

User-Centered Design of a Sustainable Navigation Interface for Smart Transportation: A Case Study of the SO-SMART Framework

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Abstract

User-centered design is an approach that actively involves users in the design process by placing their needs, characteristics, and expectations at the center. This study, conducted as part of the SO-SMART (Development of a Proactive and Social-Based Framework for Smart Transportation Solutions) project, uses qualitative research methods to examine how navigation users' expectations can be met through a website interface. Accordingly, the study presents a user-centered interface design. It is important to note that the present study focuses exclusively on the domain of user interface design. During the research process, demographic data on navigation users, obtained through a literature review, was analyzed. The developed website interface design employed user-centered design processes such as persona creation and user journey mapping. Due to limitations in field research, personas were created using a goal-oriented approach, synthesizing sustainability data from the city of Okinawa. A key finding is that the proposed interface treats environmental impact as a central design element, aiming to guide users towards eco-friendly choices, rather than as a secondary or limited display. This design, which was developed for the SO-SMART project, demonstrates a user-centered design approach for eco-friendly transportation systems.

Keywords: User-Centered Design, Smart Transportation, Geospatial Navigation, Smart Cities, User Experience (UX), Persona-Based Design

1. Introduction

Advances in digital technologies have led navigation systems to evolve beyond mere tools for finding directions and become decision-support systems. Today, users consider not only criteria such as distance and travel time when selecting a route but also multidimensional information such as traffic conditions, energy consumption, and environmental impact. This situation necessitates a more systematic approach to addressing user needs in the design of navigation systems.

Growing environmental concerns and global goals to reduce carbon emissions have made it imperative to reevaluate transportation systems with a focus on sustainability. In this context, smart transportation systems and Geographic Information System (GIS)-based solutions play a significant role in eco-friendly route planning and optimizing urban mobility. However, a significant portion of existing navigation applications present environmental impact as secondary information and do not sufficiently support users in effectively incorporating this information into their decision-making processes.

This study addresses this gap by focusing on the navigation interface design developed within the scope of the SO-SMART (Proactive Social-Based Smart Transportation) project. This project, carried out as part of international cooperation among Japan, Turkey, France, and Hungary, is being implemented

under the joint call titled “Solutions for Carbon-Neutral Cities,” which is supported within the framework of Japan–EU cooperation. The project is titled “So-Smart / Proactive Social-Based Framework for Smart Transportation”. It aims to create a more accessible, coordinated, and sustainable transportation infrastructure by integrating spatial data obtained from social sources and existing public transportation systems with cloud computing capabilities, to increase environmental awareness in Japan, and to reduce carbon emissions. This initiative specifically aims to optimize public transportation and car-sharing in the Onna–Ishikawa region of Okinawa, thereby reducing environmental impact while improving the user experience through AI-supported approaches. The proposed approach adopts a user-centered design perspective to develop an interface that integrates environmental impact as a central and visible design element. By doing so, it aims to support users in making environmentally conscious transportation decisions and enhance user experience in sustainable navigation systems.

2. SO-SMART project interface design

As part of this study, a user-centered web interface for navigation was designed for the SO-SMART project (So-Smart). The design process aimed to create a structure that would support sustainable transportation and encourage users to choose eco-friendly routes. During interface development, user requirements, literature-based data, and limitations of existing navigation systems were considered. Environmental impact information was not treated as a secondary element in the interface but as a component that was directly integrated into the decision-making process. Accordingly, the interface was designed to allow users to evaluate criteria such as carbon emissions, time, and distance together when selecting a route.

2.1. Creating Personas

Creating personas for navigation systems requires understanding not only where the user is going, but also why and how they are getting there. Navigation users should be classified not only based on their personal characteristics but also on their spatial abilities, needs, and technological proficiency (Lie et al., 2025).

Cooper (1999), one of the pioneers of user-centered design, highlights common problems in software and interaction design such as navigation systems within the framework of the persona approach. These problems stem from an engineering approach that focuses on “how the system works” rather than user needs during the design process. However, a successful design must focus on the user’s “mental model” and goals. Cooper’s “goal-oriented” persona framework, the design process should center not on the user’s basic demographic information but on a persona that prioritizes their ultimate goals.

In line with this approach, personas in this study were developed based on secondary data, as direct user data collection methods such as surveys or field studies could not be conducted due to time constraints. This approach is supported in the literature as a valid method, particularly in early-stage design processes or when primary data collection is limited (Salminen et al., 2022).

As direct user data could not be collected during the persona creation process, secondary data based on literature was used instead. User profiles were created by analyzing the demographic structure, transport habits, and sustainability goals of the city of Okinawa. Transportation preferences, levels of environmental awareness, and technology usage habits were then taken into account based on this data. Two distinct personas were then defined to represent different user needs (Figures 1 and 2). These personas represent sustainability- and efficiency-focused user types. Goals, motivations, and behavioral characteristics were determined for each persona. The persona approach ensured that the design process took into account not only users’ demographic characteristics but also their goals and decision-making processes. This ensured that design decisions were grounded in user needs.

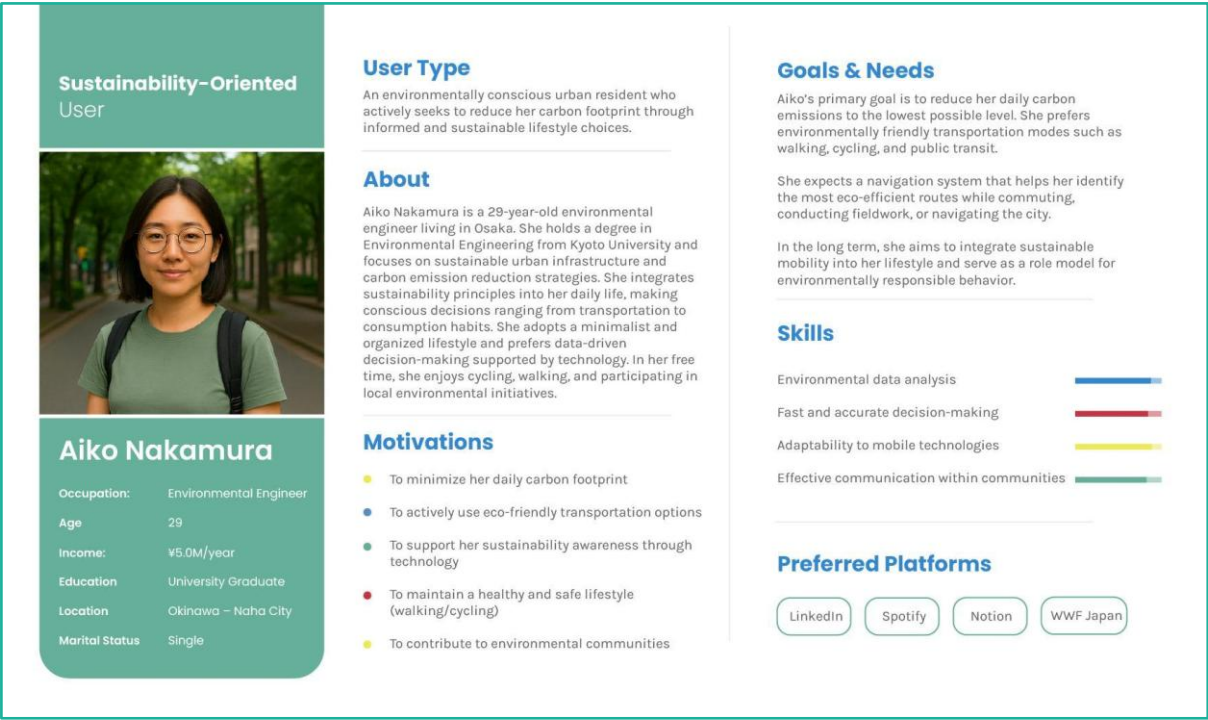


Figure 1. The creation of Persona 1 was for the navigation website interface design, which was developed as part of the SO-SMART project.

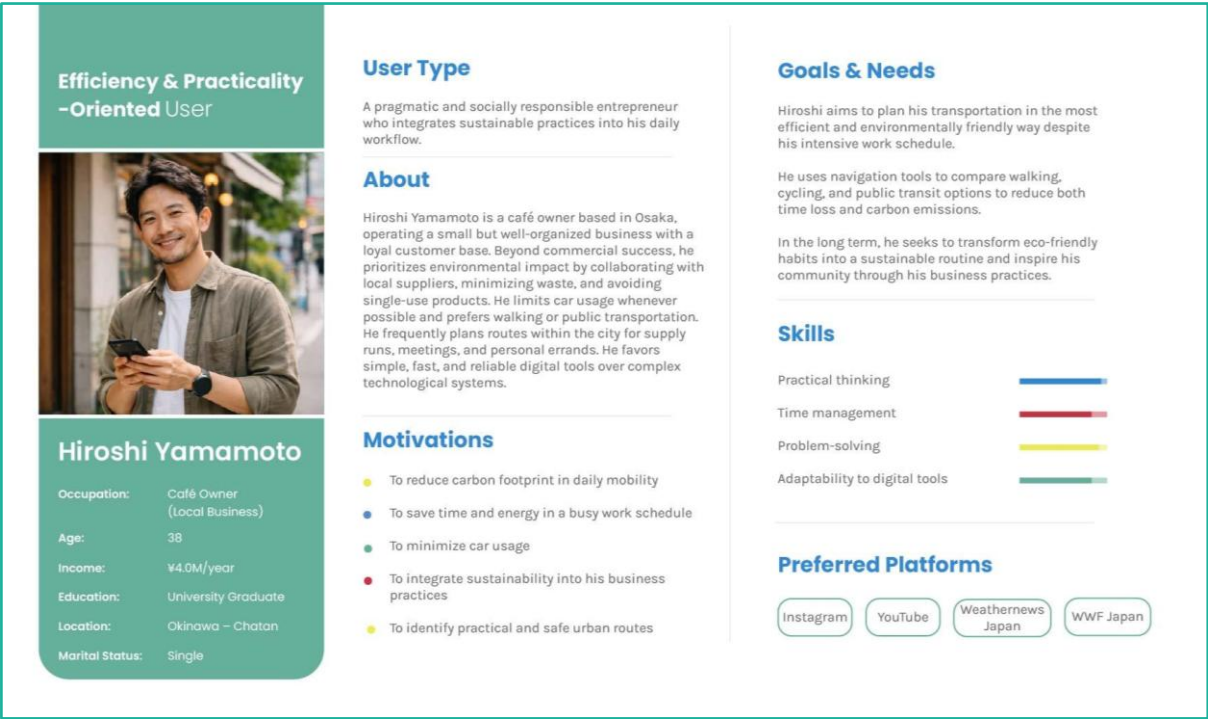


Figure 2. The creation of Persona 2 was for the navigation website interface design, which was developed as part of the SO-SMART project.

2.2. Creating user flows

Following the persona creation phase, the user flow methodology was applied. Within this scope, the process of user interaction with the system was modeled step by step. The actions that users perform and the decision points that they encounter on their journey were identified. In the flow created for the

sustainability-focused user, selecting a low-carbon route was prioritized. Users select their preferred mode of transport, compare alternative routes, and make decisions while considering environmental impacts (Garrett, 2011; Liu, 2025). At the end of the flow, the user is presented with carbon emissions and performance data. In the scenario designed for the efficiency-focused user, time and environmental impact are evaluated together. The user compares different transport options to select the most suitable route, completing the journey by following the system's guidance (Figures 3 and 4).

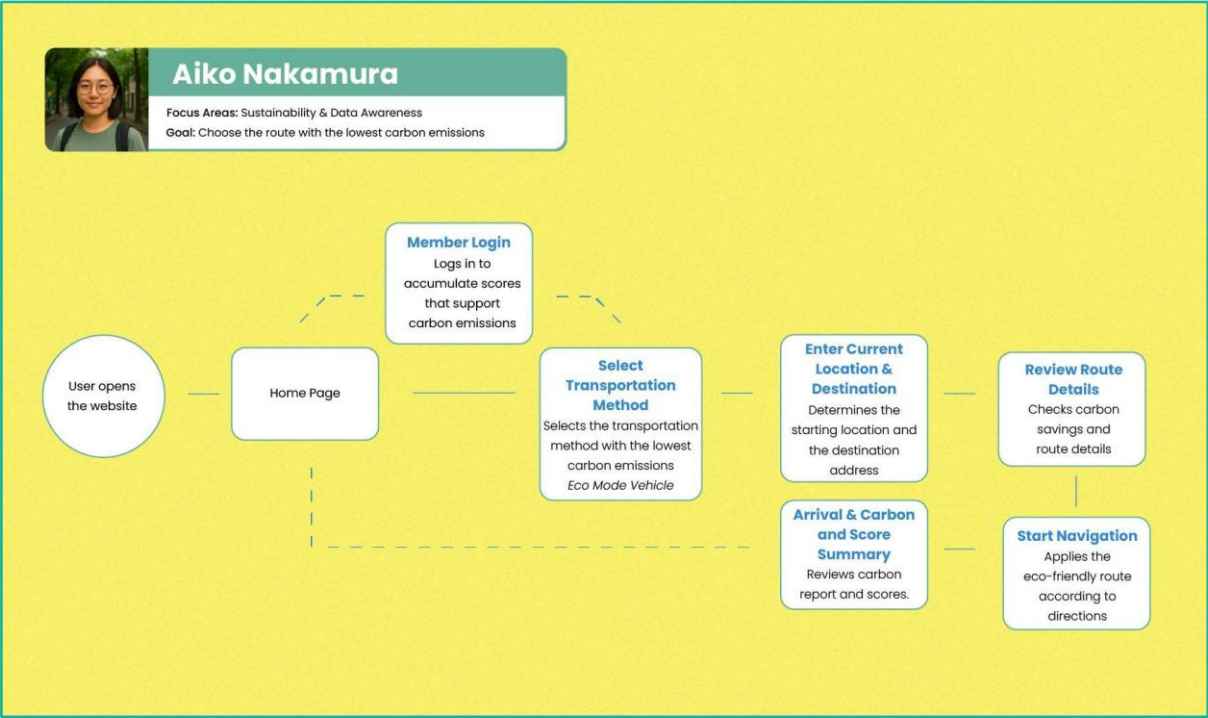


Figure 3. The diagram illustrates the user flow of Persona 1.

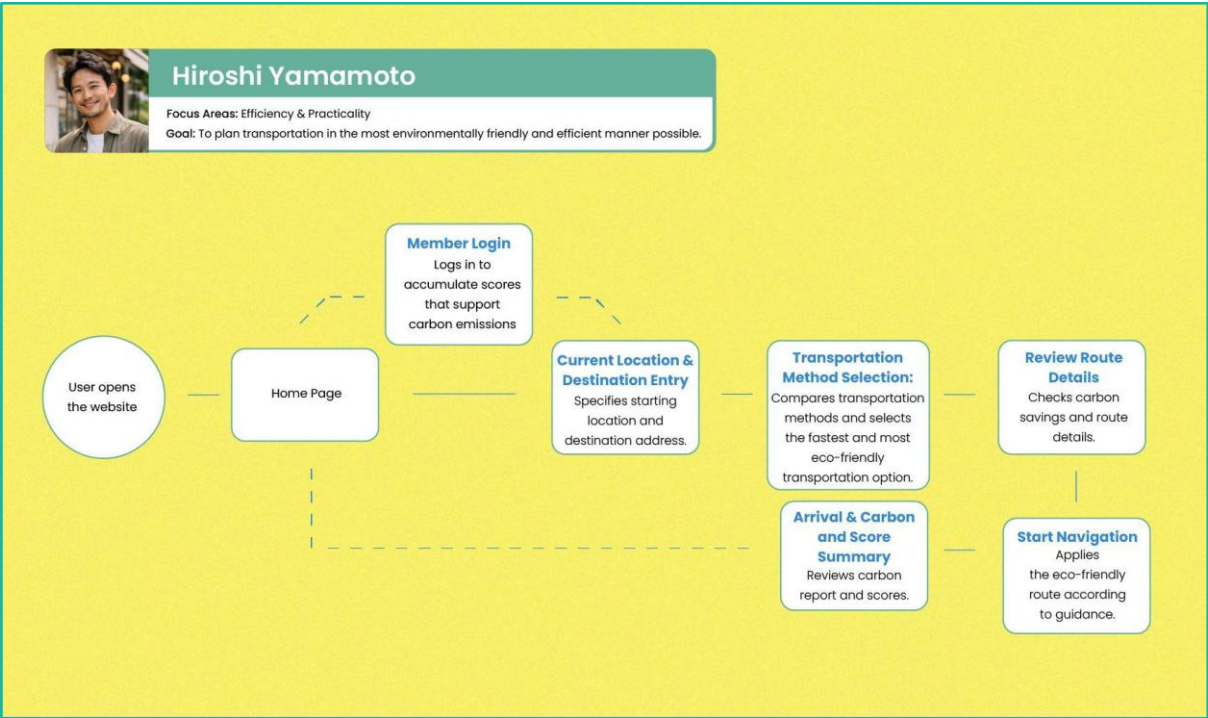


Figure 4. The diagram illustrates the user flow of Persona 2.

2.3. Page design

During the interface design process, page designs were developed based on the structure defined in the wireframing phase. A simple and intuitive design approach was adopted in this phase to facilitate user interaction with the system. Interface components were positioned to ensure quick access to the information users need. The main interface is structured around a location search field to guide users towards taking action directly. Options for selecting transportation modes, route planning, and auxiliary menus have been configured. Control components supporting basic navigation functions, such as location pinning, zooming, and navigation, have been placed on the map. The interface also includes a scoring system that provides users with feedback. Through this system, users can track data such as carbon emissions, energy savings, and time savings. Once all the pages had been created, a prototype was developed in Figma, and the interactions between the pages were defined (Figures 5 and 6).

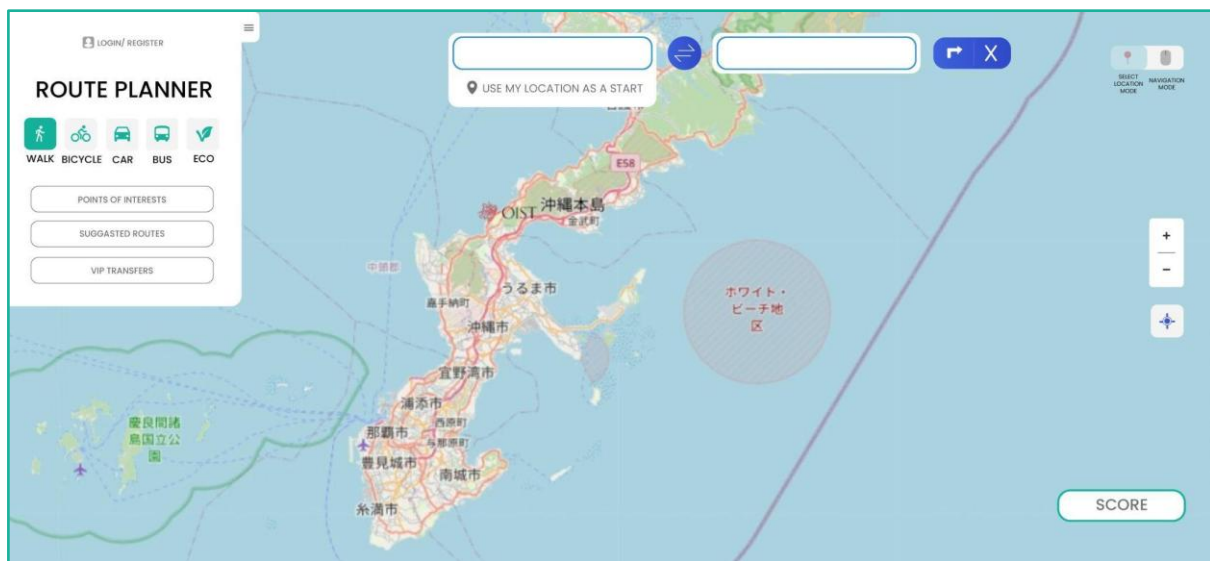


Figure 5. The main interface design for the navigation website was developed as part of the SO-SMART project.

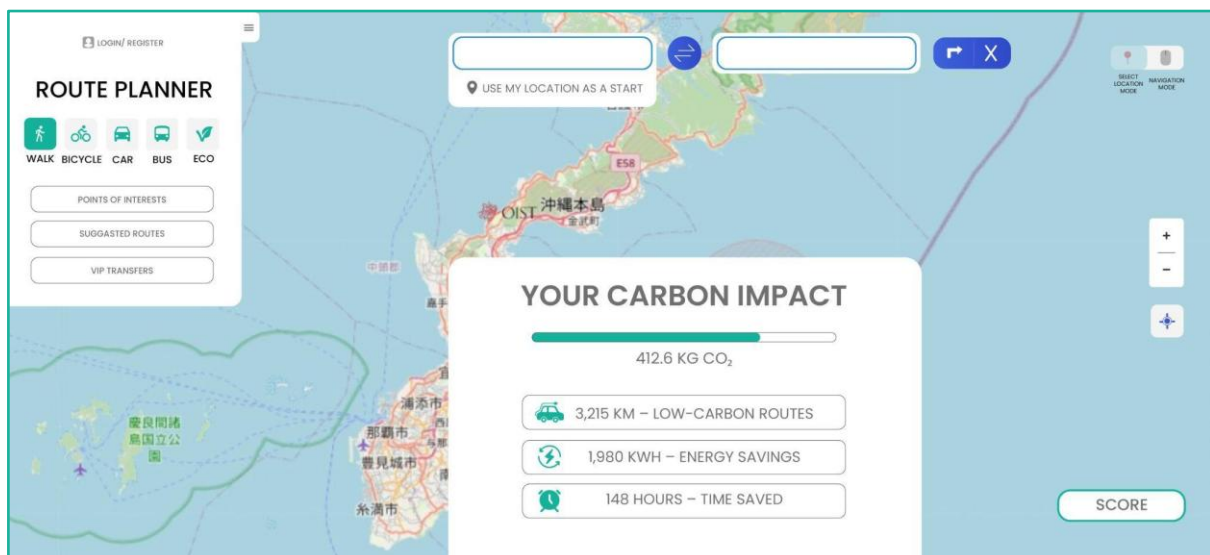


Figure 6. The design of the score table for the navigation web interface was developed as part of the SO-SMART project.

3. Results

In light of the constraints imposed by the paucity of opportunities for field research, the creation of personas based on the extant literature has been demonstrated to offer certain advantages in terms of user experience during design processes where data cannot be collected through methods such as surveys and observations. The SO-SMART interface design, developed within the framework of these personas, positions environmental impact as a central and visible design element, a distinction from existing navigation applications. The approach adopted is consistent with the principles of effective digital nudging, with the objective of reducing users' cognitive load and fostering emotional engagement. In contrast to the conventional approach of treating environmental impact as a marginal component, the designed interface integrates it as a pivotal element in the overall design. Consequently, the proposed interface facilitates the tracking of past sustainability performance and the provision of personalized feedback to users. It is evident that these features offer a comprehensive experience, facilitating not only the immediate selection of routes but also the promotion of long-term user awareness and the adoption of eco-friendly transportation options.

4. Conclusion

This design proposal, prepared for the SO-SMART project, continues to be developed in accordance with the established design principles. Consequently, a web interface design has been developed that is straightforward for users of all ages to utilize and promotes environmental awareness. The study resulted in the implementation of user experience (UX) criteria that support sustainable transportation choices within the prototype. It should be noted that this study focuses solely on interface design, and the measurement or calculation of carbon emissions is beyond the scope of this work. The proposed interface design is distinguished by its elevation of environmental impact information from a secondary element to a central and visible design feature, a departure from the approaches adopted in existing studies. The objective of this approach is to facilitate the identification of low-carbon route options by users. Moreover, there is an absence of extant application of this concept in either the literature or in practice. This study further proposes a specialized navigation interface design for Okinawa. Furthermore, users are enabled to track their past sustainability performance. Consequently, the system transcends the scope of mere real-time route selection. The proposed experience is assessed as a means of supporting the continuity of eco-friendly transportation habits. However, this advanced design has not yet entered the implementation phase and remains in the conceptual prototype stage. The study's primary limitations stem from two factors: firstly, the absence of field research, and secondly, the fact that the design has not been tested on real users. The implementation of the developed prototype in the future has the potential to make a significant contribution towards achieving carbon-neutral goals in smart cities.

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