TUC Ridesharing: A University-Oriented Social Ridesharing App

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ABSTRACT

The transition towards a Circular Economy, which constitutes a critical building block towards sustainable development, requires systemic shifts that prioritize resource efficiency and sustainable modes of consumption and production, among other factors. One such systemic shift is the enabling of various instantiations of the so-called *sharing economy*. Sharing economy (Bradley & Pargman, 2017; Daglis, 2022; Ganapati & Reddick, 2018) is a type of economic paradigm based on the sharing among peers. It typically involves peer-to-peer transactions for the shared use of goods and services using the Internet to share space, resources, and workforce. Arguably, it represents a practical pathway toward sustainable development by promoting resource efficiency, lowering environmental impact, and fostering new patterns of collaborative consumption while reducing the need for new production.

Typical sharing economy examples include *peer-to-peer accommodation services* and *ridesharing (or carpooling)*. Airbnb, VRBO, Uber and Lyft are among those companies that utilize this model. They take advantage of the underutilization of products and services in order to benefit financially but at the same time reduce waste, costs and improve the overall efficiency within the community.

Ridesharing (Asproudi 2023; Pagkalos 2021; Bistaffa et al., 2021; Bistaffa et al., 2017; Bistaffa et al., 2015) in particular, is fundamental to collaborative sustainable mobility. It is a form of shared transportation where different individuals share a common vehicle for their trip. This leads to the minimization of the individual costs for each participant and the maximization of efficiency. There are two main categories of ridesharing. The first one is *non-commercial ridesharing*, which is a peer-to-peer, a cost sharing and non-profit way of sharing a vehicle between people that travel in the same direction. Usually, the participants of the coalition are not professionals, and the arrangement occurs without using a specific platform, thus not considered a commercial service. The second is called *ride-hailing* or *mobility as a service (MaaS)*. In this case, a professional driver offers the service through applications like Uber and Bolt. There is no cost sharing but rather a fee that depends on the distance and the time that the vehicle is occupied.

The advantages of ridesharing are multiple and considerable (Bistaffa et al., 2021). A large-scale adoption of this model could significantly reduce traffic congestion in urban environments by minimizing the number of moving vehicles needed to serve the needs of their citizens, especially in cities that are currently flooded with vehicles and suffer from high CO_2 emissions. Higher emissions are strongly linked to severe climate change effects, while poor air quality from pollution continues to threaten the health and quality of life of citizens. Moreover, densely populated cities are becoming increasingly hotter due to urban heat and pollution, which triggers higher energy usage for cooling, creating a vicious cycle of demand for energy. Ridesharing also alleviates the pressure on land use, as fewer vehicles reduce the demand for large parking footprint, enabling cities to reclaim valuable space that can be devoted to green areas and community amenities. At the same time, the reduced costs of traveling—by splitting fuel and other expenses—make ridesharing more attractive for all the parties involved.

For the city of Chania, Crete, in particular, the implementation of ridesharing services is arising as an arguably imperative need, as the existing (privately operated) public transportation system is expensive and operates on rather irregular schedules. Moreover, the routes are infrequent and there is crowding during rush hours. This mostly negative image is painted and reinforced by recent studies (Ministry of the Interior et al., 2025; Boyiatzis, 2025). In particular, in the Public Services Evaluation Report conducted by the Greek Government (Ministry of the Interior et al., 2025), the Chania public transportation system scored an underwhelming 4.7 out of 10, based on the citizens' opinions.

Against this background, in this work we put forward a ridesharing solution by developing a ridesharing smartphone application (app) for the community of the Technical University of Crete (TUC) at Chania, titled *TUC Ridesharing*. The app uses a modern and minimalistic User Interface (UI) that is combined with a lightweight backend that runs 24/7/365. Our application employs a novel algorithm for suggesting rides to passengers via checking whether the passenger requested ride can be made to at least partially match one of the offered driver routes, and checking the satisfaction of various spatial, capacity, and time constraints. Essentially, our approach constitutes a novel method for *coalition formation* (Chalkiadakis, G., Elkind, E. and Wooldridge M., 2011) in this setting. An overview of approach can be seen in Figure 1.

Our main contributions can be summarized as follows:

- This is the first time a cross-platform ridesharing system is developed at a Greek university and for the community of a Greek university; in fact, to the best of our knowledge, it is among the very few university-oriented, cross-platform ridesharing applications worldwide.
- We identified requirements for this problem domain; identified specific use case scenarios; and specified a ridesharing protocol that efficiently connects passengers and drivers in a simplistic and convenient way.
- We created graphs with specific stops that connect the TUC campus to the 5 most popular destinations in the city of Chania, on which the users can travel bidirectionally. Apart from taking into consideration the spatial, time and capacity constraints, we created popular graph-based routes for Chania, so that we can simplify the ridesharing procedure. Thus, Usability is enhanced, as the app gives the user the feel that the system resembles a fixed-route bus service.
- The app utilizes the CAS authentication protocol to ensure that only verified members of the Technical University of Crete can access and use it, something that enhances safety, trust and accountability.
- The app supports both passenger and driver modes, giving users the flexibility to switch roles within the same app without needing to switch to another.
- Passengers can see all available rides and drivers can see all passenger requests; all in real-time through dedicated screens, something that improves visibility on both sides
- A “Community” screen is implemented, that displays all the TUC users that use the app (respecting any sensitive data), which boosts engagement and the “feeling of being part of a community”.

In terms of implementation, *TUC Ridesharing* is a cross-platform Android and iOS application with a common FastAPI python backend. A Kotlin Multiplatform Project (KMP) houses the front-end application logic and the Android UI. The architecture of the app is MVVM (Model-View-ViewModel) so that the app is modular, easier to maintain and expand in the future. Native UIs are built in order to enhance the user experience on both OSs. We followed the *Material You* guidelines for the Android frontend using the Jetpack Compose framework and Kotlin language. For the iOS part we followed those of the *Apple Human Interface* using the *SwiftUI* framework and the *Swift* language. Thus, we achieved a clean, modern, and cohesive experience for the users on both platforms.

The two front-ends communicate with the back-end through *REST* endpoints, WebSocket streams and notifications. The backend consists of a *CAS* authentication module that is responsible for the institutional authentication of the users, a *PostgreSQL* relational database that holds the user and ridesharing data, the match-making algorithm that handles the ride and request pairing, and the notification module that sends notifications to the smart-phones using the popular *publish-subscribe* messaging pattern.

The testing phase is taking place in the City of Chania from the 21st of July 2025 and is expected to continue until the end of September 2025. Throughout this period users can submit feedback via the application. The evaluation process is based on the System Usability Scale (SUS), and an online questionnaire. The latter is comprised of four individual sections: (a) the user demographics, (b) the 10-item SUS questionnaire, (c) the issue reporting section, and (d) the feature request section.

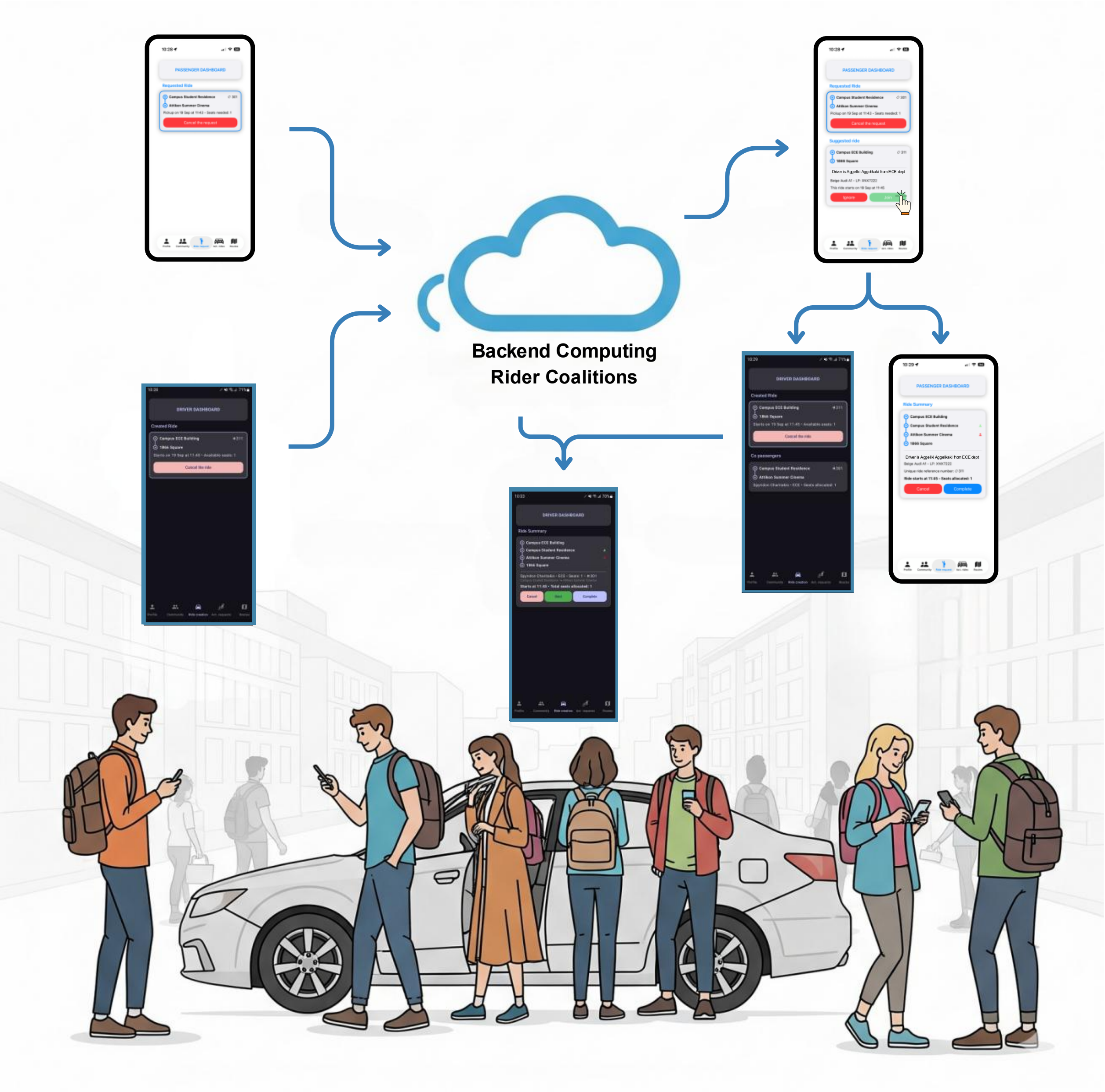

Figure 1. Match-making process overview. A passenger creates a ride request and a driver a new ride. The backend receives the data, and the match-making algorithm generates a suggested ride that the passenger receives. The passenger joins the ride and sees the ride summary. At the same time the driver receives the details of the passenger that joined. Before the ride starts, the driver receives the final passenger list, and the driver ride summary card is created.

This work paves the way for the future. First and foremost, we intend to improve the user experience via (a) considering the comments of a large user evaluation and beta-testing process we currently run; and (b) allowing the users themselves to develop new routes and stops. Another key extension is the incorporation of some game-theoretic *cost sharing mechanism* (Bistaffa, Farinelli, Chalkiadakis & Ramchurn, 2015; 2017) into the system. The integration of such a method into the system will provide a *fair* and *transparent* way of distributing travel costs among passengers, considering factors such as distance, fuel cost, number of passengers, and the initial cost of the trip had the driver taken it alone. Such methods can improve the app sustainability and user acceptance, since, e.g., the drivers will be compensated for the extra distance travelled and their effort in submitting their routes to the system.

A second proposed extension is the integration of a multiagent system like the one described by Moraitis et al. (2003). The server can host different kinds of agents, like (a) passenger, (b) driver, and (c) matching agents.

For example, instead of having a centralized coalition formation algorithm that sends out data to the users, we could replace it with an agent-centric solution that will enable peer-to-peer matching, something that would reduce the load on the system. Each user can have their own personal agent that will take into consideration the preferences, ride history and only attempt to match with users whose preferences and history align. This would greatly reduce the number of cancelations and improve the overall application speed, usage and user satisfaction. Finally, the use of appropriate coordination protocols between agents can further refine the details of the shared ride (Spanoudakis & Moraitis, 2022).

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