Studying determinants of crowd-shipping use

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ARTICLE INFO

ABSTRACT

This study explores the differences between crowd-shipping users and non-users based on responses to a 2016 online survey. We use proportional *t*-test analysis and a binary logit model to study how and to what extent the attitudes, preferences, and characteristics of crowd-shipping users differ from non-users. The results show that (1) crowd-shipping is more prevalent among young people, men, and full-time employed individuals, (2) urban areas are preferential for the development of crowd-shipping, and (3) crowd-shipping users are most inclined to use the system for medium-distance deliveries. The elasticity analysis indicates that individuals who have a strong sense of community and environmental concern are, respectively, 86.4% and 83.9% more likely to use crowd-shipping. However, individuals who have reservations regarding affordability and trust are 68.3% and 64.9% less likely to use crowd-shipping, respectively. The sensitivity analysis reveals these magnitudes of effects to vary among different population segments with experience in sending packages and gender being the most sensitive strata. The findings aid our understanding of the interaction of emerging shipping systems and user dynamics by providing a pioneering investigation of the determinants of crowd-shipping use.

1. Introduction

Urban transportation systems, both of passengers and goods, are progressively impacted by emerging mobility-on-demand solutions relying on shared and, increasingly, crowdsourced resources. Sharing mobility merges private and public mobility by giving access to both private transportation and goods delivery services on-demand. As such, these solutions rely on foregoing traditional ownership of transportation means and gaining temporary access to vehicles and other resources (Dias et al., 2017; Shaheen, 2016). Recent examples of this concept include services such as ride-sharing, ride-sourcing, or bike-sharing (Cohen and Kietzmann, 2014; Ji et al., 2017). The objectives of sharing mobility are to lower transportation costs and optimize the use of vehicles (Botsman and Rogers, 2010). Crowdsourcing, which is a growing trend in sharing systems, outsources tasks to a typically large group of non-professionals from the crowd. The development of Information and Communication Technologies (ICT) is further increasing the penetration of mobile devices and changing social habits, thereby facilitating the use of crowdsourced solutions (Schenk and Guittard, 2011). Contributors to crowdsourced systems are typically recruited through Internet platforms such as Taskrabbit (Prassl and Risak, 2016) or Amazon Mechanical Turk (Ipeirotis, 2010; Kittur et al., 2008). Therefore, crowdsourcing has the possibility to quickly engage large and heterogeneous groups of people at a contained cost (Blanquart and Carbone, 2014).

Urban transportation services such as ride-hailing draws heavily on crowdsourcing and has been identified as a disruptive transportation service. Some contexts have seen a decrease of taxi activity to the benefit of Transportation Network Companies (TNC) (Nie, 2017). Use of ride-sourcing is increasing quickly, with reports that 12% of U.S. respondents (Morning Consult, 2015) and 28% of San Francisco residents use ride-sourcing on a monthly basis (SFMTA, 2015). In recent years, this concept has also been adopted in the shipping industry for package delivery, known as crowd-shipping. The literature on crowd-shipping users is very limited, and this research seeks to offer early insights in this area.

Crowd-shipping is built on the concept of matching and connecting customers who need to send a package with drivers who have unused space in their vehicle and are willing to deliver the package. These drivers are considered occasional couriers as they are not required to have specific shipper training. The crowd-shipping industry emerged in 2012 with only a handful of actors (Vuylsteke, 2016) and is today a growing market in continuous evolution (Rai et al., 2017). Not only are traditional logistic firms and retailers such as Amazon Flex Services, Google Express (Crew, 2017), DHL, and Walmart (Office of Inspector General, 2014) adopting this system, but start-ups are joining the crowd-shipping market. To date, a number of different business models exist, adapted to specific operational contexts and demand. Rougès and Montreuil (2014) analyzed 18 different crowd-shipping models and showed that the Business to Customer (B2C) intra-urban business model was dominant.

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Although most of the crowd-shipping companies are headquartered in the U.S., the concept is expanding all over the world. For instance, PiggyBee, a Belgium international startup, is matching users willing to send parcels with air travelers who have empty space in their luggage. Another example is Nimber, a U.K. crowd-shipping firm originally based on Norway. This company is now active in Europe and North America. Some businesses propose more original concepts such as Friendshippr, which relies on users' Facebook connections to turn friend networks into shipping networks. This mobile application works like a communication platform, and helps its users to connect by gathering information about who needs to ship packages and who is travelling next, in order to make shipping more efficient. While the original definition suggests that crowd-shipping platforms employ only occasional drivers, some companies allow their users to connect with professional drivers. Cargomatic, for example, connects shippers with licensed carriers. This service is essentially designed for businesses and more than 4,000,000 pallets have already been sent by this crowd-shipping company. Other companies such as Roadie, an Atlanta based crowd-shipping platform, allow both professional and occasional drivers to join the platform. Major actors of the crowd-shipping market are Deliv and Postmates (Rougès and Montreuil, 2014). The former focuses on providing same day delivery service. The latter is becoming a major player in the on-demand food delivery market while there is a simultaneous need to consolidate grocery shipment (Yanik et al., 2014).

The crowd-shipping market is attracting attention due to not only its advantages for senders over other package delivery methods, but its potential to gain significant market shares of the parcel industry as well. The crowd-shipping market: (1) is generally less costly than traditional delivery services such as USPS, UPS, or Fedex for a similar delivery request, (2) allows more flexibility and offers customized service, which adapts to individual shipping demand and enables users to have more control over pick-up and delivery conditions using smartphone technology, and (3) has the potential to reduce the environmental impacts by optimizing deliveries and reducing the total number of vehicles on the road (Paloheimo et al., 2016). These features make crowd-shipping a promising solution to disrupt parts of the traditional package delivery industry (Rougès and Montreuil, 2014).

The contribution of the current study to the literature on crowd-shipping is twofold. *First*, we develop an exploratory analysis to examine the differences between crowd-shipping users and non-users. Using proportional *t*-test analysis, we highlight which features distinguish users from non-users. *Second*, we develop a binary logit model to quantify to what extent the attitudes and preferences of crowd-shipping users differ from non-users. For the analysis, we rely on data obtained from an online survey conducted in June 2016.

A clear understanding of user behavior and reactions is essential to improve the crowd-shipping system, to control adverse impacts, and to design adequate policies. Results from the analyses also inform crowd-shipping companies of the motivations of potential customers, and who should be targeted for user recruitment efforts. Despite its potential and the interest in industry, there are few academic studies dedicated to examining the potential usage of crowd-shipping. Most research to date has focused on the business and operational analysis. The current research contributes to filling out the gaps in understanding on the user perspective by studying the early adopters of crowd-shipping.

The rest of the paper is organized as follows. First, we synthesize the literature drawing on parallels with related mobility innovations to get insights about crowd-shipper user profiles. Second, we present the survey along with a description of its design and data collection. Third, we summarize the sample characteristics followed by a preliminary exploration of the differences between crowd-shipping users and non-users, applying a two-tailed proportion *t*-test. Then we build the binary logit model and present the results along with an in-depth qualitative and quantitative discussion on the differences between crowd-shipping users and non-users. Finally, we summarize the key findings and broach a number of caveats that we believe should be addressed in future studies.

2. Literature review

Research exploring the advantages of crowd-shipping and optimization of this delivery system is gaining momentum. The existing body of literature pertains to business models (Rougès and Montreuil, 2014), vehicle routing problems (Archetti et al., 2015), truck carrier problems (Kafle et al., 2017), dynamic pickup and delivery (Arslan et al., 2016), multi-hop driver-parcel matching problems (Chen et al., 2016), and Share-a-Ride problems (Li et al., 2014). Little is known, however, about the behavior and perception of crowd-shipping users. Understanding the behavior of users is essential as it allows for the definition of realistic model assumptions and results, which can then be implemented into optimization models. From a business viewpoint, understanding user behavior allows crowd-shipping firms to understand needs and expectations of customers. The remainder of this section reviews previous research on crowd-shipping systems. Insights are also drawn from recent research on passenger on-demand systems (Furuhata et al., 2013; Rayle et al., 2016; Shaheen et al., 2016). Like crowd-shipping, ride-hailing also relies on crowd-sourcing and uses ICT or smartphones as the main platform of communication and matching. Therefore we expect to observe similar behavioral characteristics. We note a few papers with behavioral or empirical analysis of the willingness to work as a crowd-shipping courier (Le and Ukkusuri, 2018; Miller et al., 2017; Paloheimo et al., 2016). This work is complementary but beyond the focus of the current analysis of the customer motivations.

2.1. Reasons to use crowd-shipping

Crowd-shipping offers a delivery service with several advantages for customers. Although crowd-shipping is currently an emerging system, considered as a supplement rather than a substitute for traditional delivery services, an initial comparison with traditional services is carried out. Table 1 summarizes advantages of this system including affordability, flexibility and convenience, reduced environmental impact, and cultivating social benefits such as a sense of community.

As far as the economic benefit is concerned, crowd-shipping; (1) employs occasional couriers rather than full-time professional drivers (Archetti et al., 2015; Arslan et al., 2016); and (2) allocates fewer

Table 1
Advantages and Disadvantages of Crowd-shipping.

	Point	References
Advantages	Low delivery cost	Rougès and Montreuil (2014), Archetti et al. (2015), Arslan et al. (2016)
	Flexibility	Rougès and Montreuil (2014), Ghajargar et al. (2016), Goetting and Handover (2016), Punel and Stathopoulos (2017)
	Eco-friendly	Rougès and Montreuil (2014), McKinnon et al. (2015), Chen et al. (2016), Cohen and Muñoz (2016), Paloheimo et al. (2016), Kafle et al. (2017)
	Sense of community	Cohen and Muñoz (2016)
Disadvantages	Trust issues	Rougès and Montreuil (2014)
	Privacy concerns	Goetting and Handover (2016)
	Service quality	Furuhata et al. (2013), Rougès and Montreuil (2014)