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What's the cost of a car?
And what alternatives are there?

Project Report "sustAInability – Advanced topics in sustainability and intelligence"

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Introduction and Problem Statement | Ben Yahia Youssef | TUM

Big cities such as Munich are nowadays faced with complex problems, including high traffic volumes, limited available space, and the urgent need to address climate-related challenges. For this reason, promoting sustainable mobility practices and encouraging behavioural shifts in urban transportation habits have become priorities for municipal authorities. One of the key obstacles lies in the overreliance on private motorized transport and the socio-cultural patterns that shape daily mobility choices.

To address these issues, the Mobilitätsreferat (Department of Mobility) of the City of Munich wishes to offer personalized mobility consulting services with the goal of raising awareness and promoting the adoption of sustainable mobility options. However, this service is primarily delivered through analogue, resource-intensive ways, which limits its scalability, adaptability, and reach within the broader urban population.

As the urban mobility demands are incessantly changing and the personal needs across demographics are diverging, there is a pressing need to modernize and expand the city's mobility consulting framework. This includes exploring opportunities for digitalization, data-driven personalization, and participatory engagement formats that can more effectively encourage behavioural change and contribute to the overarching goals of urban sustainability, climate protection, and improved quality of life in Munich.

In this context, the specific challenge we were tasked with was the creation of a tool that enables personalized individual mobility behaviour consultation and thus directing people effectively towards sustainable behaviour. Our main focus for this project was to sensibilize Munich citizens to the true cost associated with owning a car, which is mostly obscured due to the dispersed and often underestimated nature of varying expenses such as insurance, fuel, maintenance, parking, and other incidental costs. Afterwards, we wished to guide users of the tool towards more sustainable, cost-efficient alternatives, while taking into account their individual and personal circumstances.

Data Collection | Ferreira De Almeida Gonçalo | TUM

As part of a city-wide initiative led by München Unterwegs and the Mobilitätsreferat der Landeshauptstadt München, the goal of this project was to design a data-driven, personalised consulting service application that visualises the true cost of private car ownership and presents alternative mobility solutions available in Munich.
The initial stage involved the collection and analysis of a diverse range of datasets provided by the City of Munich. The first step was to assess the structure and relevance of the raw data and to identify the most relevant insights. Among the most informative datasets were modal split statistics that compared transportation behaviour in 2017 and 2023.[1]

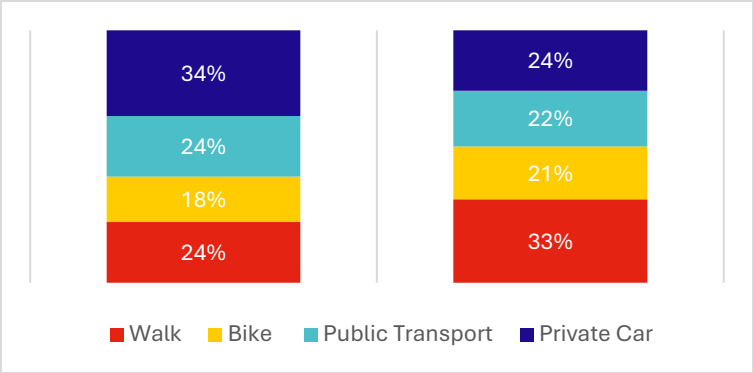

Figure 1: Modal split in Munich for the years 2017 and 2023

The figures illustrated a positive trend toward sustainable and active forms of mobility, with an increase in walking and cycling, and a notable drop in private car use, supporting the potential demand for personalized mobility consulting.
Research on the demographics of car buyers in Germany shows that 86% fall within the 18-34 age group, thereby defining a distinct target market for the digital service.[2]

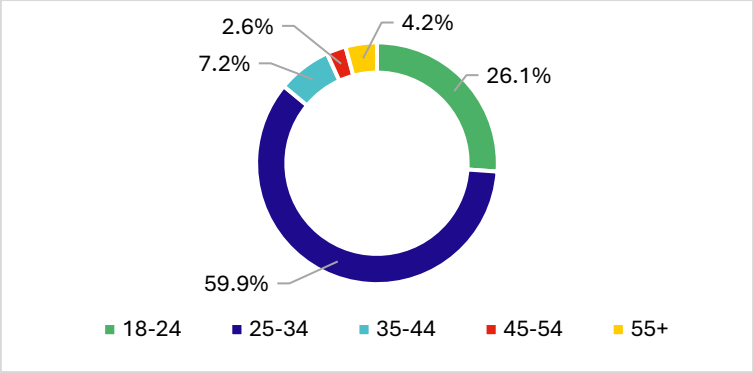

Figure 2: Age distribution of car buyers in Germany

[1] Landeshauptstadt München Stadtverwaltung, "Verkehr," 2024
[2] Start.io | Car Shoppers in Germany Audience, "Car Shoppers in Germany," 2024

Further analysis at the district level identified Altstadt-Lehel, Milbertshofen, and Thalkirchen-Obersendling-Forstenried-Fürstenried-Solln as the regions exhibiting the highest vehicle density, suggesting key regions for implementations.[3]

Follow-up research focused on the total cost of vehicle ownership across different vehicle categories (small, medium, large, and motorbikes) and propulsion systems (combustion and electric). Included in the analysis were costs related to CO_2 emissions-based taxes, insurance, parking (public, private, or owned), maintenance, fuel or electricity, and depreciation. These data points were combined to provide a comprehensive and realistic calculation of ownership costs for the specific user scenario.

To support comparative mobility decision making, an additional database was created, covering more sustainable alternatives such as the Deutschlandticket, bike-sharing systems, e-scooters, and car-sharing services. This enabled dynamic user-specified comparison between private car ownership and other mobility options within Munich.

Additionally, the dataset was expanded with external sources on environmental impact. As of 2023, new passenger cars in the EU emit an average of 108 grams of CO_2 per kilometre, while a single ChatGPT query emits approximately 2.5 to 5 grams. This comparison was included to assess the digital sustainability of the AI-based service. Although the implications will be discussed later, this data was essential during the collection phase to consider rebound effects and support AI integration.[4]

All collected data could, in the later steps, be integrated into the existing *mucGPT* system developed by the City of Munich. This integration sought to enhance the system's capabilities into a daily-use tool that provides personalized consulting services based on individual mobility profiles and real-time cost assessments. Further discussion of this integration is provided in the Conclusion and Outlook section. The quality of this data integration was evaluated using GPT-based models to assess the accuracy of the cost calculation and the relevance of the recommended sustainable alternatives.

The implementation of this evaluation in Figma, along with further investigation into the *mucGPT* system, will be discussed in the following sections of this report.

[3] Landeshauptstadt München Stadtverwaltung, "Verkehr," 2024

[4] European Environment Agency's, "CO_2 Emissions Performance of New Passenger Cars in Europe," 2024

Implementation | Schuster Quirin | TUM

The implementation phase of the project focused on building a functional prototype of a web application that calculates the real cost of car ownership and provides AI-generated, sustainable mobility alternatives tailored specifically for Munich residents. The goal was to translate complex analytical insights from the research phase into a playful, user-friendly, and interactive digital experience.

User Interface and Input Design

The front-end interface was first designed using Figma to simulate an intuitive user journey. Upon opening the application, users are guided through a structured set of questions aimed at collecting key data on their current car ownership or intended purchase. These inputs include vehicle type and fuel source, parking situation, lifestyle regarding mobility (e.g. holidays, short trips, hiking), and special needs for the means of transportation (e.g. disabilities or special space requirements).
To ensure playful use, the input process incorporates sliders, icons, and clearly labelled fields, allowing users to complete the questionnaire in just a few minutes. This design prioritizes accessibility and minimizes cognitive load, ensuring that users of varying technical backgrounds can interact with the tool easily.

User Interface and Input Design

Once users submit their data, the backend algorithm calculates the full annual cost of car ownership. This includes both fixed expenses, such as depreciation, insurance, and taxes, and variable costs like fuel or electricity, parking fees, maintenance, and repairs. All calculations are based on localized datasets from Munich, ensuring results that are accurate for each user.

Intelligent Alternative: AI-Generated Sustainable Mobility Scenarios

What truly sets the application apart is its ability to go beyond cost calculation and generate a smart, sustainable alternative to car ownership. Instead of merely presenting savings figures, the system offers a dynamic, personalized mobility scenario. This alternative is crafted to match the user's individual profile and lifestyle, combining various transport modes into one cohesive, realistic proposal.
The recommended mix may include public transportation (e.g., the Deutschlandticket via MVV and long-distance trains), cycling or e-bike options, e-scooters, and car-sharing services.
These are not generic suggestions. The AI engine, powered by GPT-based technology and designed for integration with *mucGPT*, Munich's local large language model infrastructure, creates tailored, context-aware transport profiles. Each recommendation reflects the user's

habits, preferences, and residential environment. Additionally, the system features an interactive chat interface that not only helps clarify the proposed mobility alternative but also allows users to customize it further, adapting the recommendation to their specific needs, preferences, or lifestyle changes.
This transforms the web-app into more than just a financial calculator - it becomes an intelligent assistant for sustainable mobility planning. Users don't just learn *what they could save*; they discover *how they could live* - with a concrete, personalized vision of life without owning a car.

Conclusion and Outlook | Hiltscher Yannick | HM

This project successfully demonstrates the potential of personalized consulting tools based on data to encourage choosing more sustainable transportation methods in Munich. By leveraging diverse datasets from the City of Munich (Mobilitätsreferat), the prototype app effectively visualizes the comprehensive cost of private car ownership and offers individualized, AI-powered mobility alternatives. The tool goes beyond static comparison - it creates dynamic, context-aware mobility scenarios that reflect the complexity of real-life travel behaviour and align with the city's sustainability goals.
Through careful analysis of costs, regional vehicle distribution, and demographic trends, the app identifies both economic and environmental incentives for users to reconsider car ownership. The integration of multiple transport modes into personalized recommendations ensures the tool remains relevant across diverse lifestyles, from young professionals in central districts to families in suburban areas. This individualized approach is further strengthened using AI-based technologies, which enable conversational refinement of mobility alternatives. By allowing users to interactively refine their preferences - such as adjusting commuting times, selecting preferred transport modes, or balancing cost versus speed - the tool becomes not just a source of information but a genuine mobility advisor. This interactivity increases user engagement and makes sustainable travel planning both intuitive and enjoyable.
From a technical standpoint, the web apps modular architecture and user-centric design lay the groundwork for scalable deployment. Developed with integration into the broader *mucGPT* ecosystem in mind, the tool can evolve into a robust public digital service. Its flexibility allows it to adapt seamlessly to ongoing policy shifts, real-time transport infrastructure changes, and new data inputs - ensuring its long-term relevance and functionality.
Moreover, the application has strong potential for adaptation beyond Munich. Its architecture allows for straightforward adaptation to other urban contexts with minimal reconfiguration. For example, cities like Hamburg, with unique public transport systems including water shuttles, could benefit from tailored versions of this tool. By adjusting data inputs and interface elements, the application could support a variety of urban mobility ecosystems and contribute to a broader national or even international effort to encourage sustainable urban transport.

All in all, this project presents a vision for a potential urban mobility transformation. By combining data analysis with intuitive design and AI capabilities, it shows how cities can get citizens to make smarter, greener and more affordable transportation choices. With further development and institutional support, it could become a useful tool for Munich's transition towards a more sustainable mobility ecosystem.