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Delivering meals for multiple suppliers: Exclusive or sharing logistics service

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ABSTRACT

We study a meal delivery problem faced by some logistics providers, which need to route vehicles in multiple trips to pick up meals from multiple suppliers and deliver to customers. Three types of logistics services are investigated: exclusive service and two novel sharing services. The delivery problems broadly belong to multi-trip routing with soft time windows and multiple refill locations. We develop two mainstream heuristics, iterated local search and adaptive large neighborhood search. Extensive case studies are conducted based on large-sized real-world instances. Managerial analysis shows that two sharing services generally yield much less total costs than the exclusive service.

1. Introduction

Meal booking has recently become very popular internationally. During the past few years, the number of meal booking orders has skyrocketed (Visser, 2015; iiMedia, 2018). About 271,000 daily orders are placed in 2016 at the platforms of Orders2me and GrubHub (Cohen, 2016). To deliver these meals, a meal supplier usually outsources the logistics service to a third-party logistics provider (Digo, 2016). After the logistics provider accepts the orders from multiple suppliers, it needs to schedule vehicles to first pick up meals from suppliers and then deliver to customers in urban area (see Fig. 1). As a result of the bursting requests for meal delivery, many logistics providers are facing a large-scale pickup and delivery problem every day (iiMedia, 2018). The real-world data we obtained from a major logistics provider in China has up to a thousand and two hundred lunch orders and forty suppliers a day in a city. How to accomplish everyday operations in order to achieve a cost-effective vehicle routing scheme for such a large-scale problem becomes a big trouble for meal logistics providers. This paper is just focused on the *meal pickup and delivery problem* (MPDP) from the view of a logistics provider in a real-world setting.

To handle the problem, a straightforward approach for a third-party logistics provider is to group its vehicles into subsets, each of which serves a single supplier. The approach is named as *exclusive service* in this paper. It is easy to manage and schedule vehicles using this service. However, every vehicle has to return to the fixed supplier for pickups, which will inevitably result in more deadheading distance from the last delivery to the supplier. This deadheading distance may be saved by another approach, named as *sharing service*, in which a vehicle is allowed to serve multiple suppliers and thus can visit another nearby supplier after its last delivery. To achieve more flexibility in practical operations, we present an advanced service, named as *sharing+ service*, in which a vehicle is allowed to visit a supplier not only after its delivery trip but also during the trip. That is, a vehicle can do new pickups before all its in-vehicle meals are delivered. Fig. 2 shows an example for the sharing and sharing+ services respectively. To the best of our knowledge, these logistics services have not been well addressed in the area of urban delivery.

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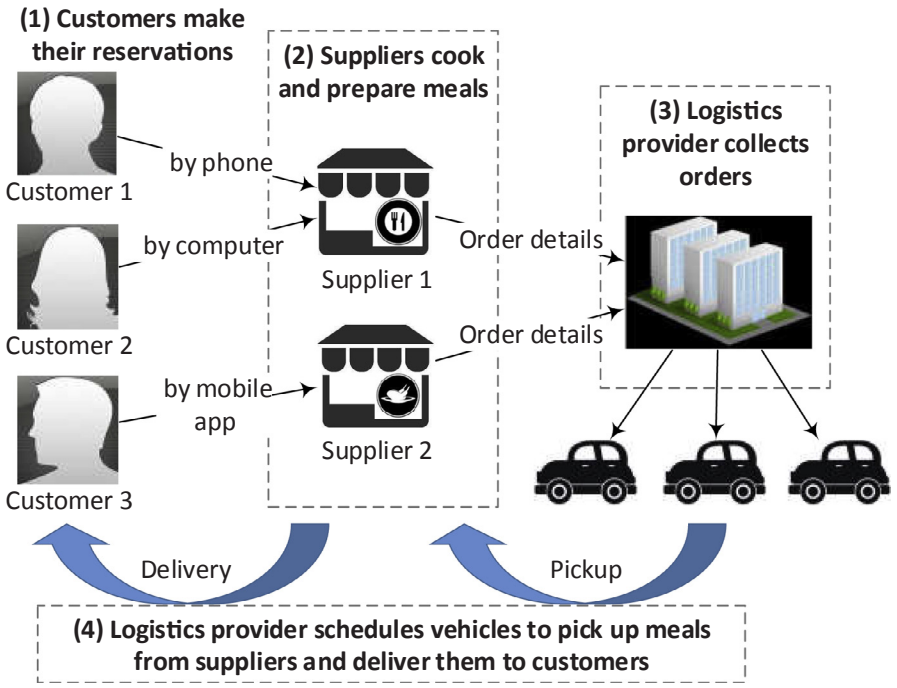

Fig. 1. The process of the ordering, preparing, and delivering of meals.

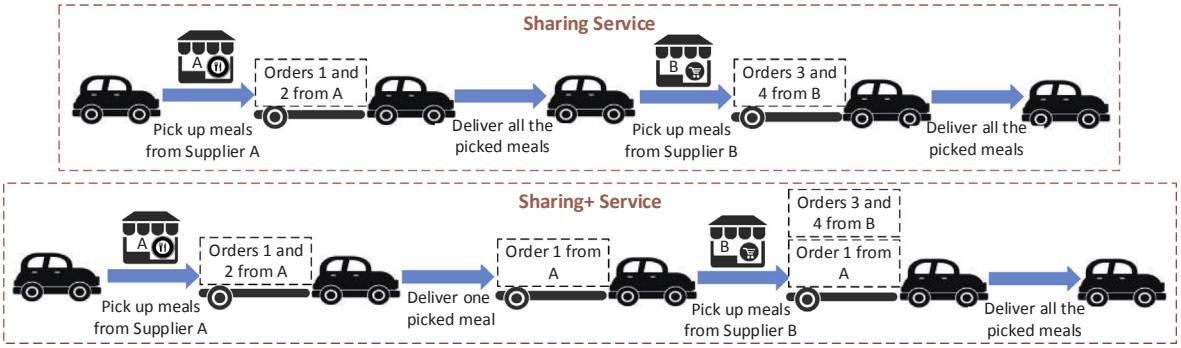

Fig. 2. Examples for the sharing and sharing+ services.

From our common sense, the sharing+ service could have the least logistics cost since it has fewer restraints and is more general than the other two services. However, in the practice, the sharing+ service has more fixed cost of hiring drivers because it puts forward stricter requirements for drivers: they have to learn the road knowledge in a wider area and exactly remember the pickup and delivery sequence and the associated meals of orders. Thus the total logistics cost of the sharing+ service is not absolutely less than the other two under all the scenarios. The focus of this paper is just on solving the problem, comparing the three services, finding the best services for different scenarios, and revealing managerial insights.

Our contributions are as follows. First, we present the MPDP and its three logistics services in the real-world setting. To the best of our knowledge, we are the first to study the three logistics services for meal delivery in the area of urban logistics. Second, we propose and customize a time-indexed model for the logistics services of the problem. Third, we exploit the special problem structure and design two effective heuristics to solve large-scale cases with over one thousand customers and tens of suppliers. Fourth, we conduct the extensive case studies with real-world data and perform managerial analysis.

The rest of this paper is organized as follows. Section 2 reviews the related work. Section 3 formulates the problem. Section 4 presents two heuristics. Section 5 discusses the results of real-world cases. Section 6 concludes the paper and provides the future directions.

2. Related work

Related studies include the delivery of perishable food products, the multi-trip vehicle routing problem, the VRPSPD, and the collaborative transportation mode.