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A persona based TCO analysis of speed pedelecs and carsharing as a holistic mobility solution

Nikolaas Van den Steen[1], Lieselot Vanhaverbeke[1]

[1]*MOBI research group, Vrije Universiteit Brussel, Pleinlaan 5, Elsene 1050, Brussel, Belgium, Nikolaas.van.den.steen@vub.be*

Executive Summary

This study investigates the total cost of ownership of a holistic mobility solution, where a speed pedelec is the primary commuting vehicle, supplemented with by carsharing for additional travel needs. By integrating user profiles and one-year longitudinal cost data, this paper calculates the total cost of ownership (TCO) for each of 13 respondents. The analysis includes costs for maintenance, repairs, accessories, and carsharing. The TCO of this mobility solution is compared to a small electric and petrol car. The findings show that a SP and carsharing configuration could be a financially viable mobility solution to car ownership of both ICEVs and BEVs. These findings can both inform individual mobility choices and policy initiatives, supporting sustainable and accessible transport solutions.

Keywords: light electric vehicles & Micromobility, electric two- & three wheelers, electric vehicles, consumer behaviour

1 Introduction

The shift to sustainable transport is happening with the adoption of electric vehicles as replacements for internal combustion engine vehicles. The International Energy Agency (2024) reports on rising adoption of electric cars in Europe [1], but the uptake is also growing within the light electric vehicle category [2]. Light electric mobility (< 1000kg) allows for a more energy-efficient way of transport, for shorter distances [3]. Examples of such popular light electric vehicles are electric scooters, pedelecs (i.e. electric power-assisted bicycles up to 25 km/h) and speed pedelecs (i.e. electric pedal-assisted bicycles up to 45 km/h) (SPs). This last type of electric bicycle is very popular in Belgium and Switzerland. SPs are also gaining a significant foothold in other European cycling countries such as the Netherlands, Germany and Denmark [3], [4], [5], [6], [7].

People in Flanders, Belgium, live relatively close to their workplaces (i.e., 82.4% live within 30 km of their work) [8] and frequently encounter traffic jams when commuting by car [9]. Commuting with a SP is thus feasible for most; it does not necessarily shorten the trips, but it makes the trip duration predictable [10]. Already, 70.000 users have selected a SP as an effective mobility solution for their commuting [3], [11]. A persistent barrier to wider SP uptake remains the purchase price [12], despite policy such as tax-free bicycle allowance [13], [14] and leasing to stimulate use. In addition, previous preliminary research [15] also showed that different SP owners have different *cost schemes,* dependent on the characteristics of their vehicle, their maintenance habits and other preferences. Frequent use may lead to higher expenditures: added purchase costs of varied accessories, more frequent maintenance costs and occasional repair costs. While occasional use might not necessitate those costs.

To understand the financial landscape of SP ownership, it is essential to go beyond simple averages and purchase costs. Insights into the total cost of ownership (TCO) are critical for potential users making informed decisions and for policymakers, designing effective incentives. This is particularly relevant given that the current average user profile is an educated, middle-aged working man with sufficient means [16],

[17]. While this demographic has embraced SPs as early adopters, it raises questions whether economic or social barriers still may be limiting access for other groups, such as younger individuals, women or those with lower incomes.

However, effective mobility solutions must go beyond commuting alone. For many users, SPs meet daily commuting needs but do not cover all trips. A car's versatility makes it advantageous for multi-purpose use, however studies show that a private car stand idle for more than 95% of the time [18], [19], [20]. A shared car is more used [21] and its services allow users to enjoy the benefits of a car. To more accurately evaluate the TCO of SPs as alternatives to cars, this study combines SP use with a carsharing subscription, allowing for flexibility across a range of trips and comparing this combination to owning a small electric or petrol car.

While earlier research has examined SPs primarily as commuter vehicles, less is known about the total cost implications when complemented with carsharing for non-commuting needs and how this performs when compared to other commuting vehicles like cars. Exploring variations could reveal whether specific costs, such as maintenance or repair expenses, disproportionately affect certain groups, creating barriers to broader adoption. Previous work [15], [22] only focused on SPs for commuting, while this work will include the cost of a carsharing program for all other trips for which the SP is not used.

This research will address the following questions:

How does the total cost of ownership of SPs vary across different user profiles, when complemented with a carsharing program to cover all trips? How does it compare to a small-sized electric car and internal combustion engine vehicle?

By answering these questions, this research aims to provide nuanced financial insights that can both inform individual mobility choices and the development of targeted policy interventions to encourage sustainable and inclusive transport. Currently, no longitudinal data of real users is available to provide input for the non-operational costs, and the inclusion of a carsharing program to complement the remaining trips was not performed yet. Belgian TCO-calculators exists comparing BEVs and ICEVs from all types [23], [24]. The Brussels *'Car cost calculator'* even includes the comparison with carsharing [23]. The '*Kostenwijzer'*, a tool made by Way To Go, a Flemish interest organisation for shared mobility, calculates in detail per mobility purpose the benefits of carsharing in Flanders [25]. Online tools to calculate the costs and benefits for speed pedelecs also exist, mostly set-up by leasing companies [26], [27] or to calculate the total earnable cycling allowance [28]. However, the novelty is considering the combination of a SP with a carsharing system as holistic mobility solution when calculating the total costs.

2 Methodology

This study adopts a longitudinal approach to help clarify the costs associated with the ownership of a SP. A total cost of ownership consists of three groups of costs: initial costs, operational costs and non-operational costs. The determination of these costs was performed in previous work. For clarity the main structure will be repeated in this paper here. Then, the approach towards the longitudinal study is explained.

2.1 TCO calculation

The TCO calculation is determined by three cost types. These cost types are similar for the four main vehicles that are compared: a BEV, an ICEV, a speed pedelec and a carsharing system. In this study, costs associated with a subscription with Cambio [29] were selected, as it is the leading station-based carsharing system in Flanders. The costs for the BEV and ICEV are taken from the TCO-calculator provided by the Flemish Government [24]. All costs are determined from the viewpoint of a Flemish user. A real discount rate of 2.796% was used.

2.1.1 Initial costs

The initial costs are assumed to be the purchase and registration costs of both the BEV and the SP. The purchase prices for the speed pedelecs are based on, on the one hand, the purchase prices indicated by the respondents of the longitudinal survey and, from an updated market overview starting from desktop research. The average purchase price is 6328€, and the median is 6049€. The longitudinal survey highlighted the top 5 brands, being Stromer [30], Klever [31], Riese & Muller [32], Ellio [33] and Qwic [34]. An average price for

the speed pedelecs in this category is €7009.

For the SP, the initial costs also involve the purchase of accessories (€330 as in [15]), among others the obligatory helmet. The initial cost for the carsharing is the initial start-up cost of a subscription of €35.

2.1.2 Operational costs

The operational costs for the BEV and SP are the electricity costs (0.35€/kWh [35]) for the energy consumed by using the vehicle. For the ICEV, the operational costs are the cost of petrol (1,7029 €/l) [36]. For the carsharing system, the subscription costs are taken from the station-based Cambio system, which is active in Flanders. The Cambio user is charged a cost per kilometre and a cost per time spent using the car. This is dependent on the subscription, as shown in Table 1. To be able to calculate the hourly charge, the average speed of a shared car is calculated from median trip distance and length from a shared car in Flanders (resp. 34.9 km & 3 hours 34 minutes) [37].

2.1.3 Non-operational costs

The **non-operational costs** for the carsharing system are quite limited compared to the different non-operational costs for the BEV and the SP. The carsharing system only requires a monthly subscription cost of either €4, €8 or €22 [11], [29]. This is dependent on the choice of subscription, as shown in Table 1. The non-operational costs for the BEV, ICEV and the SP are the maintenance, insurance costs, taxes and repair costs due to wear and tear and accidents. Taxes do not apply for the carsharing and the SP. For the SP, also the cost of additional accessories is taken into account. The bicycle allowance is seen as a negative cost specific to the SP.

Table 1: Cambio subscription costs

	Cambio car 'S-category'	
Cambio subscription category	Monthly subscription cost	Hourly cost – Cost per kilometre[1]
Start	€ 4	€2.35 – €0.38
Bonus	€ 8	€2.10 - €0.29
Comfort	€ 22	€1.85 - €0.26

As seen in Table 1, Cambio has three regular subscriptions oriented to private individuals. There is one additional oriented at driving schools, which is not considered in this analysis. As mentioned before, there is an initial start-up cost of €35. To calculate the amount and the distance of the trips that would need to be substituted by a carsharing system, the panel data from *'Onderzoek Verplaatsingsgedrag nr. 7'* (OVG7) data of 2025 [8] is used as a basis.

OVG7 shows that the annual distance travelled by working-age population is 14,964 km, aligning with 14,429 km as identified in the Car-Pass-report [38] from 2024. This is taken as a reference to calculated the number of kilometres that are travelled with a shared car. The assumption is made that the extra SP kilometres indicated by the respondents are not supplementary to their regular use and would otherwise be replaced by the carsharing service. The shared car that is considered is the Peugeot e-208, part of the S-category of vehicles of Cambio [39]. The same Peugeot e-208 is considered as baseline via the TCO-tool of the Flemish government [24] to compare with the mobility solution of a speed pedelec and a carsharing service.

2.2 Longitudinal approach to determine operational costs

To quantify the non-operational costs of SP users in Flanders, a longitudinal survey was designed and deployed over one year. First, an initial online recruitment questionnaire was sent out, followed by a series of monthly follow-up surveys. The respondents were reached in September 2022 via an open call on social media platforms (i.e. Facebook, Instagram, LinkedIn), and the researchers reached out via personal networks and specialized user groups (e.g. 'SP Vlaanderen', a community for Flemish SP users [40]). The SP owners were invited to complete the initial survey, which screened for eligibility and explained the study objectives. Only those who confirmed that they owned or used a SP were included. The recruitment phase yielded 355 entries, of which 272 valid. The main characteristics of this group are reported in [8]. 111 respondents volunteered for the monthly tracking component, 13 respondents succeeded in filling in the survey each month. Their participation

[1] These prices are for a Class S car, which is a standard city car.

was voluntary and uncompensated. The goal was to track maintenance-related expenses and other ancillary costs associated with SP ownership and use. The participants' email address was used to link as an unique identifier.

The monthly survey covered their ownership of a SP (whether they still owned and rode the same SP or acquired a different SP), the way of acquisition, the purchase price, battery size, model, typical commuting patterns (daily distance, number of commuting days, use of any employer bicycle allowance), maintenance habits (pre-emptive routinely servicing or servicing due to wear and tear), cost of accessories, and insurance. For each category of non-operational costs, the respondents indicated the frequency, costs, incidents or relevant costs that incurred:

- **Pre-emptive maintenance:** routine service actions performed by either themselves or a professional and their expenses.
- **Wear and tear:** Parts replaced due to regular wear (such as tires, chains, brake pads), specifying the components and associated costs.
- **Accidents:** Any collisions or crash incidents, making the distinction between third party or single-vehicle crashes, including the damage (physical and mechanical) and the repair costs.
- **Breakdowns:** Mechanical failures not attributed to wear (e.g. motor malfunctions, battery problems).
- **Extra costs:** Unforeseen expenses linked to the SP that do not fit aforementioned categories
- **Accessories:** Equipment bought after the initial purchase of the SP.

All collected data was anonymized before analysis and was performed in Excel, due to the qualitative nature of the data. Besides expenses and numbers of frequency, remarks were added by the respondents which added contextual value to the numerical entries. In total 13 respondents filled in the monthly survey each month.
To contextualize the findings, an average Flemish 'user persona' was constructed based on the data of OVG7. This persona has a 17.23 km single commute and works 100% of the time at work, and has direct access to a station-based carsharing platform. To simulate a more integrated mobility scenario, the assumption is that the distance not covered by a SP – when compared to a typical car-based commuting- is substituted with carsharing. This assumption entails that the persona has access to a station-based carsharing system and can use it without incurring additional travel distance. Thus, a shared car is available at all places they want to reach (home, work, hobby, shops, etcetera).

3 Results

In this section, the general results of the year-long follow-up survey are discussed. First the descriptives of each respondent are shown. Secondly, the results of the follow-up survey are shown and thirdly the TCOs are calculated for each of these respondents with the addition of a carsharing system. Fourth and final, the TCO for an average Flemish person with a SP and carsharing subscription is calculated based on the average of all costs and compared to owning and using a BEV and an ICEV of the same model.

3.1 Results of the one-year longitudinal survey

From the 111 respondents that wanted to participate in the longitudinal survey, 13 respondents diligently filled in the survey for each month during the period of October 2022 until September 2023. The responses of the first five months of this survey are discussed in [15].

Table 2: Overview of the yearlong participants

ID	Gender Age	SP brand Purchase cost	Single commute (# $days_{commuted}$)	ID	Gender Age	SP brand Purchase cost	Single commute (# $days_{commuted}$)
P01	M 35 - 44 years	Gazelle[2] €4699	30 km (211)	**P08**	F 45 - 54 years	Stromer €5050	23 km (150)
P02	M 35 - 44 years	Stromer €6350	22 km (159)	**P09**	F 55 - 64 years	Stromer €6650	25 km (67)
P03	M	Stromer	10 km	**P10**	M	Stromer	21 km

[2] This changed to a Klever N Pinion of €6899

	25 - 34 years	€7330	(132)		45 - 54 years	€4590	(172)
P04	M 35 - 44 years	Stromer €5650	28 km (111)	**P11**	M 35 - 44 years	Stromer €8118	30 km (75)
P05	M 45 - 54 years	Riese & Muller €8236	45 km (70)	**P12**	M 25 - 34 years	Riese & Muller €6139	34 km (214)
P06	F 45 - 54 years	Giant €3599	21 km (85)	**P13**	M 45 - 54 years	Stromer €7330	22.5 km (138)
P07	M 45 - 54 years	Stromer €7330	30.5 km (26)				

In total over the 12 months with the 13 respondents, 81,520 km was commuted by SP. On average this meant 49.6 km round trip per day with a median of 12 days a month. A median of €0.24/km was earned with the bicycle allowance. The bicycle allowance is an allowance paid by employers to employees who travel (part of) their commute by (electric) bicycle. This tax-exempted up to 0.35 €/km with a total tax-free cap of €3,500 [41]. In total €19,296.68 was earned during the period of one year (October 2022-September 2023). During this period 36 pre-emptive maintenance jobs were performed by the respondents themselves, 21 small and three large maintenance jobs by a professional. Median cost of a small maintenance job by a professional was €13, for a large maintenance job €219. The median cost for the pre-emptive maintenance jobs performed by the participants were 0€ as most for these maintenance jobs no extra material was bought.

Regarding repairs due to wear and tear, 22 repairs were performed with a total cost of €2951. Six repairs were performed by the participants themselves, 16 were performed by a professional. Over the period of 12 months, 9 breakdowns were recorded for which road assistance was required. Seven out of nine times this was covered by the insurance. All road assistances were related to flat tires, only one assistance was the delivery of the SP to the respondents home after an accident.

Regarding accidents during the twelve months, there were two single vehicle crashes and two third-party crashes. The single vehicle crashes were one with minor physical damage and with damage up to €110 to the SP and one with severe physical damage (bruised ribs and a sprained thumb) without damage to the SP. The third-party crashes were one crash with an e-scooter with severe physical injuries resulting in hospitalisation and minor damages to the SP covered by insurance and one crash with a cyclist resulting in minor physical injuries (i.e. bruises and abrasions) with no damage to the SP.

Throughout the year, the respondents also bought extra accessories, which can be divided into two categories: personal accessories and vehicle-specific accessories. The following was bought by the respondents: Two pairs of rain gloves, seven pairs of warm gloves, six pairs of rain covers for shoes, three pairs of regular cycling pants, four raincoats, one warm electric coat, one balaclava and one fluorescent backpack cover and one fluorescent jacket. As for the vehicle-specific accessories, the following was purchased: Two bicycle bells, three extra sidemirrors, three pairs of cycle lights, one adjusted saddle, two new handlebars, one pair of extra grips for the handlebar, one smartphone holder, tube sealant, one breakdown set and two Tannus armour inner tube enforcements [42].

3.1.1 Cost overview per respondent

Figure 1, Figure 2 and Figure 3 shown in this section show the overview of the costs and the earnings made by each respondent over the period of a whole year. The stacked bars are the costs with each month, the dots are the earnings made by each respondent through bicycle allowance. There is considerable variation among the 13 respondents in both costs and earnings. The biggest spikes in terms of costs are those related to ‘wear and tear’. Furthermore, it is clear that not all respondents profit from bicycle allowance, and if so, those revenues are dependent on the number of days commuted. P04 in Figure 1 for example has no bicycle allowance. Others like P05 and P07 in Figure 2 did not indicate their number of commuted days. These respondents either did not use their SP, or did not have their SP available for commuting due to repair as a result of an accident or did not receive bicycle allowance from their employer. When looking at returning costs, it can be stated that no respondent has a cost declared every month. It is especially striking that towards the summer months, little to no maintenance costs are declared and only some accessory costs and cost related to accidents are indicated. This decline may reflect survey fatigue, as these months coincided with the end of

the study period. In general, most costs occurred in the autumn and winter months.

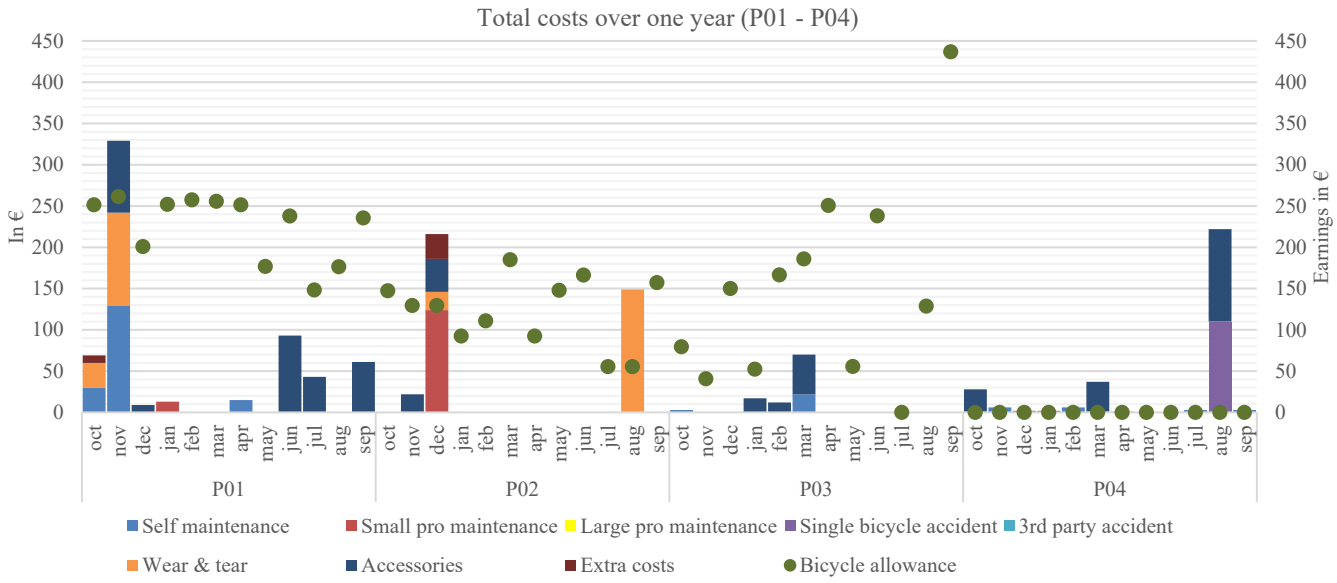

Figure 1: Stacked overview of total costs over one year per respondent (P01 - P04)

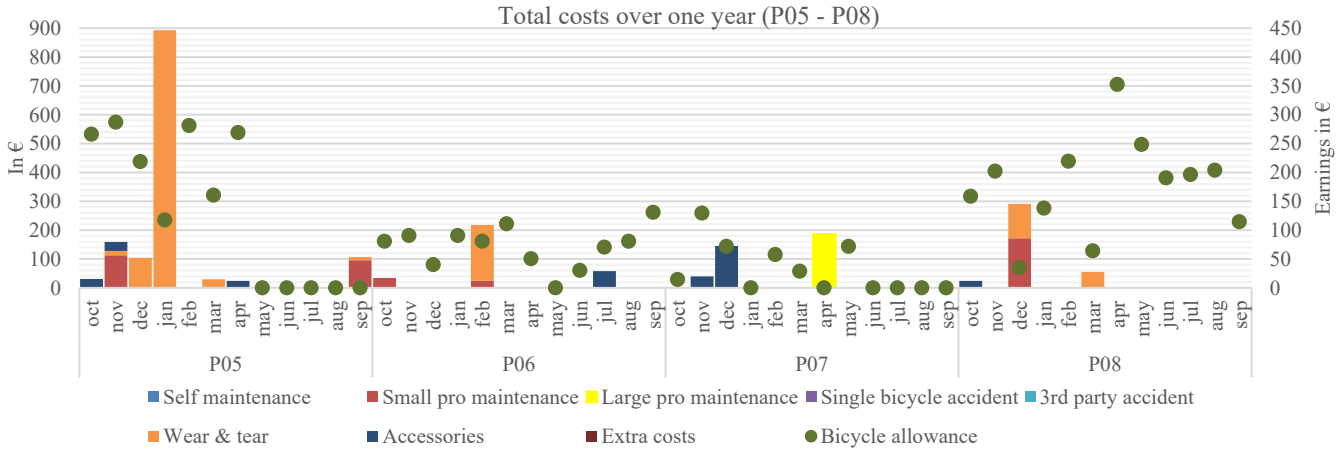

Figure 2: Stacked overview of total costs over one year per respondent (P05 - P08)

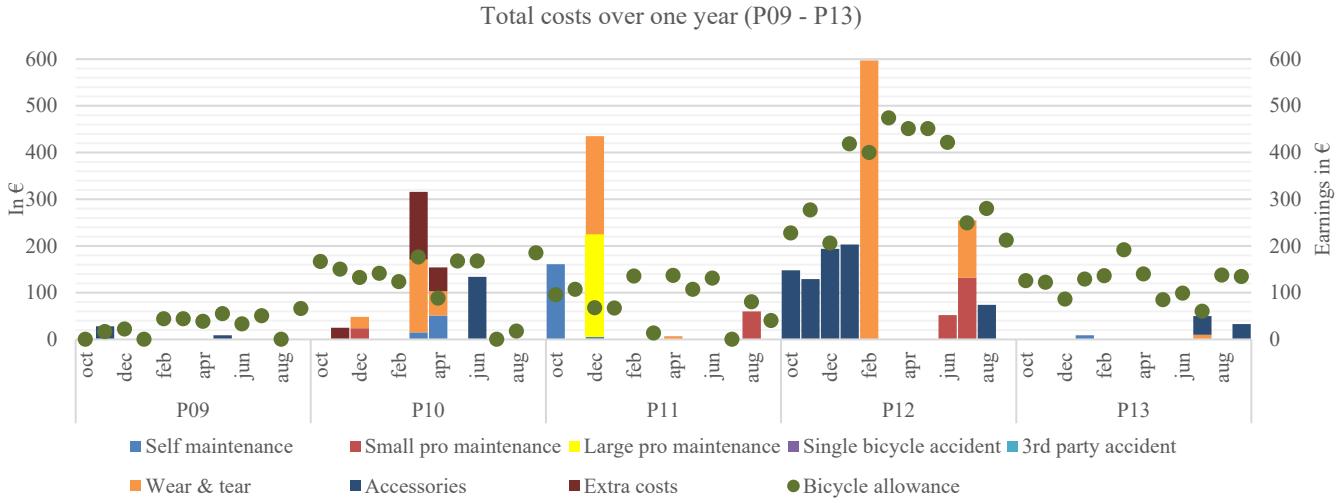

Figure 3: Stacked overview of total costs over one year per respondent (P09 - P13)

3.1.2 Total cost of ownership calculations for each respondent

Given the empirical nature of the data, being the monthly reported cost factors over a whole year, the TCO is presented on a one-year basis. The representation over one year allows for a transparent distinction between recurring and incidental costs. It also avoids overgeneralization from rare events such as accidents or sporadic accessory purchases. Extrapolation to a longer ownership period (e.g., 8 years) would require assumptions on the distribution and frequency of such events. This was done in [15], but is beyond the scope of this empirical study. The results of this one-year TCO are shown in Figure 4. The costs of owning and using a SP are combined with the cost of using a *'Comfort'* subscription of Cambio. The cost factor for the carsharing is calculated by using the kilometres that remain after subtracting the travelled kilometres by SP from the average yearly kilometrage reported in OVG7 (i.e. 14964 km). The 'Comfort' subscription was selected as it is the most cost-effective option for frequent users. Figure 4 also shows the cost per kilometre for each respondent, which is the total cost divided by the sum of the SP and the carsharing kilometres (i.e. 14,964 km, see Section 2.1.3).

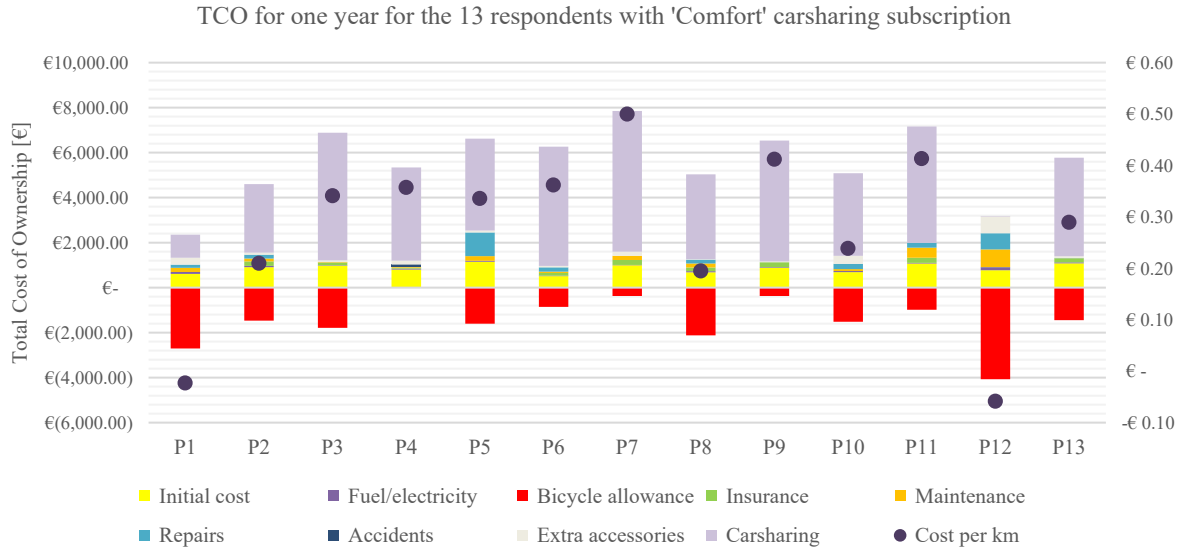

Figure 4: Stacked TCO overview of total costs & cost per kilometre over one year per respondent

The TCO values vary significantly across the 13 respondents, ranging from negative values to 7,500€. These differences are largely explained by the number of kilometres each respondent indicated that they commuted and the number of extra kilometres they travelled besides their commute. The cost per kilometre generally fall between 0.19€/km and 0.50€/km, except for P1 and P12. In the case of P12, the number of kilometres travelled solely with the SP was higher than the total average of 14,964 km. Thus for P12, no subscription was included and the cost per kilometre was calculated with the kilometres travelled by SP. This explains the low cost/km compared to the other respondents. P1 also has a negative cost per kilometre, which means the bicycle allowance more than covers the cost of SP commuting complemented by a carsharing subscription for other activities. Others, such as P7, P3, P9, P6 and P11 all have Cambio cost of more than 5,000, which is due to the low number of kilometres they travelled with the speed pedelec (both commuting & extra kilometres). P7, P11, P9, P6 and P4 have the largest TCOs and costs per kilometre. P3 is outside this five highest TCOs because of its larger share of bicycle allowance.

Table 3 shows the values per respondent for the distance travelled by SP and by Cambio-car, the TCOs for the SP and "SP + Cambio" and the cost per km for the SP and "SP + Cambio". The cost per km for the SP is calculated with the distances travelled by SP, which is dependent on the commute distance, the commuting frequency and the extra kilometres indicated by the respondents. Section 3.1.2 shows that the cost per kilometre of a Peugeot E-208 is 0.5 €/km, if the vehicle has a lifetime of eight years. This is mostly higher than the cost per kilometre for each respondent, besides P7 which has an equal number. For the petrol version of the Peugeot, P7's cost per kilometre is higher. This means that owning an electric car is less or as expensive as driving that same car with a carsharing subscription.

Table 3: Distances travelled by, TCOs for and Cost per km for SP & "SP + Cambio"

ID	Total distance SP	Total distance Cambio	TCO SP	TCO SP + Cambio	Cost per km SP	Cost per km SP + Cambio

P1	13,264 km	1,700 km	-1,381 €	- 349 €	-0.104 €/km	-0.023 €/km
P2	8,761 km	6,203 km	80 €	3,134 €	0.009 €/km	0.209 €/km
P3	2,929 km	12,035 km	-573 €	5,100 €	-0.196 €/km	0.341 €/km
P4	6,324 km	8,640 km	1,195 €	5,343 €	0.189 €/km	0.357 €/km
P5	6,456 km	8,508 km	933 €	5,022 €	0.145 €/km	0.336 €/km
P6	3,738 km	11,226 km	102 €	5,411 €	0.027 €/km	0.362 €/km
P7	1,633 km	13,331 km	1,219 €	7,474 €	0.747 €/km	0.499 €/km
P8	7,160 km	7,804 km	-860 €	2,912 €	-0.120 €/km	0.195 €/km
P9	3,596 km	11,368 km	791 €	6,164 €	0.220 €/km	0.412 €/km
P10	7,376 km	7,588 km	-108 €	3,568 €	-0.015 €/km	0.238 €/km
P11	4,035 km	10,929 km	1,007 €	6,183 €	0.250 €/km	0.413 €/km
P12	20,156 km	0 km	-906 €	- 879 €	-0.045 €/km	-0.06 €/km
P13	5,787 km	9,177 km	-60 €	4,329 €	-0.010 €/km	0.289 €/km

3.2 General TCO comparison

To compare a more general case, a persona is built. For this persona six different mobility configurations are set up, which are compared in Figure 5. The TCOs cover an 8-year period with a yearly kilometrage of 15000 km[3] [24]. The six mobility configurations are: two combinations of a SP with a 'Comfort' carsharing subscription – one full and one part time commuting with the SP –, four cars that are owned which are two electric vehicles and two petrol internal combustion engine vehicles (ICEVs). The kilometres that are not spent commuting with the SP are travelled by shared car as in previous section. The stacked bars represent the different cost components, and the dots indicate the cost per kilometre. The assumptions with regards to maintenance are based on [15], [22] and [24].

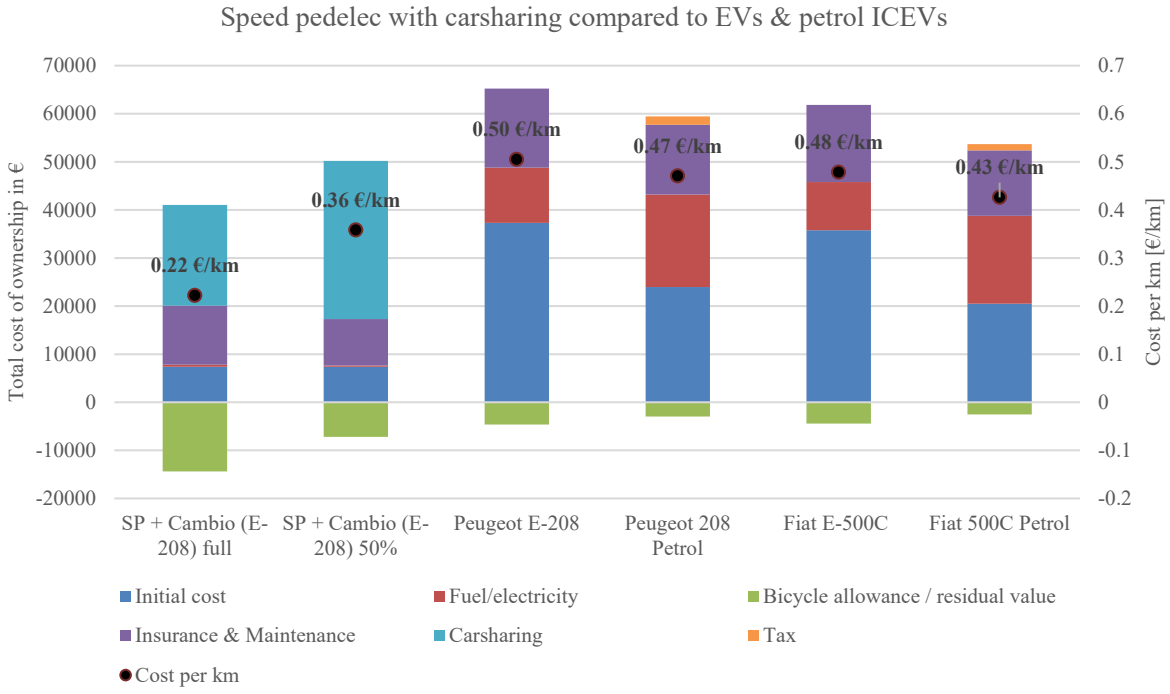

Figure 5: TCO of speed pedelec & carsharing compared to ownership of EVs and ICEVs petrol

[3] 15,000 km is the closest granularity to 14,964 km the TCO-tool of the Flemish government allows for.

Both “SP + Cambio” scenarios have significantly lower TCO values than the full ownership of private cars. When all residual car kilometres are substituted by carsharing (“SP + Cambio” full), the total TCO remains well below all private car options, though carsharing costs are the dominant cost component. The 50% carsharing substitution scenario (“SP + Cambio” 50%) increases total costs slightly but remains more economical than BEV or ICEV ownership. The car used in the “SP + Cambio” alternative is the Peugeot E-208, which is currently (ref. 2025) part of the Cambio program [39]. The subscription of ‘Comfort’ was chosen as the cheapest option, when travelling many kilometres. The ‘Start’ and ‘Bonus’ subscription each yield a cost per kilometre of 0.44€/km and 0.38€/km. While the former is cheaper than the standard petrol Peugeot, it is more expensive than a smaller petrol car such as the Fiat 500C. For these examples of cars, the TCOs and cost per kilometre for the BEV are higher than the petrol car. This is related to the higher purchase price of the BEV and the low number of kilometres that are taken into account while calculating. An increase in kilometres within the same vehicle category will make the TCO of the BEV lower than the ICEV.

Among private car options, the Peugeot E-208 (EV) exhibits the highest total cost, primarily due to a combination of high purchase price and maintenance costs. Petrol vehicles such as the Peugeot 208 Petrol and Fiat 500C Petrol show slightly lower TCOs but remain consistently more expensive than the “SP + Cambio” configurations. Notably, cost per kilometre (€/km) is lowest in the full “SP + Cambio” scenario, reinforcing the financial efficiency of combining active travel with flexible carsharing use. These findings highlight the economic viability of combining speed pedelec use with carsharing to meet daily mobility needs, particularly in urban and peri-urban contexts, while also providing flexibility without the fixed costs of private car ownership.

4 Conclusions

This study provides an empirical comparison of total ownership costs for a holistic mobility solution. By combining a speed pedelec with a station-based carsharing system it would be possible to replace owning a small BEV or ICEV. Within the context of this study, Flemish SP users were surveyed monthly for one year. The analysis of this longitudinal survey revealed substantial variation in costs across the 13 respondents. This reflects the differences in ride frequency, commuting distance, pre-emptive maintenance, repairs and the occurrence of accidents among all profiles. The bicycle allowance plays a big role as a revenue stream to counterbalance the costs associated to wear and tear. Among respondents, an evolution is noticeable where maintenance jobs are performed during winter months, while summer months have lower costs, besides the purchase of additional accessories. Importantly, for all the respondents the combination of a SP with carsharing in the specific context of this study generally incurs lower annual costs than owning the identical shared BEV; the Peugeot E-208. This does not change, except for one respondent, when owning a smaller BEV or ICEV. In particular, profiles that substitute nearly all travel to their speed pedelec and cover remaining trips via shared cars achieve the lowest cost per kilometer among the surveyed respondents. When compared on a general level, the “SP+carsharing” strategy remains more cost-effective than private car ownership with both a BEV and ICEV.

The results highlight how strongly mobility costs are shaped by individual travel patterns. Individuals who relied more heavily on their speed pedelec and would make limited use of carsharing saw the lowest overall costs. In contrast, those with fewer SP kilometers and a greater reliance on shared cars faced higher total costs. This variation shows that the balance between active modes and car-based travel plays a key role in determining financial outcomes. Nonetheless, with that balance and within the boundaries and assumptions of this study, the “SP+carsharing” configuration is cheaper than private car ownership.

By examining a range of user profiles, this study adds detail to our understanding of how different combinations of transport modes influence the total cost of ownership. The findings suggest that for many users, particularly those able to shift a majority of trips to the SP, combining it with carsharing offers a cost-effective alternative to owning a private car.

Future research would benefit from tracking a larger and more diverse sample of users over an extended period. This would enable the identification of recurring cost patterns and support a more robust segmentation of user profiles beyond individual case data. Analyzing maintenance and repair records from leasing companies could offer valuable insights into these typical patterns across a broader fleet. Additionally, exploring whether SPs function as substitutes for first or second cars—and assessing users’ willingness to adopt carsharing in place of private ownership—would shed further light on the practical viability of such mobility transitions. Finally,

a sensitivity analysis on parameters such as travelled kilometres by SP and different carsharing subscription would be valuable to show the variation on the results.

5 Limitations

The limitations of this study is the small data sample of highly motivated and avid SP users. This could influence the results. Furthermore, the number of kilometres taken into account for the carsharing activities is based on general figures, which might not exactly fit each respondent. Cambio has different tariffs for night-time use as well as a full day, a full week price and cost per kilometre is more than 100 km are travelled. These costs were not taken into account. The TCO for the car ownership are taken from the TCO calculator from the Flemish government, updated February 2025, while the cost structure for the SP is based on research from 2022. The total cost coming from the hourly tariffs is calculated with the average speed based on the median values of a trip length and duration. This is an approximation of reality. This study also does not include leasing of a SP, nor the leasing of a car, but only considers ownership.

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References

[1] International Energy Agency, 'Global EV Outlook 2024 Moving towards increased affordability', 2024. [Online]. Available: www.iea.org

[2] Bike Europe, 'McKinsey forecasts e-bike market value to five-fold by 2035'. Accessed: Oct. 29, 2024. [Online]. Available: https://www.bike-eu.com/47836/mckinsey-forecasts-e-bike-market-value-to-five-fold-by-2035

[3] N. Van den Steen, 'A user-centric analysis of preferences and performance of speed pedelec commuting in Flanders', KU Leuven & VUB, Gent, 2024.

[4] Velosuisse, 'Fahrrad-Neuverkaufe_2022', 2023.

[5] B. Europe, 'Swiss e-bike market development since 2015'. 2022. [Online]. Available: https://www.bike-eu.com/market-reports-switzerland

[6] BOVAG and RAI Vereniging, 'Mobiliteit in Cijfers: Tweewielers 2023-2024'. [Online]. Available: www.raivereniging.nl

[7] Zweirad-Industrie-Verband, 'Marktdaten Fahrrader und E-Bikes 2022', Berlin, 2023.

[8] Departement Mobiliteit en Openbare Werken, 'Onderzoek Verplaatsingsgedrag: Analysrapport 2025 (OVG7)', Indiville BV, May 2025. Accessed: May 25, 2025. [Online]. Available: https://www.vlaanderen.be/mobiliteit-en-openbare-werken/onderzoek-verplaatsingsgedrag-vlaanderen-ovg/onderzoek-verplaatsingsgedrag-vlaanderen-7-2023-2024

[9] Statistiek Vlaanderen, 'Filezwaarte'. Accessed: Oct. 31, 2024. [Online]. Available: https://www.vlaanderen.be/statistiek-vlaanderen/mobiliteit/filezwaarte

[10] B. Herteleer, N. Van den Steen, L. Vanhaverbeke, and J. Cappelle, 'Analysis of initial speed pedelec usage for commuting purposes in Flanders', *Transp. Res. Interdiscip. Perspect.*, vol. 14, no. 100589, pp. 1–10, 2022, doi: 10.1016/j.trip.2022.100589.

[11] Traxio, 'Speed pedelecs jaaranalyse: afkoeling bij nieuwe snelle fietsen maar recordjaar voor tweedehands'. Accessed: Jun. 02, 2025. [Online]. Available: https://www.traxio.be/artikels/speed-pedelecs-jaaranalyse-afkoeling-bij-nieuwe-snelle-fietsen-maar-recordjaar-voor-tweedehands/

[12] N. Van den Steen, B. Herteleer, J. Cappelle, and L. Vanhaverbeke, 'Motivations and barriers for using speed pedelecs for daily commuting', *World Electr. Veh. J.*, vol. 10, no. 4, Dec. 2019, doi: 10.3390/wevj10040087.

[13] VRT NWS, 'Vanaf mei heeft iedereen recht op een fietsvergoeding'. [Online]. Available: https://www.vrt.be/vrtnws/nl/2023/01/24/vanaf-mei-2023-heeft-iedereen-recht-op-een-fietsvergoeding/

[14] F. O. D. Finance, 'Fietsvergoeding 2024'. [Online]. Available: https://financien.belgium.be/nl/particulieren/vervoer/aftrek_vervoersonkosten/woon-werkverkeer/fiets#q5

[15] N. Van den Steen, B. Herteleer, L. Vanhaverbeke, and J. Cappelle, 'How cost competitive is a speed pedelec really?', in *EVS36 International Electric Vehicle Symposium and Exhibition (EVS36)*, Sacramento, CA, 2023, pp. 1–12.

[16] TRIDEE, 'De speed pedelec gebruiker'. 2020.

[17] M. L. M. van der Salm, 'De speed pedelec: wie zijn de gebruikers?' p. 58, 2020.

[18] J.-J. Witte, L. Kolkowski, N. Stofberg, B. Van Wee, and M. Kroesen, 'Car sharing user groups and their changes in car ownership: A latent cluster analysis', *J. Clean. Prod.*, vol. 484, p. 144334, Dec. 2024, doi: 10.1016/j.jclepro.2024.144334.

[19] J. Bates and D. Leibling, 'Spaced Out: Perspectives on parking policy', Jul. 2012.

[20] T. Zijlstra, J.-J. Witte, and S. Bakker, 'De maatschappelijke effecten van het wijdverbreide autobezit in Nederland', Feb. 2022. Accessed: Jun. 04, 2025. [Online]. Available: https://www.kimnet.nl/publicaties/publicaties/2022/02/22/het-wijdverbreide-autobezit-in-nederland

[21] A. P. Carrone, J. Rich, and D. Watling, 'Analysis of car sharing operation area performance: An idle time prediction approach', *Transp. Res. Part Policy Pract.*, vol. 190, p. 104241, Dec. 2024, doi: 10.1016/j.tra.2024.104241.

[22] N. Van den Steen, B. Herteleer, L. Vanhaverbeke, and J. Cappelle, 'Quantifying the benefits of switching to an e-bike : a multi-criteria calculation tool', in *35th International Electric Vehicle Symposium and Exhibition (EVS35)*, Oslo, 2022, pp. 1–12.

[23] 'Car Cost Calculator'. Accessed: Jun. 02, 2025. [Online]. Available: https://www.carcostcalculator.brussels/car-compare/cost-comparison?type=private_car&firstCarUuid=c2181794-4187-4859-bffe-d52c2f3e5125&secondCarUuid=a5a8c3e9-3300-48ff-8af8-4d18eed61883

[24] Departement Omgeving, 'Vergelijk milieuvriendelijke en conventionele wagens op kosten | Vlaamse Overheid'. Accessed: Jun. 02, 2025. [Online]. Available: https://mow.vlaanderen.be/tco/

[25] 'Save with carsharing'. Accessed: Jun. 02, 2025. [Online]. Available: https://kostenwijzer.waytogo.be/motieven

[26] ‘Calculator | Bike2Move’. Accessed: Jun. 02, 2025. [Online]. Available: https://www.bike2move.be/calculator
[27] ‘Leasefiets - Bereken hoeveel je bespaart - Lease a Bike’. Accessed: Jun. 02, 2025. [Online]. Available: https://www.lease-a-bike.be/calculator
[28] ‘Fietsvergoeding berekenen’, fietsvergoedingcalculator.be. Accessed: Jun. 02, 2025. [Online]. Available: https://www.fietsvergoedingcalculator.be
[29] Cambio, ‘Hoeveel kost het? | Cambio autodelen | Vlaanderen’. Accessed: Jun. 02, 2025. [Online]. Available: https://www.cambio.be/nl/hoeveel-kost-het
[30] Stromer, ‘Stromer’. 2022. [Online]. Available: https://www.stromerbike.com/en
[31] Klever, ‘Klever X-Speed’. 2019. [Online]. Available: https://klever-mobility.com/x-serie/x-speed-45
[32] R. & Müller, ‘Riese & Müller webpage’. 2022. [Online]. Available: https://www.r-m.de/nl-be/
[33] RideEllio, ‘Ellio’. 2023. [Online]. Available: https://www.rideellio.com/
[34] Qwic, ‘Qwic’. 2018. [Online]. Available: https://qwic.eu/qwic-catalogue-2020/
[35] ‘Charging at 0.35 €/kWh | EnergyVision’. Accessed: Jun. 02, 2025. [Online]. Available: https://www.energyvision.be/en/electric-driving
[36] ‘Maximumprijzen | Energia’. Accessed: Jun. 04, 2025. [Online]. Available: https://www.energiafed.be/nl/maximumprijzen
[37] ‘Deelmobiliteit-in-België-in-2024-Rapport-Way-To-Go’.
[38] Car Pass, ‘Car-Pass: jaarverslag 2023’, 2024. Accessed: Jun. 02, 2025. [Online]. Available: https://www.car-pass.be/nl/blog/car-pass-jaarverslag-2023
[39] Cambio, ‘Peugeot e-208 | Cambio autodelen | Vlaanderen’. Accessed: Jun. 02, 2025. [Online]. Available: https://www.cambio.be/nl-vla/peugeot-e-208
[40] Speed pedelec Vlaanderen, ‘Speed Pedelec Vlaanderen – Voor en door gebruikers in Vlaanderen en Brussel’. Accessed: Jun. 02, 2025. [Online]. Available: https://speedpedelecvlaanderen.be/
[41] ‘Fietsvergoeding’, FOD Financiën. Accessed: Jun. 04, 2025. [Online]. Available: https://financien.belgium.be/nl/node/3035
[42] Tannus, ‘Tannus Armour Insert’. [Online]. Available: https://www.tannusbenelux.com/shop/product/armour-insert-1#attr=221

Presenter Biography

Nikolaas Van den Steen graduated in 2017 as a Master of Energy Engineering Technology specialization Electrical Engineering at the KU Leuven Campus Ghent and achieved his Joint-PhD in March 2024 at KU Leuven and VUB on the topic of speed pedelecs. He is currently working as a post-doctoral researcher in the field of electric mobility as part of the MOBI research group. He has been and is active in several national and European projects related to electric mobility. His field of expertise are light electric vehicles, speed pedelecs and e-mobility.