A structural equation model for analysing the determinants of crowdshipping adoption in the last-mile delivery within university cities

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Abstract: Crowdshipping is an emerging delivery paradigm in urban areas, where ordinary people can become real carriers in exchange for an incentive. Nevertheless, the adoption process of crowdshipping initiatives faces multiple barriers. This study aims at analysing the determinants of crowdshipping adoption in university cities, as behavioural investigations in such communities are less explored. A model of structural equations with Innovation Diffusion Theory's five fundamental determinants that influence the consumer adoption (relative advantage, compatibility, complexity, trialability, observability), and a further fundamental component (resistance to change), is presented. The study is based on a survey that involves the interviewees who live in a university city in Southern Italy. The data collected were processed using statistical techniques and discussed, evidencing the potentiality of application and the positive attitude related to a crowdshipping service of the users located in such a territory.

Keywords: crowdshipping; last-mile delivery; innovation diffusion theory; adoption intention; structural equation modelling.

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1 Introduction

In the last decades, an increase of the movements for freight transportation and parcel delivery was registered, especially in urban areas, around the economic and social development of cities. The phenomenon has a strict correlation with different new behaviours that completely change the daily-life of consumers. People started to make a massive use of e-commerce, and this tendency is expected to grow in the future (World Economic Forum, 2017). As a result, logistics carriers need to manage a considerable number of small packages. This aspect generates various issues, inefficiencies, and externalities affecting the industry, particularly in the last-mile segment (Perboli et al., 2014; Bertazzi et al., 2019; Coelho et al., 2020).

As such, there is a greater awareness of the need to improve transportation activities in the last-mile while making them more sustainable, efficient and competitive, to reduce transportation costs and increase customer satisfaction.

These aspects have inspired different contributions and new ideas into the field. Researchers and stakeholders promote the identification of new delivery options among emerging technologies, including cargo bikes (Perboli et al., 2016; Giglio et al., 2021), electric vehicles (Taefi et al., 2016), autonomous vehicles (Gelareh et al., 2013), drones (Murray and Chu, 2015) and parcel delivery with lockers (Dell'Amico et al., 2011). On the other side, the society registers another interesting and inspiring phenomenon: the

spread out of the 'sharing economy', which became very popular and has been applied to different services (Le et al., 2019): accommodations (e.g., AirBnB, Couchsufing), finance (e.g., crowdfunding, peer-to-peer banking), information and communication technologies (e.g., cloud computing) etc.. In the transportation field, lots of new passenger and freight sharing services based on different features can be found, like bike-sharing (Lu et al., 2019), car-sharing or car-pooling (Giglio and Palmieri, 2016), shared taxis and parking spaces for passenger mobility or van-sharing for freight mobility (Cai et al., 2019; De Maio et al., 2018, Beraldi et al., 2021).

Therefore, the introduction of new delivery models, also based on the sharing economy concepts, could stimulate a better use of the transport capacity, and favour the reduction of transportation costs and emissions (Bubner et al., 2014). In this context, a very promising innovative way to improve the delivery sector in urban areas is crowd logistics. Crowdsourced goods delivery has been defined as a frontier (Wang et al., 2016) or a revolutionary change in city distribution (Macharis and Kin, 2017). Mehmann et al. (2015) defined the crowd logistics as "the outsourcing of logistics services to a mass of actors, the coordination is supported by a technical infrastructure. The objective is to achieve benefits for all stake- and shareholders" (p.123). One of the most popular paradigms of crowd logistics is represented by crowdshipping: it can be defined as a system where the delivery is outsourced to occasional drivers (that can be both professional carriers and private travellers) and is coordinated by an online platform/app-mobile to achieve benefits for the involved stakeholders (Punel and Stathopoulos, 2017).

With the introduction of crowdsourcing in the shipping market, an increasing number of online platforms have emerged (Rai et al., 2017; Rougès and Montreuil, 2014). As detailed in the work of Ermagun and Stathopoulos (2018), crowdshipping platforms usually present a flow of activities divided in three steps. First, a shipment request is charged on the website/application specifying different details related to the request: the size of the package, the pick-up and drop-off places, the time requirements. Secondly, platforms match the occasional driver with the customer by using optimisation algorithms or giving the customer the possibility to directly choose the driver among the available ones. Finally, the request is accepted by the driver that operates the delivery. Furthermore, the authors underline the importance of attracting a sufficiently large number of participants for the long-term success of this new paradigm.

From the practical point of view, a large range of real applications can be found in literature. Savelsbergh and van Woensel (2016) describe the case of Walmart (2013), a company that introduced the possibility to assign the orders collected online to the in-store customers, that assumed the role of occasional drivers, guaranteeing also the same-day delivery to online customers. Another practical application is described by Slabinac (2015) that analysed the DHL case. DHL implemented a mobile application to find users available to perform delivery services in the last-mile, on their way back home, in exchange for an incentive at the end. Amazon is exploring a similar setting for crowdshipping (Bensinger, 2015). Except for the major players, no companies existed in this new market until 2012. Nowadays, the situation is quite different because a series of crowdshipping companies were born all over the world (Punel and Stathopoulos, 2017). The majority of crowdshipping start-ups emerged in the USA (e.g., Deliv, Kaargo, UberRush), Australia (e.g., PostRope, PPost), Colombia (Rappi), Nigeria (Max), China (Renren Kuaidi), and Europe (e.g., Nimber in UK and Norway, Trunkrs in the

Netherlands, PiggyBaggy in Finland) or across countries (Parcelio, Quincus). A great overview about all the aspects influencing the crowdshipping service, existing works and literature gaps are described in Le et al. (2019).

Nevertheless, only a small fraction of them survives into the market, reaching the critical mass of users within the system (Dablanc, 2016). This aspect underlines the critical role that the willingness of acceptance plays in the development of sustainable crowdshipping services. To the best of our knowledge, there is a lack of behavioural research works in this area, that are necessary to support the birth of sustainable operational concepts as well as the spread of the emerging delivery service among its potential adopters.

Nevertheless, the study of crowdshipping is very challenging, because the field is relatively new and affected by the lack of uniformed operational systems and availability of operational data. It has the great potentiality to alter the way shipments are organised until now, and as a consequence, to change the vision related to who will be the carriers of the future, and how people expect package deliveries to be performed (Rougès and Montreuil, 2014).

The literature in the field is expanding in the last years (Saglietto, 2021; Pourrahmani and Jaller, 2021), the research community has investigated crowdshipping systems from different point of views, but only few studies provide a comprehensive synthesis, describing the possible future developments in the field. A pillar work in the literature is the review presented by Le et al. (2019). In this work, the authors deeply describe promising areas and gaps in the future scientific developments, and challenges to be faced by the different stakeholders. For the purpose of our work, we paid attention to the following findings. Firstly, Le et al. (2019) identify one of the biggest risks in the lack of customer demand, considering different unsuccessful businesses like Kozmo.com and WebVan that failed for the lack of critical volume. Secondly, they underline as different service features could affect the customer propensity to use the platform: trust perception, safety and security, service flexibility, quality. Finally, consumer satisfaction is affected by the risk perception related to new technology adoption. Indeed, Punel et al. (2018) studied the declared advantages and disadvantages of crowdshipping among users and non-users, and underlined that users have a negative opinion of some crowdshipping features.

However, the potential impact of crowdshipping depends on the real intention of the users that could operate both on the supply-side (as shippers) and on the demand-side (as customers). The literature is quite growing in analysing the cause-effect relationships correlated to the users' willingness to perform as driver, but it is relatively poor about the final customer service adoption. It is also not exhaustive in analysing the business innovation perspective, related to the introduction of an emerging technology and the consecutive customer behaviour that is one of the major components in determining the critical volume of users for the technology success.

Therefore, this study aims at investigating users' determinants of intention toward the adoption of crowdshipping solutions for the demand-side within niche scenarios (like in university cities) that is considering customers' willingness to receive parcels delivered by occasional drivers, by means of analysing the different factors impacting on their decisions (control over delivery conditions, shipping and package attributes, socio-demographic features, economic reasons, user shipping experiences, safety and security, geographical perspective or niche scenarios, etc.). Furthermore, understanding the grade of acceptance of the service is a strategical and crucial point for different

reasons. From the managerial point of view, it allows companies to deeply investigate consumers' preferences and better forecasting the demand for the innovative shipping service or planning the launch in particular geographical areas or niche scenarios (e.g., university cities). Moreover, understanding the behavioural insights could contribute to design sustainable business models and operational frameworks for managing crowdshipping, to make the service more appealing and enlarge the number of users involved. This is crucial to achieve the necessary critical mass and implement a crowdshipping delivery system with significant impacts in terms of social and economic benefits (Rougès and Montreuil, 2014; Punel and Stathopoulos, 2017).

Despite the fact that lots of studies proposed feasible crowdshipping solutions, behavioural investigations about adoption determinants and antecedents are not so well explored, especially within niche scenarios (like university areas), thus, proving the timeliness of this study and its contribution to the extant literature (Yuen et al., 2018; Punel and Stathopoulos, 2017). As mentioned before, a great attention is focused on the supply-side of the service, investigating the real intention of the users to operate as drivers, while few contributions can be found for the demand-side.

A central question investigated is the occasional driver willingness to work as carrier that is arranged between 30% to 87% of respondents (see Briffaz and Darvey, 2016; Marcucci et al., 2017; Miller et al., 2017; Devari et al., 2017; Le and Ukkusuri, 2018b). Another important question is related to the factors that influence the choice and driver behaviour: flexibility in schedule (Miller et al., 2017), previous experience in transporting freight or goods (Le and Ukkusuri, 2018b), distance tolerances, compensations for each travel and/or deviation (Le et al., 2019).

The main source of the *demand* for a crowdshipping service, is composed by customers in the role of senders and receivers, that are individual from the crowd, like e-commerce customers, retailers, people sending parcels by themselves, etc. (Rai et al., 2017; Sampaio et al., 2019). Their features are essential to understand the potential impacts of such a service.

The focus of our work is related to the demand-side, where different aspects could affect the willing to use a crowdshipping service: the usability of the platform (Frehe et al., 2017), possibility to personalised deliveries, environmental issues (Rai et al., 2018), age (Rayle et al., 2016), reliability, privacy, and accountability (Devari et al., 2017), good categories (Le and Ukkusuri, 2018a), non-professional carriers (Punel and Stathopoulos, 2017). Finally, Rai et al. (2021), in their survey on Belgian population about the consumers' perception of crowd logistics, found that more than the 70% of respondents are quite or not interested in such a service. For the remaining part, the authors argue that the prevalent consumer profile is related to a person that is community-oriented and a frequent e-commerce customer, with a marked preference to home delivery and a positive attitude towards innovation and sustainability. As described, the scientific literature highlighted the necessity to investigate why there is a so small interest in crowd logistics services, and how much socio-economic, cultural, and attitudinal factors can influence it. Furthermore, it becomes important to understand which cities or regions present an economic-social fabric that can facilitate the crowdshipping innovation development without placing so many barriers. Marcucci et al. (2017) found that 93% of Italian students were willing to receive their packages via a crowdsourcing system, if possible. Moreover Giuffrida et al. (2021) investigate the spatial feasibility of crowdshipping services in university communities, describing the

compatibility of the student flows with such a service. The authors also underline the necessity to investigate the students' attitude towards crowdshipping. Such evidence opens a great perspective in the investigation proposed in this work: indeed, the survey for analysing the determinants of acceptance of a crowd shipping service is conducted within an Italian University city (Cosenza), featured by the presence of a medium-sized university (about 26,000 students) that can represent a fertile ground for such a service with high level of innovation, demonstrating the scalability of the system in very similar Italian and European contexts. Based on the aforementioned efforts in literature, this work claims a threefold originality. First, existing literature does not consider different aspects previously described in a complete perspective, while in this work we want to focus the customer attention on different peculiarities of the service at the same time. Indeed, our work proposes a model – grounded in the innovation diffusion theory (IDT) – investigating some different and complementary variables compared to the ones considered in the others studies (Punel et al., 2018; Punel et al., 2019; Le and Ukkusuri, 2019a; Le and Ukkusuri, 2019b). Moreover, the originality of this work is also related to the geographical focus – i.e., Italy, with replicability in similar European urban contexts featured by the presence of the university area, compared to previous studies, often considering the US market. Second, the methodological approach is grounded in the application of a SEM analysis, thus, ensuring a higher reliability of results compared to preliminary determinants-related studies. Third, findings coherently differ from previous studies (Punel et al., 2018, 2019), as our results show that economic convenience, ease and reliability of crowdshipping deliveries have a direct, positive, and significant impact on the usage of crowdshipping as a customer. Moreover, our findings prove that previous experiences do not play a significant role in crowdshipping adoption, whilst trialability and observability of crowdshipping benefits positively affect the crowdshipping user likelihood.

Therefore, the goals of this paper are to provide an original theoretical contribution to the poorly-grounded extant literature on behavioural intention toward crowdshipping platform/service adoption that is directly connected with the acceptance of the emerging technology and innovative service structure by the customers.

The work is organised as follows: Section 2 provides a literature review and the main contributions of this work; Section 3 describes the theoretical framework and the hypotheses development; Section 4 describes the methodological approach; Section 5 reports the statistical results and related discussion, and Section 6 ends with conclusions.

2 Literature overview

The fast-increasing interest in crowdshipping approach generates lots of contributions in the literature that describe and analyse the paradigm from different points of view.

Crowdshipping is defined alternatively as crowd logistics or crowdsourced delivery in different studies. Indeed, the relevance of business, economic and managerial implications of crowdshipping relies in the cross-sectoral nature of the sharing economy: lots of firms are disrupting the classical last-mile freight delivery market – e.g., Uber, Deliveroo, Foodora – dealing with different product categories such as books, clothing, electronics, food and beverage, flowers, etc. (Le and Ukkusuri, 2019c).

The specific literature of crowdshipping is focused on three main branches, as described by Punel and Stathopoulos (2017): crowdshipping services are analysed on the operational-side, attribute-side, socio-demographic and contextual externalities side.

From the operational point of view, lots of researchers investigate the impact of using different types of crowd-resources to complete deliveries: a large-scale framework based on pick-up station is described by Wang et al. (2016), a crowdshipping system using a fleet of taxis is presented by Chen and Pan (2016), a great overview of vehicle routing problems with occasional drivers in city-logistics framework is described by Sampaio et al. (2019), and a discussion about pricing and compensation strategy is presented by Le et al. (2021). Other discussions related to the operative aspects can be found in Kafle et al. (2017), while managerial implications are described by Arslan et al. (2016).

From another point of view, the literature gives a great contribution considering the service attributes, also in parallel with ridesourcing services: for example, users manifest great importance to travel time, flexibility, convenience, and security of the service (Agatz et al., 2012); they also present concerns about the presence of non-professional carriers within crowdshipping service.

Moreover, it is important to understand the relevant socio-demographic and contextual features of the possible 'critical mass' to evaluate correctly the adoption intention of people. Firstly, a smart mobile device and/or a web platform is necessary to manage the service. For this reason, it attracts more the younger segment of users or high level-education people (Rayle et al., 2016). Other analyses in the field are related to: gender attitude (Shaheen et al., 2016; Anderson, 2014), security (Panda et al., 2015), and income level (Efthymiou et al., 2013); or motivations like: incentives and opportunity to make new social connections (Bellotti et al., 2015), environmental impacts (McKinnon et al., 2015), curiosity (Paloheimo et al., 2016). From a more practical point of view, also some features of the service can affect the adoption intention: length and time of the deviation – impacting significantly also on the shipper side – (Le et al., 2019), shipment cost (Punel and Stathopoulos, 2017), privacy concerns of consumers (Devari et al., 2017).

3 Theoretical model and hypotheses development

In this section, the demand-side perspective of crowdshipping is analysed. As explained before, a major gap observed in the current literature is the limited discussion of consumers' behavioural perspective and the lack of a theoretical framework to examine the determinants influencing consumers' decision to adopt crowdshipping delivery services.

This paper builds on the literature topic of crowdshipping by means of applying the innovation diffusion theory (Rogers, 2003; Baskerville et al., 2014; Yuen et al., 2018). Innovation diffusion theory identifies five determinants affecting consumers' adoption intention (or behavioural intention – BI), namely, relative advantage, compatibility, complexity, trialability, and observability. The main objective is to investigate those variables affecting the attitude of users to adopt the delivery service trough non-professional carriers.

The IDT is a theory that describes the path that new innovations or technologies must follow to become popular within the society, as well as the individual process to adopt a new innovative service or product. The process is featured by different phases occurring one after another, defined by Wijaya (2015) as knowledge, persuasion, decision, implementation, and confirmation. The knowledge phase refers to the initial moment of the process, in which the user firstly keeps in contact with the innovation and starts the knowledge acquisition about it. The persuasion phase considers the research information by the user about the innovation and the evaluation in terms of credibility and reliability of other people's opinions. Thirdly, the decision phase leads on the reception or rejection of the innovation adoption. After, the implementation phase, performed only if the decision phase results positive, consists in involving the individual in the actual innovation use, with possible positive or negative experiences. Finally, the confirmation phase may result in the decision of pursuing the usage of the new technology. It is worth knowing that IDT is based on the presence of specific attributes that influence an innovation consumers' adoption decision, namely relative advantage, compatibility, complexity, trialability, and observability. They are analysed in detail in the following:

1 *Relative advantage (RA):* it is "the degree to which an innovation is perceived as being better than the idea it supersedes" [Rogers, (2003), p.213]. It substantially depends on the possibility that the individual considers the advantages in adopting the innovation (Hashem and Tann, 2007). In general, the advantage is measured as economic profitability, status giving, social-reputation, convenience, and satisfaction. In our context, the user could consider the crowdshipping delivery service more advantageous than the traditional deliveries for different reasons: profitability (e.g., cheap costs associated with the delivery), convenience (e.g., great facility to use crowdshipping delivery), satisfaction (e.g., better experiences in using the service comparing with traditional deliveries), fastness (e.g., possibility to receive the package in a smaller time), flexibility (e.g., major opportunity to receive package after work-time without overcharge in price). If the aforementioned advantages are realised by consumers, they positively impact on the crowdshipping adoption decision. For this reason, the next hypothesis is introduced:

   H1 Relative advantage has a positive effect on consumers' intention to use crowdshipping services.

2 *Compatibility (CT):* it is the degree "to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. An idea that is more compatible is less uncertain to the potential adopter" [Rogers, (2003), p223]. An innovation can be compatible with personal and social beliefs and values, introduced ideas, lifestyle, past experiences and needs. In the context of crowdshipping, for example, individuals that possess safe-environmental attitudes could manifest a greater tendency to accept deliveries played by people that are already in movement, to shorten traffic and pollution. Be greener is a good alternative aligned with their value to protect the environment. For this reason, the next hypothesis is proposed:

   H2 Compatibility has a positive effect on consumers' intention to use crowdshipping services.

3 *Complexity (CX):* it is the degree the individual perceives the innovation as difficult to be understood and used (Rogers, 2010). It was observed that innovations requiring particular new technologies or skills to be understood (Palmieri and Giglio, 2015a, 2015b, 2015c) will be adopted slower compared with less complex-ones. For crowdshipping, complexity derives when users interact with the mobile app or web platform to use the system for charging the delivery requests, paying and checking-out the request after receiving the package. Therefore, the next hypothesis is introduced

   H3 Complexity has a negative effect on consumers' intention to use crowdshipping services.

4 *Trialability (TR):* it is "the degree to which an innovation may be experimented with on a limited basis" [Rogers, (2003), p.231]. In this case, there is low concern in adopting the innovation because the individual is able of trying it out. The user perceives a comfortable environment for experimenting with the novelty and satisfying his/her curiosity about it (Strömberg et al., 2016). It is expected that users who consider crowdshipping easy to be tested will view the usage of such service with less uncertainties. For this reason, the next hypothesis is introduced:

   H4 Trialability has a positive effect on consumers' intention to use crowdshipping services.

5 *Observability (OB):* it refers to the presence of tangible benefits in adopting the innovation (Pannell et al., 2006). If the results are very visible and positive, the users are more inclined to adopt the innovation. In the crowdshipping context, if the procedures of the service are easy to be learned, observed and explained to other users, consumers have a greater intention of adoption. Therefore, the next hypothesis is introduced:

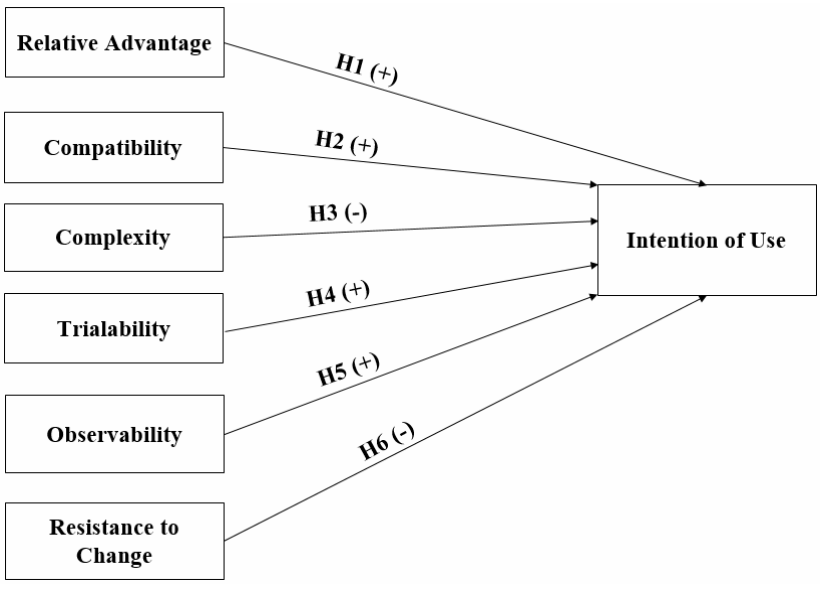
   H5 Observability has a positive effect on consumers' intention to use crowdshipping service.

In addition to the five main attributes of the IDT, we introduce another important feature related to the users' adoption intention, namely resistance to change (RC). It aims to consider an important aspect that is activated when starting an innovation process that is the inertia of users (Perri and Corvello, 2015; Perri et al., 2020). In general, it is defined as the attitude to prefer maintaining the *status quo* and contrasting the pressure of alter own habits and comfort zone (Zaltman and Wallendorf, 1983). Several theories in psychology (Watson, 1971; Sheth, 1981) explicitly suggest resistance can be considered a normal response of consumers when confronted with innovation. The cause-effect relationship is analysed in the crowdshipping case to understand how resistance to change weighs on adoption intention. For these reasons, the last hypothesis considered is the following:

H6 Resistance to change has a negative effect on consumers' intention to use crowdshipping service.

As a result of the above discussion, we propose the following model in Figure 1.

Figure 1 The theoretical model adopted to investigate crowdshipping adoption intention



4 Research methodology

4.1 Scale development and survey design

This study is based on a survey questionnaire administered online, whose development considered the customers' preferences quoted within the existing literatures and IDT theory main components, to test if the hypothesised constructs were significant determinants of users' preferences.

The questionnaire was preceded by a description of crowdshipping to briefly and neutrally explain what it is and how prospective users may be involved in the implementation of this innovative service.

The questionnaire uses the 7-point multi-item scale in Table 3 (Churchill, 1979; Nunnally, 1978) where 1 and 7 indicate that respondent definitely disagrees or agrees, respectively. Three reverse-scaled items are utilised (CX1 for 'complexity', RC1 and RC2 for 'resistance to change') to check the response set: only coherent records are analysed (Perri and Corvello, 2015; Perri et al., 2020).

Before collecting data, a pilot survey (through elicitation interviews) has been realised to improve the quality of this study (Perri and Corvello, 2015; Perri et al., 2020). Then, 291 responses were collected (229 valid, validity rate 78.69%) among residents in a university city of Southern Italy (Cosenza), where the potential users represent a great variety in terms of income, cultural level, origin (many people move from the hinterland or the region to the city for study or work). This choice is justified by the fact that we are investigating a completely scalable system, considering the territorial dimension (i.e.,

regional) of applicability. If the crowdshipping service will be attractive for this context, it is plausible to think that transposing it in other regional contexts – where the infrastructures and services are even more advanced - would require lower start-up costs.

Since data were collected from a single source, potential common method bias (CMB) threats have been considered (Doty and Glick, 1998). CMB was minimised through several approaches (Podsakoff et al., 2003). First, the anonymity of respondents was ensured, motivating them to respond sincerely. It was also clarified that there are no right or wrong answers. Second, CMB was checked through ex post statistical approaches (Harman's single-factor test): total variance explained was far below 50%. CMB has also been considered in ex ante procedures by carefully designing the questionnaire structure in terms of spatial positioning, temporal sequence and psychological implications. Survey items have been analysed by checking their specificity and meaningful connection with the overall scale. Finally, CMB did not pose any threat to this work, and non-response bias was checked by analysing early and late responses: no significant differences were noticed.

4.2 Dataset description

Table 1 shows the demographic characteristics of the respondents.

Table 1 Demographic characteristics of respondents

Attribute	*Number (N = 229)*	*Percentage (%)*
Gender		
Male	123	53.71%
Female	106	46.29%
Age		
18–29	119	51.96%
30–39	82	35.80%
40–50	9	3.9%
>50	19	8.29%
Education level		
Medium school	3	1.31%
High school	66	28.82%
Bachelor/master degree	113	49.34%
PhD, MBA, etc.	47	20.52%
Annual income		
<€5,000	92	40.17%
€5,000–10,000	93	40.61%
€10,000–25,000	28	12.23%
€25,000–50,000	9	3.93%
>€50,000	7	3.05%

Table 1 Demographic characteristics of respondents (continued)

Attribute	*Number (N = 229)*	*Percentage (%)*
Components of family		
1	29	12.66%
2	40	17.46%
3	31	13.54%
4	84	36.68%
>4	45	19.65%
Children		
0	190	82.96%
1	13	5.67%
2	20	8.73%
More	6	2.6%

4.3 Data analysis

The data analysis has been split into two parts: a full SEM analysis and a linear regression analysis.

Potential socio-demographic predictors (Table 1) of users' behavioural intention have been investigated through a linear regression analysis (Table 2). Each independent socio-demographic variable is measured by means of a single item, thus, not being possible to respect the minimum number of items required to include them into the SEM analysis.

Data have been elaborated through an EFA [with maximum likelihood (ML) and Promax rotation], followed by confirmatory factor analysis (CFA) and full SEM analysis – path analysis is devoted to more complex models, with many dependent variables (Hair et al., 1998; Klein, 1998; Streiner, 2005; Streiner, 2006). Reliability and validity have been tested following reference literature (Anderson and Gerbing, 1988; Hair et al., 2006).

5 Results

5.1 Linear regression analysis

Adoption intention towards crowdshipping is the dependent variable and socio-demographic variables in Table 2 are the independent ones, coherently with extant literature (Yuen et al., 2018). Linear regression analysis has been conducted on the whole sample and, then, split by gender (Table 2).

The regression model is significant. Model results are reported below for the whole sample, only men, only women, respectively: $F = 4.189$, Sig. $= 0.001$, $R^2 = 0.086$, $N = 229$; $F = 2.864$, Sig. $= 0.019$, $R^2 = 0.125$, $N = 106$; $F = 2.472$, Sig. $= 0.036$, $R^2 = 0.096$, $N = 123$.

Table 2 Linear regression analysis

Variables	*Mean*	*Pearson correlation with BI*	*Sig.*	*bi*	*Sig.*
Total sample					
Age	1.6856	–0.286*	0.000	–0.265*	0.000
Education level	2.8908	0.082	0.109	0.061	0.371
Annual income	2.4148	–0.114*	0.043	–0.040	0.576
Number of family members	3.2795	0.034	0.305	–0.009	0.897
Number of children	0.3100	–0.079	0.118	–0.011	0.876
Men					
Age	1.6226	–0.327*	0.000	–0.330*	0.007
Education level	2.9151	0.147	0.067	0.070	0.499
Annual income	2.3962	–0.016	0.434	0.037	0.713
Number of family members	3.3679	0.149	0.063	0.077	0.463
Number of children	0.1981	–0.065	0.255	0.061	0.590
Women					
Age	1.7398	–0.260*	0.002	–0.206*	0.041
Education level	2.8699	0.032	0.361	0.054	0.557
Annual income	2.4309	–0.180*	0.023	–0.166	0.141
Number of family members	3.2033	–0.059	0.260	–0.139	0.198
Number of children	0.4065	–0.094	0.150	–0.024	0.806

Note: *Significant (p-value < 0.05).

Among all socio-demographic variables, only ‘age’ is significant. It impacts negatively users’ behavioural intention: younger people tend to adopt crowdshipping more than other consumers, coherently with previous results on other innovative logistics services (Rayle et al., 2016). All remaining variables are non-significant, unlike Rayle et al. (2016) that proved how higher-educated people are more inclined to adopt mobility systems based on sharing economy. Also, Efthymiou et al. (2013) found that people with lower yearly income tend to adopt cheap sharing economy solutions. As for our study, yearly income is correlated with women’s adoption intention, not with men’s. Finally, differences among men and women sub-samples are barely perceivable (i.e., BI-yearly income correlation) and not significant. Hence, the overall perception of crowdshipping is substantially overlapping for men and women.

In conclusion, Table 2 suggests that most of socio-demographic variables do not adequately explain users’ adoption intention towards crowdshipping, thus, paving new avenues of research geared to investigate other stronger predictors.

5.2 Reliability analysis and exploratory factor analysis

Internal reliability has been proven by Cronbach’s alpha, alpha-if-item-deleted (AID) and ITC values in Table 3 (Nunnally, 1978), all exceeding the minimum thresholds

(De Vellis, 1991). Cronbach's alphas of some constructs (CT, RA, TR, RC) got better by removing some items (CT1, RA5, RA6, TR1, RC1).

Table 3 Measurement scales: reliability analysis

Factor/item	*Corrected item-to-total correlation*	*Cronbach's alpha-if-item-deleted*
Compatibility (CT) ($\alpha = 0.859$)		
Previous experiences (CT1)[a]	-	-
Lifestyle/daily routine (CT2)	0.700	0.835
Needs (flexibility, privacy, safety and security, etc.) (CT3)	0.773	0.766
Personal preferences (CT4)	0.730	0.806
Relative advantage (RA) ($\alpha = 0.846$)		
Easier to receive parcels (RA1)	0.689	0.803
Faster to receive parcels (RA2)	0.783	0.759
Economically more convenient (RA3)	0.669	0.811
Higher environmental sustainability (RA4)	0.598	0.840
More reliable for high-value products (RA5)[a]	-	-
More reliable for fragile products (RA6)[a]	-	-
Complexity (CX) ($\alpha = 0.736$)		
Ease to use (CX1)r	0.646	0.554
Difficulty to understand how to use (CX2)	0.581	0.624
Information/Competences required (CX3)	0.466	0.769
Trialability (TR) ($\alpha = 0.811$)		
Ease to try out (TR1)[a]	-	-
Previous long-term utilisation (TR2)	0.686	-
Used by friends/family (TR3)	0.686	-
Observability (OB) ($\alpha = 0.945$)		
Learning after observation (OB1)	0.831	0.960
Explaining to others after observation (OB2)	0.948	0.807
Telling others whether is beneficial (OB3)	0.879	0.924
Resistance to change (RC) ($\alpha = 0.889$)		
Trusting non-professional shippers (RC1)[a,r]	-	-
Tendency to test new products (RC2)[r]	0.799	0.833
Tendency to maintain own habits (RC3)	0.791	0.837
Tendency to use well-known products (RC4)	0.767	0.856
Behavioural Intention (BI) ($\alpha = 0.853$)		
Adoption possibility upon availability (BI1)	0.757	-
Urge to adopt (BI2)	0.757	-

Notes: α – Cronbach's alpha.
[a]Item dropped during scale purification: Cronbach's alphas < 0.6 is not acceptable.
[r]Reverse-scaled items.

EFA showed that CT and RA variables have overlapping loading values that suggest to merge constructs coherently with innovation diffusion theory (Rogers, 2003). In fact, despite Griliches (1957) believes that in the long-term the sociological dimension is not significant for the innovation diffusion compared to (economic) relative advantage, Rogers (2003) states that "to argue that economic factors are the sole predictors of rate of adoption is ridiculous" (p.215), since "not surprisingly, rather strong evidence refuting Griliches' assertion has been brought to bear on the controversy" [Rogers, (2003), p.215]. Dixon (1980) "led to the general conclusion that profitability [pertaining to relative advantage] and compatibility are complements, not substitutes, in explaining the rate of adoption. So the original controversy seems to have died now to a close approximation of consensus" [Rogers, (2003), p.215]. In fact, Rogers (2003) considers also "compatibility to be of relatively less importance in predicting rate of adoption than other attributes, such as relative advantage. This result may be in part an artifact of difficulties in measuring perceived compatibility. In most of the studies […], compatibility was found to be positively related to rate of adoption, even though the correlation was often not significant when the effects of other attributes were removed statistically" (p.226). Moreover, he states that "one dimension of compatibility is the degree to which an innovation is perceived as meeting the needs of the client system" [Rogers, (2003), pp.225–226]. Finally, Rogers' theory supports the merge of compatibility (CT) and relative advantage (RA), and of the corresponding hypotheses (H1 and H2) into the following one:

H1/H2 Relative advantage and compatibility have a positive effect on consumers' intention to use crowdshipping services.

As a consequence, the reliability tests and validity checks (EFA) of RACT variable have been run, again (Table 4): results clearly support the merge of these constructs.

Bartlett's test of sphericity value is 3,320.575 (sig. = 0.000, df = 190) and Kaiser-Meyer-Olkin measure is 0.832: variable correlation is significant, goodness-of-fit is high. Most loadings were higher than 0.5 and properly grouped with communalities above the minimum threshold (Horn, 1965; Keeling, 2000; Lautenschlager et al., 1989), coherently with Kaiser's rule and scree plot. Hence, data are suitable for factor analysis (Huh, 2001).

Table 4 Measurement scales: reliability analysis after merging RA and CT into RACT variable

Factor/item	*Corrected item-to-total correlation*	*Cronbach's alpha-if-item-deleted*
RACT ($\alpha = 0.892$)		
Lifestyle/daily routine (CT2)	0.678	0.878
Needs (flexibility, privacy, safety and security, etc.) (CT3)	0.700	0.875
Personal preferences (CT4)	0.739	0.871
Easier to receive parcels (RA1)	0.750	0.869
Faster to receive parcels (RA2)	0.747	0.870
Economically more convenient (RA3)	0.606	0.886
Higher environmental sustainability (RA4)	0.608	0.886

5.3 Confirmatory factor analysis

The CFA proves the goodness-of-fit of the model (Hair et al., 2006): χ^2/degrees of freedom = 3.87461; root mean squared error of approximation (RMSEA) = 0.110; p-value test-of-close-fit = 0.000; standardised root mean square residual (Std RMR) = 0.0788; normed fit index (NFI) = 0.904; confirmatory fit index (CFI) = 0.927; Tucker-Lewis index (TLI) $\triangleq$ non-normed fit index (NNFI) = 0.910. The χ^2/degrees of freedom is acceptable. RMSEA and its p-value are not acceptable. However, Std RMR is the most sensible statistic to detect non-/bad-fitting models: it is acceptable. Also, incremental fit indices – i.e., NFI, NNFI, CFI – show a good fit, |std residuals| < 3 and Qplot of std residuals fits the bisector.

Table 5 Measurement scales: CFA analysis

Factor/item	*Completely std loading value*	*t-value*
RACT (α = 0.892)		
Lifestyle/daily routine (CT2)[a]	0.718	-
Needs (flexibility, privacy, safety and security, etc.) (CT3)	0.769	11.131
Personal preferences (CT4)	0.793	11.486
Easier to receive parcels (RA1)	0.806	11.669
Faster to receive parcels (RA2)	0.787	11.398
Economically more convenient (RA3)	0.643	9.302
Higher environmental sustainability (RA4)	0.637	9.227
Complexity (CX) (α = 0.736)		
Ease to use (CX1)[a]	0.996	-
Difficulty to understand how to use (CX2)	0.628	8.553
Information/Competences required (CX3)	0.460	6.549
Trialability (TR) (α = 0.811)		
Previous long-term utilisation (TR2)[a]	0.509	-
Used by friends/family (TR3)	0.900	1.964
Observability (OB) (α = 0.945)		
Learning after observation (OB1)[a]	0.862	-
Explaining to others after observation (OB2)	0.996	24.004
Telling others whether is beneficial (OB3)	0.926	21.064
Resistance to change (RC) (α = 0.889)		
Tendency to test new products (RC2)[a]	0.911	-
Tendency to maintain own habits (RC3)	0.841	16.286
Tendency to use well-known products (RC4)	0.804	15.207
Behavioural Intention (BI) (α = 0.853)		
Adoption possibility upon availability (BI1)[a]	0.907	-
Urge to adopt (BI2)	0.834	15.674

Notes: α – Cronbach's alpha.
[a]Item with lambda imposed equal to 1.

Table 6 Construct summary statistics: correlations, construct reliability and AVE

	RACT	*CX*	*TR*	*OB*	*RC*	*BI*	*AVE*
RACT	1						0.5462
CX	–0.376	1					0.53284
TR	0.146	–0.163	1				0.69054
OB	0.601	–0.454	0.084	1			0.86489
RC	–0.306	0.410	–0.135	–0.278	1		0.72772
BI	0.720	–0.534	0.167	0.539	–0.651	1	0.77895
Mean	4.6900	3.1106	1.5895	5.2838	3.3916	4.6725	
SD	1.3206	1.2610	1.0615	1.5871	1.5764	1.4889	
CR	0.8931	0.7561	0.7876	0.95034	0.88885	0.87572	

Note: RACT – relative advantage and compatibility; CX – complexity; TR – trialability; OB – observability; RC – resistance to change; BI – behavioural intention; SD – std deviation; CR – composite reliability; AVE – average variance extracted.

For CFA results (Tables 5 and 6), completely standardised loading values and |t-values| are acceptable: convergent validity and unidimensionality are supported; composite reliability (CR) and average variance extracted (AVE) values are excellent (Anderson and Gerbing, 1988; Bagozzi and Yi, 1988; Fornell and Larcker, 1981). The maximum value of variance inflation factor (VIF) is 1.380: no multi-collinearity is detected.

5.4 Structural model, hypotheses testing and full SEM analysis

The SEM analysis proves an excellent goodness-of-fit (Hair et al., 2006): $\chi^2 = 600.565$; df = 155; p-value = 0.000; $\chi^2/df = 3.87487$; RMSEA = 0.110; p-value test-of-close-fit = 0.000; std RMR = 0.0788; NFI = 0.904; CFI = 0.927; TLI $\triangleq$ NNFI = 0.910; most |std residual| < 3, Qplot of std residuals fits the bisector, |t-values| >> 1.96.

Table 7 reports the SEM analysis results: all the hypotheses are significant and supported. Compatibility and relative advantage (RACT), trialability (TR), and observability (OB) have a significant and positive impact on adoption intention (BI), while complexity (CX) and resistance to change (RC) negatively affect the attitude of users towards crowdshipping.

Table 7 Hypotheses testing

Paths	*Coefficients*	*Hypotheses/added paths*
RACT → BI	0.504	H1/H2: supported
CX → BI	–0.147	H3: supported
TR → BI	0.008	H4: supported
OB →BI	0.052	H5: supported
RC → BI	–0.421	H6: supported

6 Discussion

The analysis of the hypotheses indicated that adoption intention of both the crowdshipping solutions for deliveries and the corresponding technology are positively linked to users' evaluation of the adoption consequences. Users perceived that the adoption could generate relative advantages like flexibility, fastness, and costs, coherently with the studies conducted in literature, so far, according to several variables (Rogers, 2003; Hashem and Tann, 2007) – e.g., the importance of service attributes (Agatz et al., 2012), business and economic aspects disrupting the market (Le and Ukkusuri, 2019c; Punel and Stathopoulos, 2017), income- and incentive-related advantages (Efthymiou et al., 2013; Bellotti et al., 2015). Furthermore, users are reassured from the trialability and observability of the phenomenon and the compatibility with their own values, as evidenced in previous studies (Rogers, 2003; Bellotti et al., 2015; McKinnon et al., 2015; Le et al., 2019; Devari et al., 2017).

Finally, all these attributes counteract complexity over the barriers for the adoption of smart technologies, and resistance to change and attitude to evolve to new service. In fact, innovations are not always easy to be understood and adopted (Rogers, 2010), and devoted technologies or skills need to be sometimes deepened by potential users (Palmieri and Giglio, 2015a; Palmieri and Giglio, 2015b; Palmieri and Giglio, 2015c), like in the case of elderly users required to adopt mobile apps or web platforms for the operations of crowdshipping services. Moreover, the inertia of users and their tendency to maintain the status quo, instead of changing their habits is a typical psychological response towards innovation (Perri and Corvello, 2015; Perri et al., 2020; Zaltman and Wallendorf, 1983; Watson, 1971; Sheth, 1981). Such findings are coherent with the consolidated theoretical foundations of innovation diffusion theory (Rogers, 2003), and further validated by the SEM analysis with a high goodness-of-fit of the model.

It is expectable to notice that relative advantage and compatibility are significant components influencing positively customers' adoption intention, based on Rogers (2003). In fact, customers that consider the crowdshipping service better or as good as the traditional delivery, are pushed to try the innovation (Hashem and Tann, 2007). The same reflection can be done considering the perception that crowdshipping is compliant with their needs, values and lifestyle, according to several perspectives and sociodemographic context (Agatz et al., 2012; Shaheen et al., 2016; Anderson, 2014; Rayle et al., 2016; McKinnon et al., 2015; Paloheimo et al., 2016, among others). In fact, it is worth observing that a major point is understanding the real perception of relative advantage from the consumer point of view, that sometimes is not strictly related only to the knowledge of other ways of delivering. For compatibility, it is crucial to clearly define the context of analysis, because this perception may differ significantly among individuals, cultures, religions and countries (Shaheen et al., 2016; Anderson, 2014; Rayle et al., 2016; Efthymiou et al., 2013; Paloheimo et al., 2016).

Although trialability and observability maintain a positive impact on the adoption intention, it is less significant if compared to relative advantage and compatibility. Hence, the possibility to try out or test the service reduces the distrust related to the adoption decision, transmitting a major sense of security in changing own habits. In particular, Paloheimo et al. (2016) showed how curiosity may play a relevant role in the attraction process of potential users, and any possibility of experimentation is key to foster a favourable attitude towards innovations overcoming uncertainties (Strömberg et al., 2016). Furthermore, it is easy for users to envisage the benefits of crowdshipping through

observation as long as they are very visible and easy to be learned and explained to others (Pannell et al., 2006), thus, explaining the positive effects of trialability and observability on customers' intention.

Complexity has a negative impact on customers' adoption intention. Indeed, if customers perceive crowdshipping as difficult to be used, they present low propulsion to adopt it (Rogers, 2010; Palmieri and Giglio, 2015a, 2015b, 2015c). Nevertheless, its effect is not very remarkable, probably because the complexity involved in crowdshipping services is limited to the use of a mobile app or a web platform with an integrated on-line payment system. These components are very diffused nowadays and relatively easy to be used compared to other innovations.

Additionally, the resistance to change presents a deep effect on the adoption intention, quite similar, but opposite to the positive effect related to compatibility and relative advantage. In general, this behaviour is very common in the process of innovation and new technology adoption, because a great part of potential users is influenced by the inertia to adapt to something new (Perri and Corvello, 2015; Perri et al., 2020; Zaltman and Wallendorf, 1983; Watson, 1971; Sheth, 1981). Indeed, adaptation implies switching costs for setting to the new service. This aspect can be related to distrust, laziness, or poor perceived advantage over the proposed innovation, and it is typical of the 'late majority' and 'laggards', while it is balanced by compatibility and relative advantage in the 'early majority' adopters, coherently with Rogers' (2003) innovation diffusion theory.

Finally, all the aspects described before can be more significant if we consider the starting context: the survey was submitted in a medium-size university city. This aspect leaves space to consider that territories/regions with a 'younger' population are suitable for designing, implementing and experimenting this innovative logistics service. As affirmed by Rayle et al. (2016), both millennial generation and higher-level education people have a good approach in adopting sharing systems. Our regression analysis supports the findings in literature that younger people are more inclined to adopt crowdshipping, but rejects a significant relationship with education level. The positive approach of younger people is probably related to their perception of not so high entry-barriers or switching costs when considering technology-based innovation and social sharing, and to a major attention to the environmental issues.

Lots of university cities with the same features characterise European and Italian regions and territories, hence, the managerial conclusion of this study can be considered general and scalable to other regions, upon very limited context-dependent adaptations that is taking mainly into account the cultural differences that can affect compatibility across different countries or regions.

As such, relevant managerial and institutional implications prove to come out from the findings of this study. In fact, as regards those private firms operating in the logistics industry and interested in designing and putting at work crowdshipping services, their managers could have now a clearer picture of what and how may influence consumer's adoption intention. Moreover, as regards those national, regional or local governments and institutions interested in relieving the environment of pollution and reducing traffic costs and time, the corresponding policy-makers have now more information at their disposal to support and incentivise crowdshipping for the sake of the regional community, firstly, and of the global society, secondly.

7 Conclusions

This paper has investigated both the theory and the management of crowdshipping services. From the theoretical perspective, the paper enlarges the literature that applied the IDT framework – e.g., by merging relative advantage and compatibility variables. Furthermore, we consider another important factor that influences the customer's intention of crowdshipping adoption: resistance to change. The results underline that IDT is a suitable theory for this context and provides a deep and complete picture of the decision-making process concerning the selection of last-mile logistics services. Furthermore, the introduction of the sixth attribute (resistance to change) greatly enriched the theory and enlarged the perspective of analysis related to the crowdshipping adoption intention.

From the managerial perspective, the results of this study are very interesting and show important implications for last-mile logistics service providers, that can evaluate a good reduction of their operating costs by encouraging consumers to use the crowdshipping paradigm. This is especially valuable in relatively low-income areas like Southern Italy, where reducing operating costs may allow companies to adopt lower prices while still maintaining acceptable profit margins. On the other hand, more potential consumers would be encouraged to become actual users of crowdshipping platforms thanks to a more economically accessible price if compared to Southern Italy standard of living. Moreover, understanding the determinants in adoption decision is a good starting point to build a user-friendly, advantageous, secure, appealing, and attractive service, and ensure the economical sustainability by reaching the critical mass of adopters. Indeed, logistics service providers can focus on the two main determinants of the innovation adoption process, namely, relative advantage and compatibility. In particular, this study helps understanding the specificity of the determinants affecting the adopters located in university cities in Southern Italy, thus, providing a more detailed reference to those platforms aiming at developing and operating crowdshipping services in urban contexts located in these regions. Another important point is the competitive scenario related to the last-mile services: traditional home delivery performed with professional carriers is the most diffused paradigm, largely considered satisfactory and reliable. Such a remark is especially relevant to Southern Italy's regions, where there is an almost monopolistic prevalence of traditional professional carriers onto the market, at the time the questionnaire has been administered. So, logistics providers should improve their communication to customers to underline all crowdshipping-related benefits and advantages, also focusing on the reduction of the environmental impact, flexibility and possibility to save money. This way, the high significance and impact of relative advantage on adoption intention could be further leveraged on.

Another important point is related to the trialability and observability of the services. Despite these attributes do not have a high impact on the adoption intention, they could be considered for producing an effect that balances, in part, the resistance to change. Usually, the possibility to try an innovation without the constriction to keep on using it, or the possibility to observe other people during the utilisation, underline the innovation benefits better than a simple description. If the potential user is able to experiment the service and the related advantages, he/she could be captured by a greater level of curiosity or by the conviction that changing is necessary. Crowdshipping services can be made more interactive by adding more experimentation like trivia games, as already suggested by Yuen et al. (2018) for the self-collection systems. It is even more important

to highlight that having the possibility to observe and/or try the crowdshipping service within the same context where the potential observer-user lives and works – that is Southern Italy – is the best way to experiment and highlight the innovation benefits in the eye of the observer-user himself/herself.

Finally, this study has also some limits that could be improved through future studies. First, a larger number of respondents would make it possible to identify a better insight of the population. Second, despite the IDT represents a consolidated theoretical foundation for this kind of study, still other factors may be missing, also with reference to other study areas characterised by different features from university cities and from Southern Italy. Thirdly, other theoretical models could be adopted – perceived value theory (Cheng and Tseng, 2016), theory of planned behaviour (Yuen et al., 2017) – to make a comparison with this study and further increase the understanding of the determinants. Fourthly, interviews were conducted before the pandemic outbreak, so, unforeseeable evolutions or alternative conditions should be explored in post-pandemic studies.

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