

Empirical Analysis of Demand Patterns and Availability in Free-Floating Carsharing Systems

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Abstract—Carsharing (CS) services enable users not to have to depend on a privately owned vehicle by supplying cars for spontaneous rental. Optimized service, higher system availability and a more efficient urban transportation system can be obtained by analyzing a wide usage behavior and diurnal patterns within such a system. In order to gain a deeper understanding of the spatio-temporal behavior of such a service, it is vital to distinguish different demand patterns occurring within urban areas. We therefore analyze the demand for carsharing in the city of Munich, Germany. Based on data of a free-floating carsharing (FFCS) service provider we analyze rentals, drop-offs, and resulting availability of vehicles within different urban areas as well as develop diurnal demand patterns and cluster these by incorporating an incremental cross-correlation clustering. The compiled pattern clusters reveal notable distinctions in terms of demand, returns, and vehicle availability between the examined areas. By recognizing and analyzing these distinctions, FFCS will be able to adapt to new business areas, service operation, and pricing strategies in order to optimize their service.

Keywords—carsharing, demand patterns, usage behavior, spatial analysis

I. INTRODUCTION

Over the years FFCS services have gained popularity most notably among urban dwellers in large cities [1]. The idea behind this success is the opportunity for users to choose the best means of transportation available for every single leg of a daily itinerary through a city solely depending on factors like location, destination, urgency, baggage, or traffic situation. This decision is independent of any regret leaving the own car somewhere in the city to be recollected later, since it was not utilized in the first place. However, this flexibility for users implies a big challenge for FFCS system operators. In order to operate such a system, it is vital to understand customers' demand and behavior to optimize the system in terms of spatial and temporal supply of vehicles. So far, research primarily focused on whole systems and analyzed demand rather as a holistic phenomenon occurring uniformly over the considered business area of a provider. In this work, a microscopic

analysis of selected areas was performed in order to find differences in demand, drop-offs, and availability, which facilitate local optimization approaches. By analyzing rental data of a German FFCS provider, diurnal patterns of demand, drop-offs, and availability for each of the selected areas were derived. Furthermore, compiled demand patterns were clustered by utilizing an incremental cross-correlation clustering, revealing two main types of demand patterns. Moreover, special areas with distinct patterns were found, not resembling those of revealed main clusters. Knowledge of such patterns and their distribution among areas can help to optimize the business area's shape, service operations, as well as the application of pricing strategies, enhancements in supplying vehicles to customers in demand, and a general understanding for other purposes like city planning or optimization of fleet operations with autonomous vehicles. This paper is structured as follows: an outline of current research within this topic is given. Then the current state of CS is characterized and the motivation on demand patterns and their applications is presented. Subsequently, the incorporated data and the applied implementation are described. The resulting patterns are then presented and analyzed. In the final section, results are discussed as well as future opportunities.

II. RELATED WORK

There have been various studies analyzing demand within sharing systems. An empirical analysis of FFCS data was conducted in [2]. By analyzing rental data from the cities of Berlin, Germany, and Munich, Germany, the development of CS in these cities could be characterized. The authors were able to show temporal variability in rentals as well as usage differences between particular weekdays by outlining an average weekday pattern that is consistent over two cities. Diurnal usage and specific differences in average patterns of both cities were revealed. Furthermore, spatial hotspots of usage based on the starting locations of the considered bookings were identified. After all, authors gave an insight of the usage of an FFCS system as a whole but do not analyze usage patterns on a more local level.

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