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# The effect of spatial and temporal flexibility on the profitability of one-way electric carsharing systems

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## Abstract

Carsharing is an advanced car rental service, which allows its users to rent vehicles for a short period. One-way carsharing systems allow users to drop-off rented vehicles to different spots than where they are picked-up. Although one-way systems offer additional flexibility to their customers, i.e. using different pick-up and drop-off stations, the operators do not prefer because of the additional complexity that one-way option brings. To have an acceptable level of service, the vehicles and empty spots should be at the right place and time. One-way systems also experience demand imbalances between stations throughout the day. For these reasons, one-way systems require relocation of vehicles between stations. Either a group of personnel and/or the users (with positive incentives) execute relocations. One of the ways of decreasing relocations without compromising the service level could be providing spatial and temporal flexibility to users with incentives. If the operator can offer a pick-up time not very earlier/later, and origin and destination stations not very distant than the users asked for, with an incentive (i.e. discounted rental fee), the operator can serve its users with fewer relocations. For this reason, we developed a solution framework that decides on detailed relocation operations, and demand reject/accept (with alternative) decisions simultaneously. Experiments with real data have shown that 1km pick-up and drop-off location distance flexibility and 60 minutes pick-up time flexibility, increase the profit of the non-flexible system over 10% by increasing the number of demand served over 25% and decreasing the personnel cost by over 60%.

**Keywords:** one way carsharing, vehicle relocation optimization, integer programming, network flow, spatial and temporal flexibility

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