

Article

# Public Transport-Based Crowdshipping for Sustainable City Logistics: Assessing Economic and Environmental Impacts

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**Abstract:** This paper aims at understanding and evaluating the environmental and economic impacts of a crowdshipping platform in urban areas. The investigation refers to the city of Rome and considers an environmental-friendly crowdshipping based on the use of the mass transit network of the city, where customers/crowdshippers pick-up/drop-off goods in automated parcel lockers located either inside the transit stations or in their surroundings. Crowdshippers are passengers that would use the transit network anyhow for other activities (e.g., home-to-work), thus avoiding additional trips. The study requires firstly, estimating the willingness to buy a crowdshipping service like the one proposed here, in order to quantify the potential demand. The estimation is realized adopting an extensive stated preference survey and discrete choice modeling. Then, several scenarios with different features of the service are proposed and evaluated up to 2025 in terms of both externalities (local and global pollutant emissions, noise emissions and accidents reductions) and revenues. The results are useful to understand and quantify the potential of this strategy for last mile B2C deliveries. Moreover, it provides local policy-makers and freight companies with a good knowledge base for the future development of a platform for public transport-based crowdshipping and for estimating the likely impact the system could have both from an economic and environmental point of view.

**Keywords:** crowdshipping; on demand; e-commerce; urban freight; discrete choice model; transport externalities; COPERT

## 1. Introduction

Urbanization and e-commerce are two fast-rising trends that make city logistics solutions even more challenging. The European Commission has started promoting research and innovation to define effective policy interventions in urban freight transport [1]. Several urban freight transport strategies could be adopted to find a good balance between positive impacts on accessibility and economic development and negative externalities in terms of congestion and polluting emissions (e.g., [2,3]). Recent and relevant solutions refer to: Demand management (e.g., [4,5]); electrification (e.g., [6,7]), regulatory measures (e.g., [8,9]) and improved capacity utilization (e.g., [10,11]).

Crowdshipping is one of the most promising solutions that foresees an integration of passenger and freight mobility. In line with the sharing economy, it implies delivering goods using the crowd making use of modern information communication technologies [12].

The type of crowdshipping this paper investigates is linked to e-commerce in its B2C manifestation and is based on crowdshippers using public transportation, specifically using the metro network of a city. In fact, planning urban freight activities along metro lines is relevant for sustainable logistics [13]. Crowdshippers are, in this case, passengers that would use the metro lines anyhow for other motivations (e.g., home-to-work) and they pick-up/drop-off goods in automated parcel lockers (APLs) located either inside the metro stations or in their surroundings.

The adoption of APLs demonstrated an increase in the number of successful first-time deliveries, to optimize delivery rounds and to lower operational costs in the e-commerce B2C sector [14]. In this study, the potential of APLs are connected with the metro network, thus proposing a more environmentally friendly crowdshipping with respect to a fully based rubber-tired crowdshipping. In fact, it does not imply performing any additional trips in the last mile delivery, and those that are taking place are making use of one of the least polluting modes.

This paper aims at understanding and evaluating the environmental and economic impacts of this public transport-based crowdshipping in urban areas. In fact, it is expected that this goods distribution system would produce a positive impact on the environment and on the urban community by exploiting unused transit capacity. On the other hand, the paper aims to assess also the economic sustainability of the service.

The evaluation focuses on the last mile of the delivery chain in the urban area of Rome. The last leg of delivery is also the most appropriate part of the e-commerce supply chain where a crowdshipping scheme might prove applicable and useful [15–17]. In fact, most of the goods are small in size and light in weight, allowing the ‘crowd’ of commuters to act as a last-mile vector. Investigating crowdshipping in Rome is also motivated by its characteristics: Large extension, complex transit network and congested road network. In more detail, almost three million people live in the city, who perform around 700,000 thousand trips during the morning peak period; congestion causes about 135 million hours lost, while operators perform more than 35,000 loading/unloading operations [18,19].

This paper is structured as follows: Section 2 reports the background of crowdshipping, underlining the need to forecast the economic and environmental sustainability of this growing sharing system; Section 3 describes the methodological approach used to assess economic and environmental sustainability; while Section 4 reports the results obtained related to the implementation of the public transport-based crowdshipping service in Rome. Section 5 concludes illustrating future research.

## 2. Background

This research builds on previous studies by explicitly addressing both environmental and economic benefits of an innovative crowdshipping system, focusing on emissions and traffic externalities. Moreover, it contributes to the increasing body of the literature on public transport-based crowdshipping services. In fact, to the best of our knowledge, only a few studies have dealt with this kind of crowdshipping system [20–22], whereas most of the literature on this issue focuses on car-based crowdshipping.

Buldeo et al. [23] performed a literature review on the state of practice of crowdshipping identifying three main issues affecting its overall sustainability: (i) The involvement of professional third parties in case of insufficient or underperforming crowd; (ii) crowd motivation (either monetary or environmental/social); (iii) modal choice (car vs soft modes, public transportation, or clean vehicles).

Some researches have focused on environmental impacts. Buldeo et al. [24] compared the external costs imposed on society when delivering parcels with crowdshipping and professional systems, finding that uncontrolled use of the platform (car-trips dedicated to delivering parcels) results in higher external transport costs and thus higher emissions. Therefore, crowd logistics could offer a sustainable alternative only if the crowd exploits existing car trips. Savelsbergh and Van Woensel [25] discuss the

case of Walmart that foresees the involvement of its in-store customers delivering items ordered by online customers, conclude that, from a city logistics perspective, this type of service would increase the number of freight movements and make coordination and consolidation of direct-to-consumer deliveries even more challenging.

Other researchers have focused on the economic and financial aspects. Mak [26] investigated the potential impact on retailers' operational and marketing strategies due to the use of in-store customers delivering orders to online customers. Archetti et al. [27] used a multi-start heuristic procedure for vehicle routing problems with occasional drivers, showing that employing occasional drivers may reduce the costs for satisfying the demand, especially if coupled with an appropriate compensation scheme. Gdowska et al. [28] introduced an agent-oriented approach to minimize problems in the last-mile delivery for couriers who occasionally "carpool" a parcel. They provide a method to calculate the total delivery cost associated with both the occasional couriers' compensation fee and the delivery cost generated by the professional delivery fleet used for the delivery of remaining parcels. Their stochastic approach assumes that the occasional carpooler is an independent agent, who is free to reject assignments. Behrend and Meisel [29] analyze a platform combining shipping requests with community members' planned trips through the development of mathematical and heuristic models with the aim of maximizing profits. The results quantify the benefit of integrating item-sharing (i.e., sharing of tools or leisure equipment between community's members) and crowdshipping as a function of crowdshippers' detour flexibility and compensations. Due to these findings, the authors conclude that integration of item-sharing and crowdshipping has the potential to push collaborative consumption by delivering through the crowd.

The increased attention in urban freight behavior analysis (e.g., [30,31]) has led academic researchers investigating stakeholders' preferences and attitudes. Marcucci et al. [32] explore the necessary pre-requisites a crowdshipping service needs to satisfy and to be attractive within the highly competitive urban freight delivery market. They find that students are prone to operate as crowdshippers deviating from the usual path, but this willingness depends on the remuneration and delivery box dimensions. At the same time, online buyers are willing to receive goods via a crowdshipping service especially when they can contact the crowdshipper and track the package. Punel and Stathopoulos [33] used state choice experiments, investigating the factors influencing the users' acceptability towards hypothetical delivery schemes performed by professional and non-professional shippers. Punel et al. [34] compare attitudes, preferences, and characteristics of crowdshipping users and non-users. They found that young people, men, and full-time employees and individuals with a strong sense of community and environmental concern were more likely to use crowdshipping service. Yildiz and Savelsbergh [35] deal with crowd-sourced transportation for on-demand meal delivery, investigating the interaction between courier satisfaction (i.e., couriers' willingness-to-wait), courier compliance (i.e., couriers' offer acceptance-probability) and profit.

Finally, other studies describe crowdshipping initiatives illustrating their operational/technological functioning (e.g., [36,37]).

### 3. Materials and Methods

This section illustrates data, methods, and models adopted in this study to evaluate the environmental and economic impacts of a public transport-based crowdshipping platform.

The methodology architecture is reported in Figure 1. The first step is to define possible crowdshipping demand levels as a function of the main features of the service. Second, the demand is converted into orders, and the vehicle-kilometers saved by public transport-based crowdshipping are computed. Finally, the benefits and costs of the service are evaluated in terms of externalities reductions, revenues, investment, and management costs, thus computing the net present value of the proposed service.

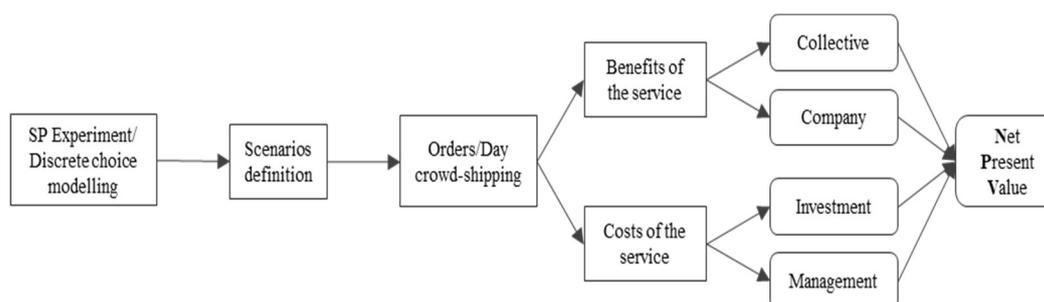


Figure 1. Methodological scheme.

This paper uses stated preference (SP) exercises, including the most important features associated with the willingness to use the crowdshipping service, to estimate the crowdshipping demand. SP was chosen since it is perfectly suitable for investigating individuals' perceptions, acceptance, and reactions towards hypothetical conditions not present in the market. In fact, SP has been widely used in the transportation context for: (i) Evaluating potential behaviour changes (e.g., [38,39]); (ii) estimating modal shift (e.g., [40,41]); and (iii) analysing attitudes or satisfaction related to innovative services (e.g., [42,43]). SP has also been applied to the freight sector for: (i) Predicting stakeholders' reactions to policy changes (e.g., [44,45]); (ii) fostering stakeholder involvement and acceptability in the planning process (e.g., [46,47]), and (iii) in combination with other methods such as agent-based models (e.g., [48,49]). Following Gatta and Marcucci [50] who suggest using advanced experimental design techniques when performing SP exercises in the urban freight transport field, a Bayesian D-optimal design was adopted to define the choice tasks in the questionnaire. The final configuration foresees four different blocks, each including three choice exercises with three alternatives (two unlabeled linked to a crowdshipping service) and a "no choice" option (i.e., the *status quo* of not using the crowdshipping service).

Specifically, the SP studies the role of service time and cost, parcel tracking availability, delivery schedule date/time flexibility (Table 1) in stimulating potential e-commerce users to choose a crowdshipping service for delivering the goods they have bought. Shipping fees and time refer to current national shipping companies operating in Italy. Additional data was collected (e.g., socio-demographic characteristics, actual behavior and attitudes).

Table 1. Description of features and levels for the stated preference scenarios.

Features	Levels
Shipping fee (with respect to current national shipping companies)	<ul style="list-style-type: none"> <li>● Lower (+1)</li> <li>● Typical (−1)</li> </ul>
Shipping time (with respect to current national shipping companies)	<ul style="list-style-type: none"> <li>● Lower (+1)</li> <li>● Typical (−1)</li> </ul>
Parcel tracking	<ul style="list-style-type: none"> <li>● Available (+1)</li> <li>● Not available (−1)</li> </ul>
Delivery date and Time schedule flexibility	<ul style="list-style-type: none"> <li>● Yes (+1)</li> <li>● No (−1)</li> </ul>

The SP survey was undertaken during October 2017 from approximately 240 inhabitants of the city of Rome. Almost two-thirds of the interviewees were contacted via social media (i.e., Facebook) and e-mail, while one third were "face-to-face". Respondents had to fill in the same web-questionnaire. We used the time duration for completing the questionnaire as a proxy for reliability, verifying no significant difference between the different methods.

Next, discrete choice modeling was used to analyze SP data. A multinomial logit model was estimated to calculate the probability of choosing a crowdshipping service. The estimation process was based on a likelihood maximization and performed via BIOGEME [51].

Scenario analyses were performed from the econometric results and different assumed service specifications. In particular, three demand scenarios (base, favorable, and unfavorable) were considered depending on the acceptability level of the service.

Individual orders were transformed into vehicle equivalent units, i.e., the number of commercial vehicles needed to transport a certain quantity of orders, so to compute the vehicle-kilometers savings (shifted to public transport-based crowdshipping). For this computation, the load capacity of a light commercial vehicle was set at eight cubic meters in compliance with the vehicle fleets of the major national couriers operating in Rome. However, since Nuzzolo et al. [52] suggested that the load factor in Rome is about 50% of the transportable volume, we assume that the load value to be four cubic meters. The average dimension of the parcel has been set equal to  $40 \times 30 \times 30$  cm. This size is consistent both with the crowd (couriers) and with the typical e-commerce orders [53].

This paper uses the COPERT 5.1.1. (CComputer Programme to calculate Emission from Road Traffic, EMISIA SA, Thessaloniki, Greece) calculation model to estimate the environmental benefit due to lower emissions of air pollutants. Specifically, the reduction in emissions for particulate, nitric oxide, carbon monoxide and carbon dioxide are computed, thus covering both local (urban scale) and global impacts (greenhouse gases emissions).

In COPERT the emission of a vehicle  $i$  is calculated as the sum of three contributions:

$$E_i = E_{\text{hot},i} + E_{\text{cold},i} + E_{\text{vap},i}$$

where:  $E_{\text{hot},i}$  : hot emissions, generated by the engine at operating temperature;  $E_{\text{cold},i}$  : cold emissions, generated during the engine warm-up phase;  $E_{\text{vap},i}$  : evaporative emissions, composed exclusively by NMVOC (Non-Methane Volatile Organic Compound).

The Emission Factor equations of the COPERT method are discussed in [54,55]. Data on traffic conditions, vehicle fleet composition, kilometers traveled for each year and the cumulative value of the kilometers traveled during the lifetime are particularly important model inputs (Table 2). In this study, vehicle fleet categories derived by the registered fleet in Rome in 2017; kilometers traveled each year by Light Commercial Vehicles (LCV) are reported in [56] as trend estimates based on the elaboration of different sources of data (ACI, 2000–2015 and ISPRA, 2015). Finally, the cumulative value of the kilometers traveled are computed based on the model reported in Ricardo-AEA [57].

**Table 2.** Light commercial vehicles data.

EURO Class	Vehicle Category (EURO) *		km/year **	km Cumulative ***
	LCV-Petrol	LCV-Diesel		
0	0.8%	11.7%	4950.00	608,319.69
1	0.6%	7.9%	7920.00	368,979.34
2	1.0%	14.3%	14,548.00	272,132.62
3	1.4%	19.0%	19,000.00	223,531.25
4	1.4%	19.8%	28,726.00	190,067.89
5	1.1%	15.3%	30,193.00	138,635.23
6	0.4%	5.4%	36,000.00	36,125.92

\* Registered fleet in Rome (2017) [58]. Open Data Ministero delle infrastrutture e dei trasporti. \*\* ACI, 2000-2015 and ISPRA, 2015 [56]. \*\*\* Ricardo-AEA [57].

Once evaluated the reduction in emissions and vehicle-kilometers traveled, traffic externalities related to local, global, acoustic pollution, and accident risk have been transformed into monetary terms. This paper uses Ricardo-AEA [57] and Litman [59] unit costs to perform this task.

The last part of the methodology implements a Cost-Benefit Analysis (CBA) calculation for the crowdshipping service in Rome. This is the most frequently used analysis for evaluating projects of collective interest and represents a useful tool for policy-makers. One can summarize the key elements of the CBA analysis as follows: (1) Investment costs; (2) operating costs; and (3) cash inflows.

The Net Present Value (*NPV*) is a synthetic index to express CBA results. It measures the difference between the present value of cash inflow and that of outflow over a given period of time:

$$NPV = \sum_{t=0}^n \frac{S_t}{(1+i)^t}$$

where  $S_t$  is the net cash flow at time  $t$ ,  $i$  is the discount rate, and  $t$  the time of the cash flow. This study assumes a 3% social discount rate as set by the European Union [57].

For evaluating the financial sustainability of the service, the paper considers a time-frame up to 2025 and takes into account the following factors: (i) E-commerce demand growth, (ii) socio-demographic evolution, and (iii) metro network expansion. As it is for (ii) and (iii), the planning document S.T.A.T.U.S. (Transport and Environmental Scenarios for Sustainable Urban Transport) by Rome Mobility Agency has been adopted, where the long-term scenario is assumed as 2025. About the socio-demographic evolution, a very low increase (about 60,000 residents and 36,000 employees) is expected by S.T.A.T.U.S. in the long-term scenario [60].

For each demand scenario and each reference year, the externalities saved were estimated assuming that a certain share of orders, and therefore equivalent vehicles, are transferred to couriers (crowdshippers) using the metro network to commute to work. The reductions in environmental externalities were subsequently transformed, using unit costs, in monetary values so to calculate the ensuing economic benefits.

Considering private company profits, in line with other crowdshipping services already operating in the market, we assume that crowdshipping platform retains a 10% margin on the fee paid to the crowdshippers for the service produced. In other words, if the traveler-courier fee is € 1, the platform earns € 0.10, and the final consumer pays the delivery service € 1.10. Besides, the shipping cost for the detour the crowdshipper has to perform could also be added to the final price.

The service costs, divided into investment costs and management costs, are assessed on the base of each scenario. Investment costs refer to the purchase of automated parcel lockers (APLs) and the creation of an IT platform to manage the service. APLs are based on the daily demand and assuming each order is collected the same day: Fixing one-day pickup; the minimum number of lockers is required; thus assuming the minimum costs for the private company. Indeed, the evidence shows that collection slots have to last longer [14]; however, the same-day logistics is destined to expand yet further in the coming years.

Purchasing and management costs have been derived from different sources, including articles and manufacturers' brochures and websites. The average purchase cost used in this study ranges from € 11,000 for a block of 50 lockers up to € 60,000 for one of 400 [61]. As for the cost of the IT platform, the paper uses a flat-rate cost of € 20,000.

Operating costs include APLs maintenance and software updates. This paper assumes a €30/unit-year for the former and a flat annual rate of € 5000 for the latter. Moreover, from a mid-term perspective, it seems fair to assume that APLs management costs decrease in line with technological improvements and economies of scale. This motivates setting a € 3/unit-year reduction for lockers' maintenance.

## 4. Results and Discussions

### 4.1. Econometric Results

The utility specifications of the multinomial logit model are reported below where the two unlabeled options are defined by four attributes and the "no choice" option depends on the alternative-specific constant (ASC) and the variable "Age":

$$\begin{aligned}
 V_A &= \beta_1 \times \text{Shipping Fees}_A + \beta_2 \times \text{Shipping Times}_A + \beta_3 \times \text{Parcel Tracking}_A + \beta_4 \times \text{Delivery Planning}_A \\
 V_B &= \beta_1 \times \text{Shipping Fees}_B + \beta_2 \times \text{Shipping Times}_B + \beta_3 \times \text{Parcel Tracking}_B + \beta_4 \times \text{Delivery Planning}_B \\
 V_{\text{no choice}} &= \beta_5 \times \text{Age} + \text{ASC}
 \end{aligned}
 \quad (1)$$

The attributes characterizing the hypothetical alternatives are: Shipping cost (typical, lower than typical), shipping time (typical, lower than typical), parcel tracking availability (yes, no), and delivery schedule date/time flexibility (yes, no).

The model fits the data well (Rho-square around 0.3, Table 3). Moreover, the sample reconstitution, i.e., the number of times the model can reproduce the right choice of the users, is equal to approximately 60%. All the coefficients have the expected signs and are statistically significant. Age coefficient is positive showing that older people are less interested in using a crowdshipping service. It is important to note that the “no choice” option can reveal not only a negative perception towards crowdshipping but also an indifference position between the two crowdshipping systems presented. In line with Cantillo et al. [62], further research will explore this issue.

**Table 3.** Multinomial logit model: parameter estimates, fit statistics and validation.

		MNL			
		Coeff. ( $\beta$ )	Stand. Error	t-Test	p-Value
Attributes	Age	0.0905	0.0118	7.65	0.00
	Shipping fees * [a]				
	<i>Lower</i>	0.6750	0.0998	6.76	0.00
	Shipping time ** [a]				
	<i>Lower</i>	0.5870	0.0882	6.65	0.00
	Parcel tracking ***				
	<i>Present</i>	0.6980	0.0946	7.38	0.00
Delivery date and Time schedule flexibility ****					
<i>Yes</i>	0.7860	0.0886	8.87	0.00	
“no choice” [ASC]	−5.2300	0.5880	−8.90	0.00	
* base level: “Typical”; ** base level: “Typical”; *** base level: “Not available”; **** base level: “No”. [a] with respect to current national shipping companies					
<b>Model Fit Statistics</b>		MNL			
N. of observations (individuals)		618 (206)			
Null log-likelihood		−678.942			
Final log-likelihood		−469.842			
Likelihood ratio test		418.201			
Rho-square		0.308			
Adjusted rho-square		0.299			
<b>Simulation test</b>					
Sample reconstitution		59.9%			

Since attributes are qualitative and expressed in effects coding (see Table 1), one can compare the magnitude of the various coefficients. The possibility to plan the delivery date and its time schedule is the most relevant feature while having a lower shipping time with respect to the current situation has the lowest impact on utility. This reflects the fact that the actual delivery system is, in general, efficient in terms of shipping time (e.g., same-day delivery) while time windows are usually large, and people have to wait at home for their goods, producing either dissatisfaction or missing deliveries.

Data on socio-demographic characteristics, actual behavior and attitudes are also acquired. There is a high percentage of young respondents (around 40%) with a gender balance in the sample. As it is for mobility habits, by assuming a catchment area of 800m radius for each stop [63], one finds that 75% of the interviewees passes close to, at least, one metro station during his/her home-based trip. Other information regarding Roman citizens’ mobility-related habits and activity density can be found

in [19,64,65]. Most of them prefer to pick-up the parcel during the afternoon (38%) or evening (33%) and to have the withdrawal option available at least for 24 hours (44%). Many respondents (68%) self-stated a medium level of green attitude, based on the interest in/concern about environmental problems. Finally, about half of the sample foresees a successful crowdshipping service in urban areas, while only a quarter in the case of suburban areas.

#### 4.2. Economic and Environmental Impacts

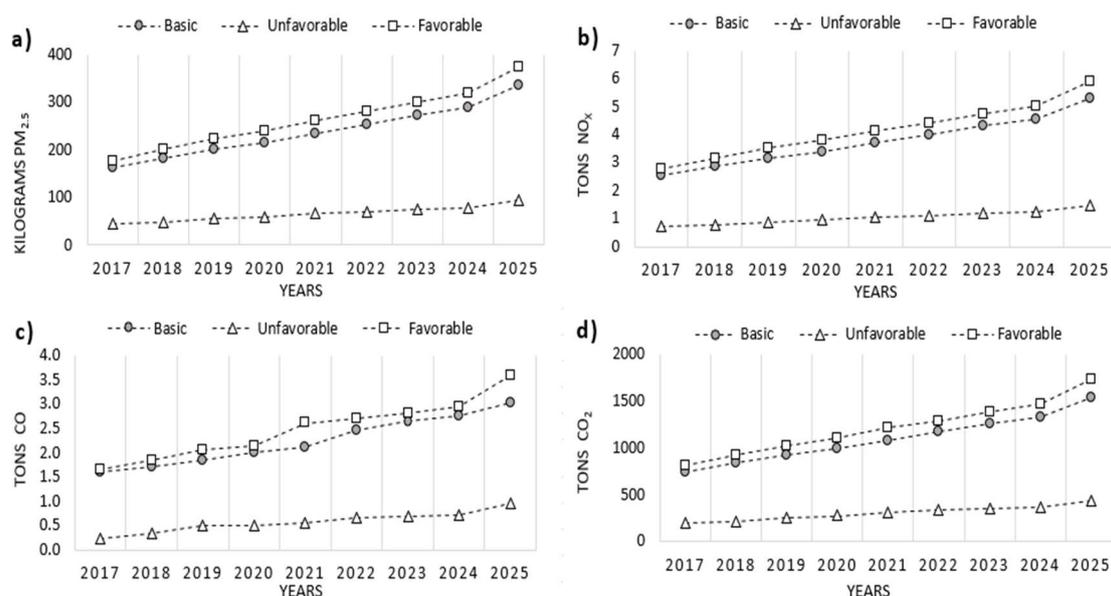
According to the results obtained, three demand scenarios have been considered (Table 4). The “base scenario” is the one assuming the most likely configuration of the possible crowdshipping service. The base scenario is compared with others called “favorable” (with lower shipping fees) and “unfavorable” (with no flexibility in delivery date and time schedule), respectively. The probability of choosing such a service ranges from 16% to 66%.

The potential crowdshipping demand is mainly generated by the same users of the metro network, as well as by the inhabitants located in the surrounding areas of the metro stations (the latter computed adopting a catchment area of 800 m radius for each stop and reducing the number by the modal share of the metro service in Rome). Then, it is converted in potential daily orders considering an e-shopping rate of 0.0262 orders/day per inhabitant, both for the current state and the year 2025. E-shopping rate is calculated taking into account the percentage of the population making at least one online purchase, the percentage of orders requiring a physical shipment and the annual average rchase [66–68].

**Table 4.** Estimation of potential demand for crowdshipping by public transport (current state–year 2025).

Demand SCENARIOS	Crowdshipping Service Adoption Probability	Potential Demand Current State (Orders/Day)	Potential Demand Year 2025 (Orders/Day)
Favorable	66.10%	14,100	29,540
Base	59.70%	12,730	26,680
Unfavorable	16.40%	3500	7330

Below we report the environmental-related benefits for the 2017–2025 period, based on the above assumptions, for the implementation of a crowdshipping service in Rome (Figure 2).



**Figure 2.** Estimation of pollution emissions saved: particulate (a), nitric oxide (b), carbon monoxide (c), carbon dioxide (d).

One can, on average, save 239 kg of particulates per year, with oscillation between 66 kg and 265 kg. Nitrogen oxide will, on average, be reduced by 3.76 tons per year with a variation between 1.04 and 4.17 tons. For carbon monoxide, the reduction is 2.24 tons per year with a minimum of 0.58 and a maximum of 2.49 tons. Finally, for carbon dioxide, the emission avoidance is 1098 tons per year with extreme values reaching 304 and 1215 tons.

The growth of e-commerce implies that the number of equivalent vehicles replaced by crowdshipping will increase with a consequent upsurge of emissions saved.

Without considering public benefits, the NPV obtained is negative, underlining that costs prevail over revenues for the platform operator (Figure 3). However, considering that environmental benefits and accident reduction impact on society as a whole, it is reasonable to suppose that their economic value can be converted into public incentives and, therefore, be deducted from the total costs of the platform. Following this assumption, the NPV takes a positive sign, indicating the economics as well as the environmental sustainability of the platform during the eight years has been considered.

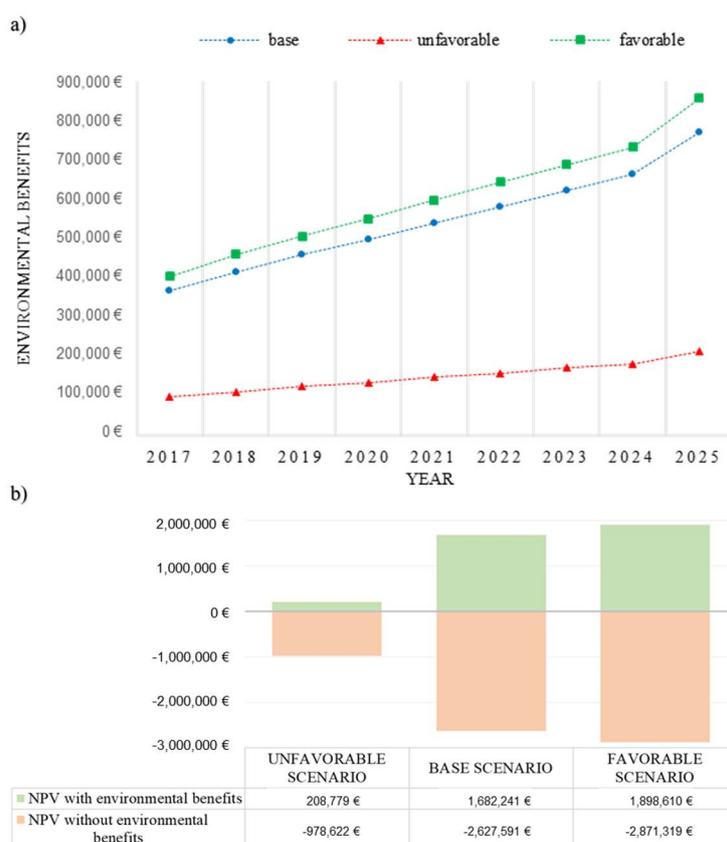


Figure 3. (a) Estimation of monetized collective benefits. (b) Net present value.

The biggest challenge policy-makers have to face is the redistribution of costs and benefits among stakeholders. In particular, policy-makers should provide the subsidies needed to cover platform costs due to the collective benefits it would produce.

In fact, as shown in Figure 4, if the collective benefits were converted into subsidies for crowdshipping operators were less than 100%, then a reduction in net income occurs compromising the economic sustainability of the platform. A 25% reduction in subsidies implies a non-sustainable scenario should an “unfavorable scenario” materialize. A 50% subsidies reduction makes no scenario economically sustainable.

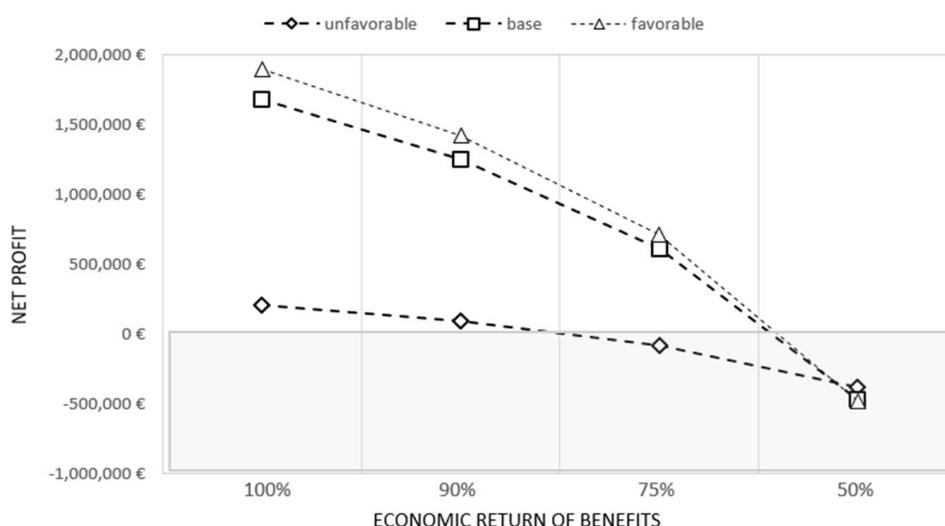


Figure 4. Net income as subsidies change.

## 5. Conclusions

Cities need new logistical solutions to deal with the requirements of the on-demand economy. Crowdshipping is a promising solution for sustainable urban freight distribution.

This paper provides an assessment of economic and environmental impacts of a “green” crowdshipping service based on public transport for the city of Rome, Italy. It starts with an SP survey in order to study the potential crowdshipping demand. Then, adopting discrete choice modeling, scenario analyses are performed to calculate the reduction in externalities, the revenues for the crowdshipping operator, as well as the investment and management costs for the crowdshipping platform.

The environmental assessment suggests that implementing such a crowdshipping service in Rome produces a total savings of 239 kg of particulates per year. Moreover, the economic sustainability is reached only with public incentives justified by the reduction of externalities to the society that such a system can produce.

Future research endeavors will focus on providing: (i) A more detailed environmental evaluation using micro-simulation modeling both accounting for realistic traffic conditions and availability of commercial bays, and comparing traditional versus public transport-based crowdshipping; (ii) an in-depth analysis of both technical requirements (e.g., parcel lockers location and size) and the needed coordination between shippers, logistics operators and crowdshipping platform providers; and (iii) a comprehensive analysis investigating, under a multidisciplinary approach, the full range of critical elements (e.g., economic, legal, social, psychological issues) that might hinder the adoption of a successful business model.

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