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Assessing Map Designs to Enhance Human Participation in Sustainable Mobility

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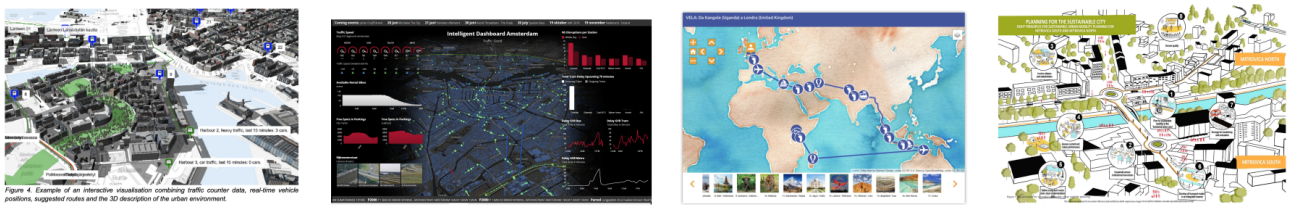
Abstract:

Sustainable mobility is a pressing issue that involves improving transport efficiency, shifting to green mobility, and reducing travel demands. This process has shared responsibilities among many stakeholders, such as policymakers, public transport operators, urban planners, travelers, and vehicle suppliers (Banister, 2008). Achieving sustainable mobility highly relies on coordinating the needs of multiple sectors, including transport planning, the automotive industry, the energy industry, legislation, and social awareness. Maps are widely used to represent mobility data in various analytical tools, mobile applications, and reports. Achieving sustainable mobility requires not only displaying mobility data via maps, but also encouraging map users to actively take action. Therefore, accessing how maps were designed to serve this purpose can provide insight into future map design.

To gain a comprehensive understanding of map functions in the context of sustainable mobility, we conducted a qualitative content analysis with 48 maps. The collection was firstly searched by keywords, such as *sustainable mobility map*, *sustainable traffic dashboard*, and *digital twins and sustainable mobility*. Then the maps that are used as a major communication method was selected. Figure 1 shows some of the collected maps that represent mobility data to citizens, and encourage actions that contribute to sustainable mobility. The applications are used for (a) walkable area planning, (b) showing the locations of environment-friendly vehicles, (c) using counter data for traffic monitoring, (d) using counter and GPS data for traffic monitoring, (e) integrating traffic data and pollution data for traffic monitoring, (f) interactive green trip planning tool for education, (g) visual stories for planning a sustainable city, (h) explanation of the impact of traveling to the environment. The full map collection is available on Zenodo at: https://zenodo.org/records/11620024.



(a) (b) (c) (d)

Figure 1. Four selected examples of maps made to communicate sustainable mobility: (a) a 3D scene showing the traffic flow with the urban environment (ConnectedUrbanTwins, 2023), (b) a dashboard showing the real-time location of public transportation and statistical data (Geodan, 2022), (c) an application that allows people to plan their trip (KidsGoGreen, 2019), (d) an illustration of a future sustainable city (UN-Habitat, 2021).

We chose content analysis (Drisko and Maschi, 2016) to quantify the design patterns of the collected maps. We developed a codebook to access the maps in terms of context, theme, data, visual design, and visual richness. *Context* describes the social framework of a map for sustainable mobility, such as intent, provider, audience, and implication. *Theme* outlines the perspectives addressed by map makers to approach sustainable mobility, including approach (such as promoting clean travel mode and improving infrastructure), transport mode, and focus (individual person or overview). *Data* includes the source, geography, time, number of variables, and data transformation methods. *Visual design* considers map type, cartographic process, textual element, and interactivity. *Visual richness* evaluates color mean, color standard deviation, color skewness, entropy, magnitude slope, and fractal dimension. Two authors independently evaluated the collected map samples. The reliability of the codebook is examined using Krippendorff's alpha (Krippendorff, 2004) with a high agreement (k=0.96).

After we evaluated the maps, we propose the following design suggestions for map designers to consider in the future map design process. Extending the roles of maps from passively presenting geographic information to actively calling for actions.

Accessible. Digital twins contain multiple data, modeling, and algorithms. It is necessary to make not only the relevant data available to the target users but also the information on metadata and preprocessing methods available (such as the example in Figure 1a). This information is important for fostering trust.

Understandable. Mobility data often exhibits complex data features, such as rich spatiotemporal information and multiple attributes. Therefore, cartographic and visualization methods should be carefully chosen to maximize understanding. For example, show the relevant information in a logically organized style (such as the example in Figure 1b).

Interpretable. Provide general information on related fields so that stakeholders with diverse backgrounds can have a good understanding of how the components are influenced by each other. Sufficient contextual information should be provided for users to interpret the perceived information.

Empathetic. Provide a way for map readers can easily position themselves in the context of sustainable mobility. For example, an application (Figure 1c) allows users to plan their holidays and mark the itinerary with possible sustainable travel modes.

Actionable. Showing different possible decisions and their impact on climate. This can involve them as an active part of sustainable mobility and provide suggestions. In addition, communicating the influences of different actions can encourage users to take sustainability as a factor in their decision-making (such as Figure 1d).

This work contributes to the map design in manifold: 1) created a dataset with excellent examples of maps used to achieve sustainable mobility, 2) proposed a codebook to assess maps with the aim of sustainable mobility, and 3) provided design suggestions for future map design for sustainable mobility topics. The next step of this research is to combine user studies to evaluate user experience from the users' perspective.

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