students. It limits the implications of the results to broader socioeconomic groups. The dominance of women participants makes it difficult to infer gender correlations with high confidence. Additionally, the ecological validity is limited by the evaluation of safety features using a digital prototype in a controlled setting, which is unable to accurately mimic the actual psychological strain of navigating a roadway at night. Lastly, the dependence on self-reported data also introduces potential recall bias for previous instances.

5. Design Motto: Designing Safety without Ambiguity

Acknowledgements

We would like to acknowledge the support of generative AI tools that were used to improve the overall readability of this report. In particular, tools such as Grammarly and ChatGPT assisted us in proofreading and language clarity. All design decisions, implementation, analysis, and interpretations were developed by the group members.

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