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SIMULATION-BASED PRICING FOR A RIDESHARE MODEL

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ABSTRACT

This case study contributes to modelling and simulation suited for contexts where ridesharing services are rolled-out in areas characterised by low income, poor accessibility to public transport and/or hard-to-reach essential services. It is inspired by the first author's experience in working with a U.K-based company under a completed industrial project "Pricing and Incentives for New Transport Solutions in Towns and Small Cities". Applying concepts from revenue management and industrial organisation (a sub-field in economics), we develop a demand model and pricing formulae. These are combined with simulation to understand key market levers for juggling both profitability and affordability. We find that the trade-off between profitability and affordability is an interplay of factors in potential market size, competition dynamics, and passengers' willingness to pay (WTP). We also hope to share learnings and reflections from the academic-industry collaborative project.

1 INTRODUCTION

Uneven dispersion of population often leads to a higher transport cost for those who live in rural areas. According to a study from Guardian (2019), London residents usually pay less for a single bus ticket than their counterparts living in big towns like Hampshire. Moreover, people living and working in rural areas are affected by frustratingly limited and expensive transport options (UK Department for Transport 2021.) Mobility plays a key role in social inclusion and well-being, with implications for inequality towards the distribution of job opportunities, education, and other essential services (e.g., healthcare and grocery shopping). According to Gates et al (2019), many U.K rural areas remain hit by a mismatch between "where people live" and "where job opportunities are". To resolve such inequality, ridesharing popularised by Uber and Lyft seems promising. However, one cannot simply lift an existing model and deploy it in rural areas where the population is more dispersed. Thus some fundamental changes are made in our case study: **First**, a unique demand-triggered system, partnering with taxi, van, and mini-bus providers, was adopted to ensure no wasted running capacity with implications for greener transport provisioning. Without ownership of any vehicles, the ridesharing firm in the case retains its "asset-light" feature just like Uber or Lyft. **Second**, ridership is not predicated on real-time matching between supply and demand, but one that is based on demand expressed through a reservation system (either through phone calls or using web-based technology). With advanced demand information, the ridesharing firm can organise the resources needed to meet demand. It is worth noting that such a system is also vulnerable to cancellations or no-shows. **Third**, this service is rolled out to employees of local companies, agencies and education providers. The service resolves unreliable transport by converting rented vehicles into shared shuttles for workers, benefiting those who live in remote areas.

What key market levers could be important for the uptake of their services, in particular pricing for shared transport? To gain further insights, we use a mathematical model and then simulation to understand how a variety of features such as market size, consumers' willingness to pay, trip shareability, vehicle mix, and rental cost structures can affect profitability under various price points.

2 MODELLING & SIMULATION OVERVIEW

One important role of our simulation is to evaluate the profitability of a hypothetical ride-sharing service for a major employer (a logistics company). The demand for the service is simulated through a three-step approach: First, we simulate the number of workers, including how they are spatially distributed in the nearest towns adjacent to the employer's location. Second, we simulate workers' willingness-to-pay (WTP) based on uniform random variables whose bounds are set by bus and (distance-based) taxi fares. Third, we count the number of "booked" or "reserved" seats at a given price whenever a worker's surplus (i.e., simulated WTP minus price) of service consumption is positive. The simulation then proceeds to allocate spaces to those bookings in shared taxis and calculate the costs for each trip for each "passenger". We repeat the process at various price points, feeding those estimated demands into a tailored optimisation model that captures both profitability and affordability. This allows us to evaluate profit margin based on the price of each trip, cost per vehicle and the required number of vehicles needed to meet the projected demand. The approach can easily be adapted to recommend the appropriate mix of vehicles (that is, vehicles ranging from taxis to shuttle buses of various capacities). Key information including (estimated) vehicle rental prices and refuelling costs is required during this exercise. Overall, our model combines various revenue management and econometric principles. The simulation-based optimisation approach is scalable and flexible to incorporate policies that includes publicly funded subsidy models (an example of governmental intervention) and risk-sharing (under circumstances when there is not enough demand).

3 CONCLUSION

In the first simulation, the passengers were able to share a taxi ride for £3.50 each trip. By applying appropriate parameters of the passengers' characteristics, this price yields a profit margin in the range of 16% to 30%. Further experimentations were then conducted using bus and van (with average profit margin ranging between 10% to 25%). From the pricing perspective, we were able to evaluate the trade-off between two risks: "unable to make a profit" and "pricing out consumers who need the service". There is potential in using this approach to determine the value of additional options such as advanced booking or a guaranteed seat, on the basis where one simulates additional willingness to pay for these "premium" services. For the longer term, there is tremendous value to incorporate software engineering when the transport service is offered at a larger scale.

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