DESIGNING FOR SUSTAINABLE CITIES: A COURSE ON USER EXPERIENCE AND URBAN MOBILITY

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ABSTRACT
Sustainable urban mobility is crucial for environmentally friendly cities. Smart mobility solutions and digital platforms are key to this transition. This paper presents a User Experience (UX) course designed to equip students with skills and insights to create digital solutions for sustainable mobility. Focused on a metropolitan city in Eastern Europe, the course explored the intersection of design education and sustainable mobility, emphasising the critical role of digital platforms in reshaping urban mobility. The paper presents the course design and structure, two standout projects (a personalised route planning platform and a mobile app discouraging short-distance taxi usage) that exemplify the potential of digital solutions, and reflections on their design process and outcomes. The paper can inspire other design educators in planning and executing project-based design courses aimed at empowering students to contribute to more sustainable and resilient urban environments.

Keywords: Sustainable urban mobility, user experience, digital platforms

1 INTRODUCTION
The transportation sector is a major contributor to greenhouse gas emissions [1]. Developing sustainable mobility solutions that minimise environmental impact is imperative. Digital platforms help achieve this. For instance, mobile applications can encourage citizens to choose public transportation or active modes of transportation like walking and cycling (e.g., Ciclogreen). Ride-sharing services can promote car-pooling by providing a trustworthy and user-friendly service (e.g., BlaBlaCar). Recently, such platforms have proliferated globally and become prominent in reworking everyday urban transport. Still, issues like limited-service availability, technical problems, trust, privacy, and platform misuse impede their widespread adoption, hindering their sustainability potential.
Designing seamless interactions with these platforms is essential for smoother sustainability transitions. In this respect, training future designers to create digital solutions addressing complex urban mobility challenges is crucial. While design researchers showed considerable interest in studying the intersection between digital technologies and sustainable mobility [2], courses focusing on this intersection and studies examining such courses along with students' experiences are lacking from the literature.
To this end, this paper presents experiences of developing and managing a User Experience (UX) course aimed at equipping students with the skills and knowledge to design digital solutions that improve urban mobility while promoting sustainability. The course, which was centred around a metropolitan city in Eastern Europe, delves into the intersection of design education and sustainable mobility, highlighting the pivotal role of digital platforms in transforming urban mobility. This paper presents the course design and structure, along with two standout projects that exemplify innovative thinking and the practical application of sustainable urban mobility solutions (i.e., a personalised route planning platform and a mobile app discouraging short-distance taxi usage). The empirical data presented in the paper were derived from instructors' experiences and observations, the analysis of course outcomes, and students' reflections on the course. This paper can inspire other design educators in planning and executing project-based design courses that empower students to become innovative problem solvers capable of contributing to more sustainable and resilient urban environments.

2 BACKGROUNDS
According to a report from the European Environment Agency, transportation accounts for 71.7% of CO_2 emissions, and domestic transport is the only sector where greenhouse gas emissions have increased over the past three decades [1]. A more recent report confirms this trend, revealing that private cars

make up almost half of the transportation sector emissions, while cars and vans collectively account for around 10% of global CO_2 emissions [3].
Digital platforms can offer substantial benefits for sustainable mobility. They can encourage more sustainable modes of transportation such as public transportation, walking, and cycling (e.g., [4–6]). Platforms offering micro-mobility solutions (e.g., Lime) have been proven to reduce car dependency and lower greenhouse gas emissions in urban areas [7]. Furthermore, platforms like BlaBlaCar provide ride-sharing services, bridging the gap between traditional public transport and private car ownership. These services contribute to reducing the number of private vehicles on the road, leading to decreased congestion, lower emissions, and improved urban air quality [8, 9]. Within the past two decades, such digital interventions have appeared all around the world. Digital "shared mobility" platforms and emerging, more sophisticated "mobility-as-a-service" platforms, which coordinate multiple discrete services into a single portal, have risen to prominence in cities [10]. As these technologies are becoming a part of urban life, designing our interactions with them in a seamless way has become essential.
[Anonymised] is a large city in Eastern Europe with a population of over 16 million. In parallel with its size, it offers various modes of transportation, including public transportation options like Metro, Tram, Funicular, Bus-Rapid Transit (MetroBus), Bus system, Ferryboats, private cars, and bikes. The city has an estimated 30 million daily urban commutes, 31.6% of which were done by private vehicles or shuttle services. In 2021, its transportation sector alone generated approximately 50.6 million tons of CO_2, accounting for 10% of the country's total emissions. Notably, the transportation sector stands as the second-largest contributor to these emissions, with a substantial 28% share [11].
Creating sustainable, inclusive, effective, and active mobility has been an important goal of the city's vision [11]. However, there are many barriers to achieving this goal, such as the lack of integration between active modes of transportation and public transportation [12], individuals' tendency to prefer private cars over public transportation due to perceived comfort, and the emotional and cultural value of private cars [13, 14].
In line with the global mobility trends, several digital platforms operate in the city, encouraging sustainable modes of transportation. For instance, a super mobility app has been recently introduced to the market to offer various transportation services to its users, including ridesharing, e-scooters, and e-bikes. Besides such local initiatives, global platforms like BlaBlaCar and Uber have also started operating in the city. Despite all these efforts and the introduction of new platforms for supporting sustainable mobility, the dominant mobility option is still commuting by car.

3 USER EXPERIENCE COURSE

The UX course was offered for the Spring 2023 semester at Authors' University. 11 undergrad students (junior and senior level students) took the course. The students previously took courses on Basic Design, Design Thinking, Creative Thinking, and UX Principles, which helped them learn the fundamentals of design, design methods, and UX research and design. The course was project-based, and it aimed to i) provide students with an opportunity to incorporate their existing UX knowledge into practice, ii) familiarise them with the iterative process of user-centred design, and iii) help them work on a real UX problem under the supervision of experts. The UX challenge they worked on was "exploring new digital solutions to support sustainable modes of transportation in [Anonymised city]". They were expected to select a problem and were given the option to work as teams or individually. The course duration was 14 weeks. It consisted of six phases, following a regular design thinking process.

- **Onboarding (3 weeks):** This phase was designed to integrate sustainability into UX design by engaging students in academic literature on sustainable mobility, technologies to support sustainable mobility, motivating sustainable mobility behaviours through design, and issues and solutions in the local context. Each student was allocated readings on these topics and asked to summarise them before class. The readings and the discussions held in class hours allowed students to develop an understanding of sustainable mobility.
- **Empathy (3 weeks):** In this phase, they conducted desk research to expand their understanding of the problem and the solution area and frame their project goal statement. They also conducted exploratory user research, surveying or interviewing current and prospective users of the city's urban mobility system (Subway, bus, bike) and associated technologies (e.g., mobility apps) as well as domain experts (e.g., planners, policymakers, urban designers, and governmental officials).
- **Define (1 week):** In this phase, they synthesised the insights gained through user research and desk research into empathy maps, user experience journeys, and goal statements.

- **Ideate (2 weeks):** Although two weeks were allocated to this phase, idea generation started at the beginning of the semester and continued till the end. The students utilised various techniques, including rapid brainstorming, associative brainstorming, and reverse brainstorming. They combined ideas generated prior to this phase and created new ones during an in-class exercise.
- **Prototype (2 weeks):** Based on the feedback derived from the preliminary jury, the students revised their concept and rapidly developed a prototype via low or mid-fidelity prototyping tools such as wizard-of-oz prototypes, video sketches, or interactive prototypes.
- **Test (3 weeks):** In this phase, the students assessed whether the envisioned concept addresses their design goal by conducting evaluative research with potential users. Based on insights gathered from the evaluative research phase, the teams revised their design concept, developed a mid to high-fidelity prototype, and finalised the envisioned scenario.

A preliminary jury right after the ideate phase, and a final jury after the testing phase were organised. The jury consisted of the course instructors, who have profound knowledge of sustainable design, and external members with mobility planning expertise who work in the municipality's planning agency. The goal was to assess students' progress and ensure that their projects align with sustainable mobility.

4 THE UX PROJECTS CREATED WITHIN THE SCOPE OF THE COURSE

There were six projects presented to the jury. These were 1) A car-pooling app specialised for Author's university community to reduce solo car travels, 2) A bike rental and navigation app to encourage cycling in the city, 3) A route-planning app to encourage public transportation through personalised route planning, 4) A travel companion app aims to create a sustainability culture around commuters through gamification, 5) A route planning app to discourage short distance taxi usage and encourage public transportation or ridesharing, and 6) A mobile app aiming to transform public transportation spaces into art spaces through virtual exhibitions and events. The third and the fifth were selected for this paper since they received higher grades, they explained their concept clearly in the final reports, which were submitted at the end of the semester, and their approach to sustainable mobility differed, emphasising the nuances between projects, though they worked on similar problems and solutions.

4.1 Project 1: BeamUP

The team's primary challenge was the excessive reliance on short-distance taxi usage in [Anonymised] city. During their literature review, they found that private car usage both increases the city's traffic and air congestion, and they focused on a solution that prioritises public transportation. They then conducted interviews with 6 frequent private car users and 6 taxi users and learned that despite the availability of alternative transportation options, people often resort to taxis, even when they are within walking distance or very close to their destination. In a way, commuters prioritise comfort and speed over affordability. Upon this discovery, the team decided to work on a solution addressing this phenomenon, framed as taxi addiction.

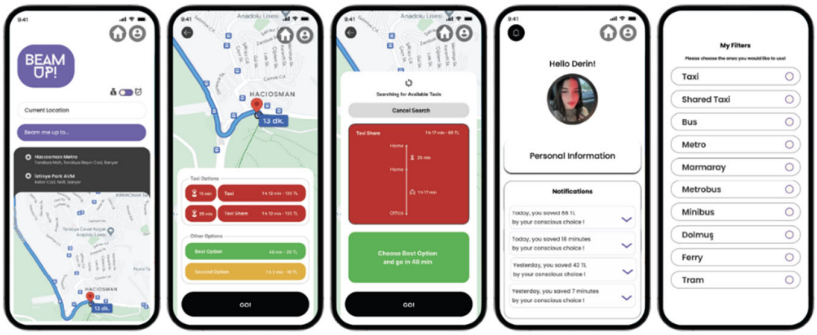

Figure 1. Example screens for BeamUP App

Their response to this challenge was The BeamUP (Figure 1), which was an app to discourage short-distance taxi usage. While the app allows users to plan routes using all forms of public transportation, including taxis, it also provides a platform for frequent taxi users to compare their alternatives with more environmentally friendly, time-efficient, and cost-effective ones, which are referred to as the "Best Option". The users can filter transportation options for a customised plan, which were designed to attract

dedicated taxi users reluctant to use public transportation. Instead of "punishing" these users by disabling the taxi option (and prioritising other, more environmentally friendly options), it allows them to disable public transportation options they do not want to use and choose a taxi share option. The user testing they conducted with 10 potential users showed that the combined use of taxis and public transportation in mobility planning was appreciated.

4.2 Project 2: Gezgin

This team identified their problem after surveying 35 participants and interviewing 12 participants. This exploratory user research revealed that the current mobility services and route planning apps are inadequate due to their lack of consideration for individual preferences, discouraging locals from using public transportation. They also observed that residents often consult with friends when planning a route, since they trust this information more than the information that can be found in existing planning apps. The identified target problem was the lack of a mobility service offering a seamless and personal mobility experience. The city's complex transportation system, with its diverse transportation modes and diverse user preferences, necessitates a holistic mobility service. Thus, they aimed to get people to use public transportation, making it a viable and desirable option by designing a personalised route planning app (Figure 2). Gezgin app provides individuals who intend to use public transportation with a service that will transform the city's vast and complicated mobility network into an approachable one by offering a customised, reasonable, and reliable mobility experience. It provides personalised route suggestions by considering users' familiar routes and preferred transportation methods and finds more predictable and validated recommendations from friends and family. It further supports using public transportation through a loyalty program that utilises a point system, challenges, and rewards. The surveys they conducted with 30 participants and user testing done with 10 participants at the end of the project revealed that prospective users liked the app and found it useful, easy to use, and clear.

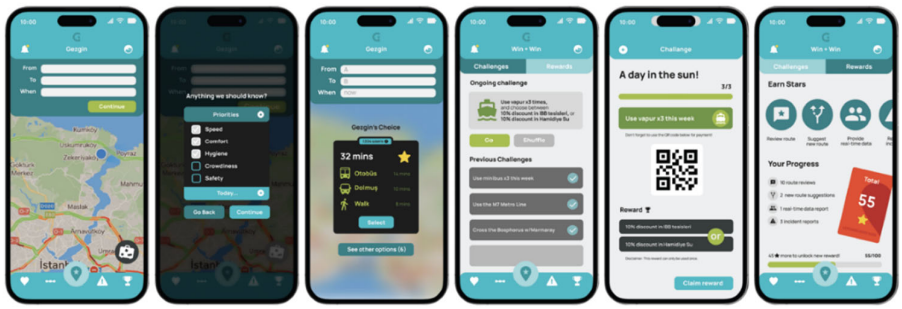

Figure 2. Example screens for Gezgin App

5 REFLECTIONS ON STUDENT PROJECTS AND THEIR DESIGN PROCESS

Students conceptualise that sustainable urban mobility is not only about reducing carbon footprints but also about creating a comfortable mobility experience for commuters. Both Gezgin and BeamUP aim to provide personalised route planning to increase users' comfort. While the former does this by identifying safe and comfortable routes according to commuter preferences, the latter does it by prioritising costs over convenience. This strategy is in line with the literature, indicating that factors like status, financial independence, safety, and hedonic motives are quite important in predicting commuters' mobility purchase intentions besides environmental motives [15]. Both projects aim to encourage behaviour change. While the BeamUP app discourages short-distance solo taxi usage by creating friction during route planning[16], the Gezgin app encourages public transportation by providing trustworthy (real-time reporting of incidents by app users) and highly personalised route planning (personalised filters) [17].
Furthermore, both teams directly targeted local mobility problems (short-distance taxi usage in the case of BeamUP, a multitude of mobility options, and a lack of personalised route planning solutions in the case of the Gezgin App). This is in line with environmental psychology literature, indicating that contextual factors such as the quality of public transport or availability of time and money are influential in encouraging people to perform environmentally responsible behaviours [18, 19]. This observation reveals an important implication for adapting the course design to other cities: the discovery of problems relevant to the local context through focused literature review and exploratory user research is crucial for creating solutions relevant to the local context.

As for the reflections on student teams' UX processes, the reflection reports they submitted at the end of the semester emphasise certain aspects. The five students who participated in the development of the BeamUP App and the Gezgin App found the task very challenging, i.e., designing a digital solution to support sustainable mobility practices in [Anonymised city]. One student from the Beam Up team exemplifies this with the following: "…I had thousands of problems in my head as I was coming up with ideas and trying to solve them, but I couldn't get past the notion that if there were a solution, it would already be in use". Besides, they observed that commuter behaviours and habits cannot be easily changed with the help of digital technology, further increasing the perceived complexity of the project. Nonetheless, according to their reflections, various aspects of the course design helped them progress and overcome the feeling of stress stemming from this complexity. First, working on a problem at a local scale did not require them to familiarise themselves, as they were already experiencing the problem firsthand. This familiarity also facilitated their exploratory research; finding participants and relating to their experiences was easy, according to students. For instance, one student from the Gezgin team stated the following: "Being familiar with the project topic made it easier to come up with user scenarios, and once again, it made me realise the importance of user research. One thing I always criticise myself for is not talking to more people. It feels satisfying to talk to the target group and witness the bigger picture becoming clearer." Second, engaging in discussions around sustainable mobility during the onboarding phase, along with sharing the user research results with other teams, helped them find the "right" design direction. Third, feeling in charge of the process gave them a sense of control over their ideas, allowing them to evolve their solutions according to their preferences. Fourth, feedback obtained from the users, tutors, and external jury members helped them understand the weaknesses and strengths of their solutions and create more effective ideas. One student from the Beam Up team illustrated this with the following: "Although I was in such complexity during the beginning of the course, the feedback sessions we had before and after the preliminary jury were very effective in my understanding of the actual situation and forming a more effective design idea".

6 CONCLUSIONS

Digital platforms can facilitate the transition towards sustainable urban mobility practices. As technologies advance rapidly, designing positive user experiences is crucial for the success of these platforms. This paper presented a course at the intersection of UX and sustainable mobility. Through the course design and two example projects, the paper emphasised the pivotal role of digital platforms in reshaping urban mobility. The reflections on the course outcomes and students' processes revealed important takeaways for integrating sustainable mobility into UX design education. First, studying sustainable mobility through contextual problems nurtures students' familiarity with the problem area, helps them formulate actionable design goals. Second, sustainable mobility has aspects beyond carbon footprint reduction, thus requiring a holistic and user-centred lens to problem-solving. Third, giving students control over their project process, leveraging feedback from various sources (tutors, users, external experts) and interactions among different teams, particularly during the early stages (onboarding and exploration research), helps them embrace the iterative nature of design and make progress within a complex design space.

The generalisability of the results should be considered in accordance with sample size and study context. The paper presented a semester-long course taken by 11 students, and the analysis presented two projects. Furthermore, the students who took the course had familiarity with design principles and the UX design process. Teaching this course to students without a design background might be challenging, as their unfamiliarity with the design process hinders smooth progress. In conclusion, this paper serves as an inspiration for design educators, guiding them in planning and executing project-based design courses that empower students to contribute to sustainable and resilient cities.

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REFERENCES

[1] European Parliament CO2 emissions from cars: facts and figures (infographics) | Topics | European Parliament 2019, March 22. Retrieved February 27, 2025, from

https://www.europarl.europa.eu/topics/en/article/20190313STO31218/co2-emissions-from-cars-facts-and-figures-infographics.
[2] Sadeghian S., Wintersberger P., Laschke M. and Hassenzahl M. Designing Sustainable Mobility: Understanding Users' Behaviour. *Main Proceedings - 14th International ACM Conference on Automotive User Interfaces and Interactive Vehicular Applications*, AutomotiveUI 2022, 34–44. https://doi.org/10.1145/3543174.3546833.
[3] Tiseo I. Global CO2 emissions by year 1940-2024 2025, January 15. Retrieved February 27, 2025, from https://www.statista.com/statistics/276629/global-co2-emissions/.
[4] Meurer J., Lawo D., Janßen L. and Wulf V. Designing Mobility Eco-Feedback for Elderly Users. *Conference on Human Factors in Computing Systems - Proceedings 2016*, 07-12-May-2016, 921–926. https://doi.org/10.1145/2851581.2851599.
[5] Cellina F., Bucher D., Raubal M., Rudel R. and Rizzoli A. E. Promoting sustainable mobility styles using eco-feedback and gamification elements. *Introducing the GoEco! living lab experiment*. 2016. Retrieved from http://www.uc.pt/en/org/inescc/org_scientific_events/behave2016.
[6] Froehlich J., Findlater L. and Landay J. The design of eco-feedback technology. *CHI - Proceedings 2010*, 3, 1999–2008. https://doi.org/10.1145/1753326.1753629.
[7] McQueen M., Abou-Zeid G., MacArthur J. and Clifton K. Transportation Transformation: Is Micromobility Making a Macro Impact on Sustainability? 2020, 36(1), 46–61. https://doi.org/10.1177/0885412220972696.
[8] Mitropoulos L., Kortsari A. and Ayfantopoulou G. A systematic literature review of ride-sharing platforms, user factors and barriers. *European Transport Research Review 2021*, 13(1), 1–22. https://doi.org/10.1186/S12544-021-00522-1/TABLES/4.
[9] Shaheen S., Stocker A. and Mundler M. Online and App-Based Carpooling in France: Analysing Users and Practices—A Study of BlaBlaCar. *Lecture Notes in Mobility 2017*, 181–196. https://doi.org/10.1007/978-3-319-51602-8_12.
[10] Stehlin J., Hodson M. and McMeekin A. Platform mobilities and the production of urban space: Toward a typology of platformisation trajectories 2020, 52(7), 1250–1268. https://doi.org/10.1177/0308518X19896801.
[11] İstanbul'da Sürdürülebilir Ulaşıma Doğru 2023. İstanbul. Retrieved from https://ipa.istanbul/yayinlarimiz/genel/istanbulda-surdurulebilir-ulasima-dogru/.
[12] Canitez F., Alpkokin P. and Kiremitci S. T. Sustainable urban mobility in Istanbul: Challenges and prospects. *Case Studies on Transport Policy 2020*, 8(4), 1148–1157. https://doi.org/10.1016/J.CSTP.2020.07.005.
[13] Canitez F. Sustainable Urban Mobility in Istanbul: Transition and Planning. *Journal of Intelligent Decision Making and Information Science 2024*, 45–54. Retrieved from https://jidmis.org/index.php/jidmis/article/view/11269/8375.
[14] STEG L. Can Public Transport Compete with The Private Car? *IATSS Research 2003*, 27(2), 27–35. https://doi.org/10.1016/S0386-1112(14)60141-2.
[15] Herberz M., Hahnel U. J. J. and Brosch T. The importance of consumer motives for green mobility: A multi-modal perspective. *Transportation Research Part A: Policy and Practice 2020*, 139, 102–118. https://doi.org/10.1016/J.TRA.2020.06.021.
[16] Cox A. L., Gould S., Cecchinato M. E., Iacovides I. and Renfree I. Design frictions for mindful interactions: The case for micro boundaries. *Conference on Human Factors in Computing Systems - Proceedings 2016*, 07-12-May-2016, 1389–1397. https://doi.org/10.1145/2851581.2892410.
[17] Berkovsky S., Freyne J. and Oinas-Kukkonen H. Influencing Individually. *ACM Transactions on Interactive Intelligent Systems (TiiS) 2012*, 2(2). https://doi.org/10.1145/2209310.2209312.
[18] Ertz M., Karakas F. and Sarigöllü E. Exploring pro-environmental behaviours of consumers: An analysis of contextual factors, attitude, and behaviours. *Journal of Business Research 2016*, 69(10), 3971–3980. https://doi.org/10.1016/J.JBUSRES.2016.06.010.
[19] Steg L. and Vlek C. Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology 2009*, 29(3), 309–317. https://doi.org/10.1016/J.JENVP.2008.10.004.