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Streamlining deliveries through crowdsourcing

By ***Alp Arslan***

Internet shopping is taking an increasing share of the retail market, putting pressure on retailers to slash delivery times and to get products to customers quickly. This reduces operational efficiency and increases transportation costs for retailers with dedicated fleets of delivery vans. Using crowdsourced deliveries by ad-hoc external parties could offer a cost-effective solution.

The prospect of using mobile technology and crowdsourcing to reduce delivery lead-times is an exciting new way of dealing with this. The concept uses excess capacity on journeys that will take place anyway, to make deliveries of small packages, thus negating the need for an additional journey. In a recent paper, my colleagues Niels Agatz, Leo Kroon, Rob Zuidwijk and I investigated how much this could benefit retailers in practice.

Peer-to-peer

Recent years have seen the advent of peer-to-peer (P2P) platforms for transportation. Some focus on long-distance shipping; others on on-demand local deliveries. But one thing they have in common is that they all offer online solutions and mobile smartphone apps that connect delivery tasks (parcels that require shipping) with drivers willing to make a drop-off on a journey they were going to make anyway, in return for a small fee. Drivers pick up packages from a retail store, warehouse or dedicated pickup location, and deliver them to customers located along their route.

Instead of being dedicated delivery drivers, these drivers work on an ad-hoc basis on their own initiative. They might also be willing to make deliveries simply to help others, and to support environmental improvements, and not just to earn some extra money. After all, they may also be helping to reduce vehicle emissions, and easing congestion by removing the need for an additional dedicated delivery vehicle. It also fits the current trend towards the "sharing economy".

To ensure that all parcels are delivered in time, P2P delivery platforms can use a third-party service as backup when no ad-hoc driver can be found. And to ensure the reliability and trustworthiness of drivers, it might also use a feedback mechanism, letting customers rate the service. The alternative to this is to vet drivers in advance, by verifying their licence, insurance and registration, or by doing background checks.

Crowdsourcing schemes already exist. Walmart recently began testing a scheme whereby it asks its in-store customers to drop off packages on their way home if it only added a few minutes to their travel time and was not an inconvenience. DHL also ran a pilot scheme in Stockholm called "MyWays" using local people to perform deliveries; and Amazon operates a similar service in Seattle called Amazon Flex.

Modelling the benefits

Crowdsourcing certainly works in theory, but we wanted to test the best ways to implement it in the real world. We wanted to find out what the most-efficient way is to send a parcel from A to B, making deliveries faster and cheaper. This meant converting the theory into an algorithm to create a virtual environment in which we could model various scenarios.

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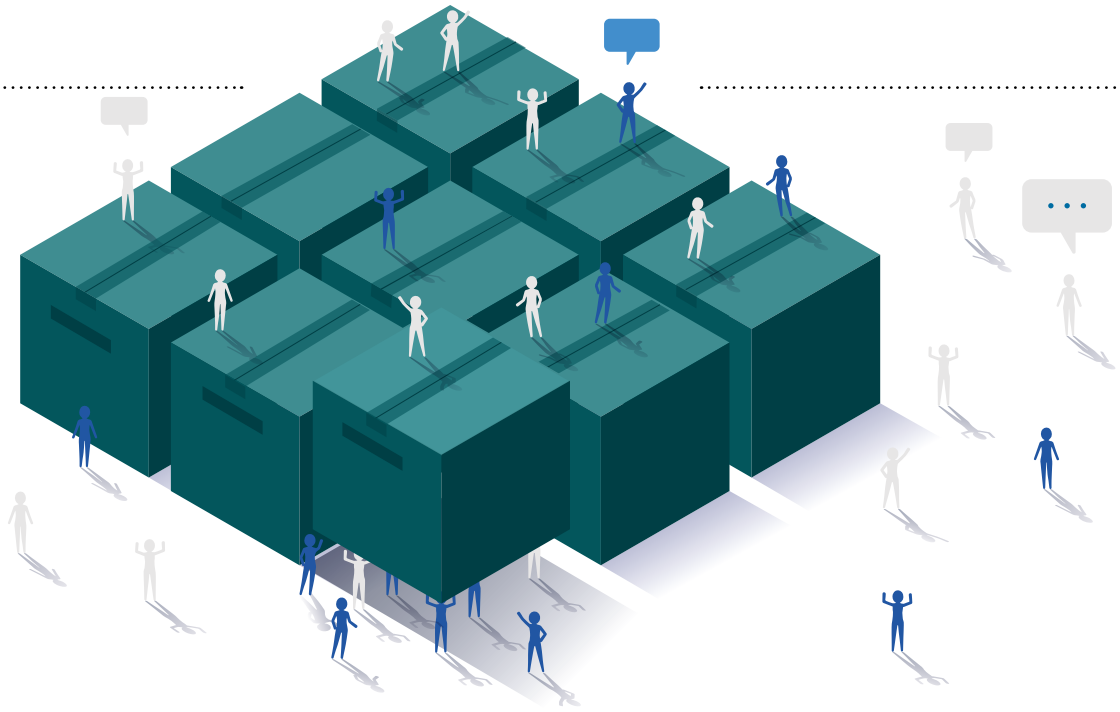

The solution we applied is a variant of the classic pickup and delivery problem (PDP) that aims to transport goods from an origin to a destination at minimum cost. Unlike the traditional model, however, we only used our dedicated vehicle fleet as a back-up option, to make deliveries that cannot be made by ad-hoc drivers, or if none were available. This is similar to ridesharing or carpooling, whereby individual travellers share journeys to save on costs. There does still need be a dedicated fleet of backup vehicles, however. And therefore you also need to know how to use this in the most efficient way.

A crowdsourcing provider needs to assign parcel delivery tasks to drivers and to determine the best associated delivery routes. One problem is, however, that ad-hoc drivers vary greatly with regard to how much time they are willing to spend and how flexible they are about making detours. Some may only want to make a small deviation to take a parcel on a trip that they were already making, while others may be willing to make multiple stops.

If a driver is matched with only one task, there is only one route – the origin of the driver and then the parcel, followed by the destination of the parcel and then the driver. If there are multiple pickups and drop-offs on a single trip, things get more complicated. There will be several feasible routes, and you need to figure out which is the optimal route sequence.

Since delivery tasks and available drivers arrive dynamically throughout the day, we also factored in an event-based rolling horizon framework, which repeatedly solved the problem of matching tasks to drivers each time a new task or driver arrived.

Impressive savings

To quantify the benefits, we compared the performance of a crowdsourced system with a traditional dedicated delivery set-up. The results suggest that using ad-hoc drivers can make the delivery much more cost-efficient, and can reduce system-wide vehicle miles, significantly reducing transportation costs.

Using a combination of both crowdsourced delivery and a dedicated fleet is the most effective and practical solution. It could generate potential travel cost savings of 18 to 37 per cent when compared to using a purely dedicated fleet. The highest level of savings comes when drivers do not have to make detours to accommodate a pickup. The ▸

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best way to do this is to tap into the unused capacity in existing traffic flows.

Our results also proved that time flexibility and stop willingness on the part of the drivers has a strong impact on performance, with increasing flexibility improving cost efficiency. Moreover, you also need fewer drivers to do the same amount of work if each individual driver makes more stops, or if you combine several delivery tasks. And by using crowdsourced drivers in addition to their dedicated fleet means managers can also make extra savings by decreasing the size of the fleet, by as much as 18 per cent on average, we calculate.

One important thing that our results showed, however, is that you cannot always trust the availability of crowdsourced delivery as a stand-alone solution. Therefore, you will probably always need some form of dedicated vehicles in your resource pool, as cover in case no crowdsourced option is available.

Nevertheless, in the best-case scenario, a manager could save up to 20 per cent in costs. This offers flexibility as it would release budget and resources that could be spent on external costs such as accident insurance and incentives.

Future tasks

Our research only considered delivery costs, under the assumption that dedicated vehicles and ad-hoc drivers incur the same amount of unit cost. In future we plan to study other aspects, such as identifying the correct financial incentives to attract a sufficient crowd, and how you can minimise system-wide costs.

One thing we are now looking at is using only one driver on specific routes. If you allow the drivers to transfer parcels between themselves, you can create a web or a network of individual driver routes (like a relay system between nodes), so that no one has to extend their individual journeys, but the parcel still gets delivered as quickly as possible via the shortest distance possible.

To increase the efficiency on the crowdsourced side, you also need to keep the delivery drivers happy at all times, otherwise they may be less willing to work for you. Prioritising is therefore key. But we believe that if managers do this, it may even become possible one day to dispense entirely with the need for a dedicated delivery fleet. And that would take cost savings to another level. ■

This article draws its inspiration from the paper *Crowdsourced Delivery: A Dynamic Pickup and Delivery Problem with Ad-hoc drivers* written by Alp M. Arslan, Niels Agatz, Leo Kroon and Rob Zuidwijk (5 September 2016). ERIM Report Series Research in Management. DOI: http://dx.doi.org/10.2139/ssrn.2726731

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