Economic balance of door-to-door and road containers waste collection for local authorities and proposals for its optimisation

Final version

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This study was commissioned by the *Associació de Municipis Catalans per a la Recollida Selectiva Porta a Porta* (Association of Catalan Municipalities for Door-to-Door Selective Collection) to Fundació ENT.

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Executive Summary

This study aims to provide local authorities with actual and accurate information about the costs of waste management from a holistic perspective, with particular emphasis on a comparison of the door-to-door and road containers collection models.

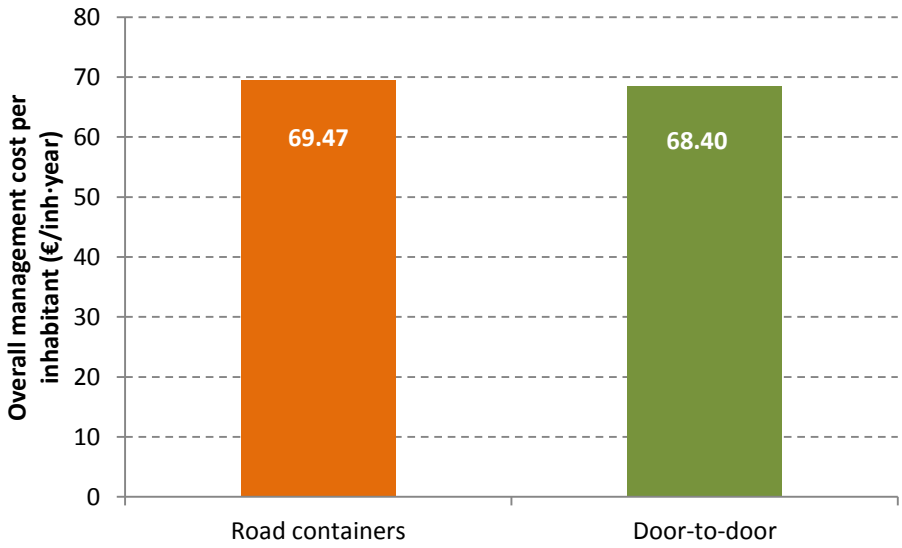
The study is based on real data on 81 Catalan municipalities of up to 20,000 inhabitants, of which 41 have door-to-door collections and 40 use road containers.

For a comparison of these two models, the indicator that has been considered to be most appropriate is the overall management cost per registered inhabitant. The overall management cost is calculated as follows:

Overall management cost = Collection costs + treatment costs - incomes

The results show that this indicator does not show significant differences between the two models. The door-to-door model has a slightly lower average overall cost, but the difference is negligible.

Overall management cost per registered inhabitant, depending on the collection model (simple average of the values in each municipality).



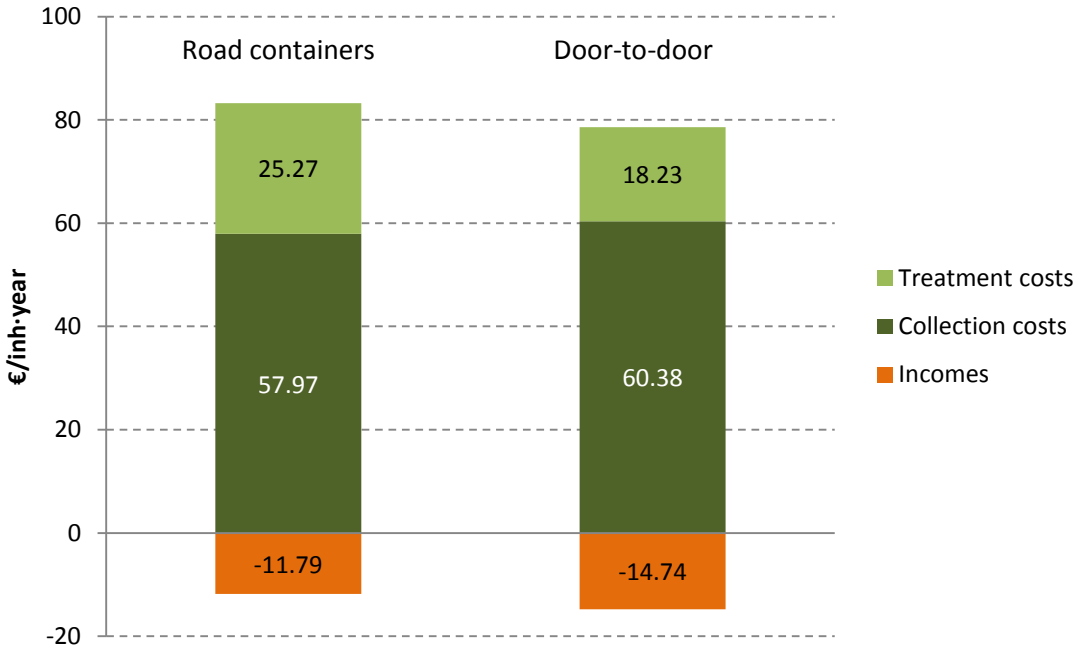
No influence of the size of the municipality on the overall management cost was observed. If the values of each municipality are weighted according to their size (number of inhabitants), the difference between the two models is somewhat higher, but still not significant.

The general conclusion of the study is that the overall costs of door-to-door collection for local authorities are, on average, similar to those under the road containers collection system; indeed, they are virtually identical if measured in relation to the registered population.

By item, the cost of collection is the largest contributor to the overall cost, particularly in the case of the door-to-door model. This cost, however, is offset by a lower cost of treatment and

higher revenues in municipalities with this model, thanks to the fact that they generally achieve higher levels of separate collection.

Overall cost of management per registered inhabitant, broken down, depending on the collection model (simple average of the values in each municipality)

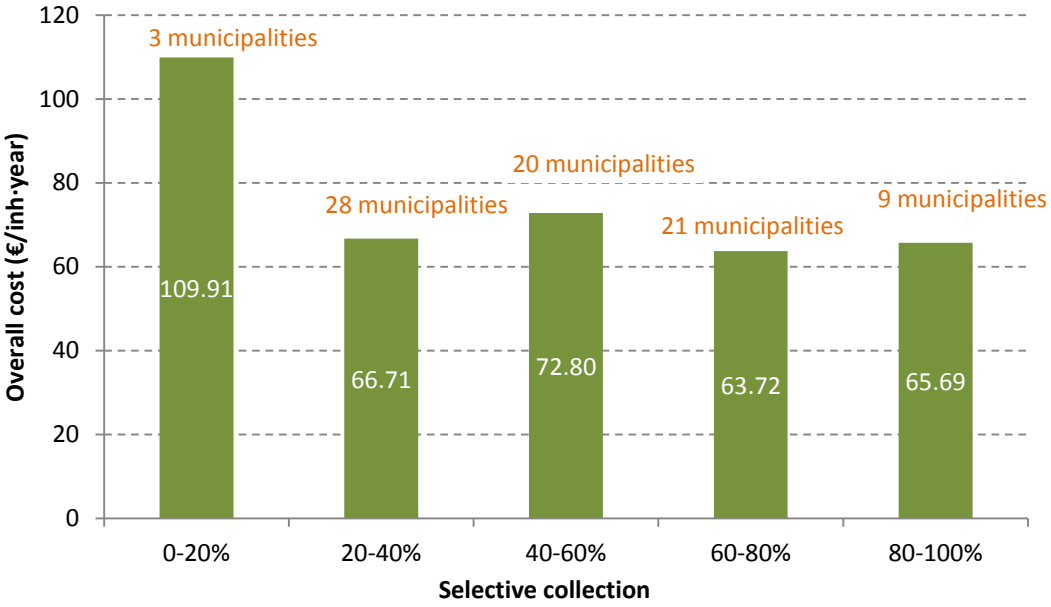


Considering all the municipalities together, separating them by separate collection rate, we observe, except for the section of 0–20% of selective collection, which is insignificant (because there are few observations), that the overall cost in the other sections is very similar and that no clear correlation is seen in the sense that a higher percentage of separate collection entails lower costs, or vice versa.

Although this is an aspect that has not been used in the study due to a lack of disaggregated data, thanks to its configuration, both the existence and the intensity of the waste tax[1] and its rebate affect the costs of waste management of local authorities, encouraging municipalities to better separate collection regardless of the model implemented.

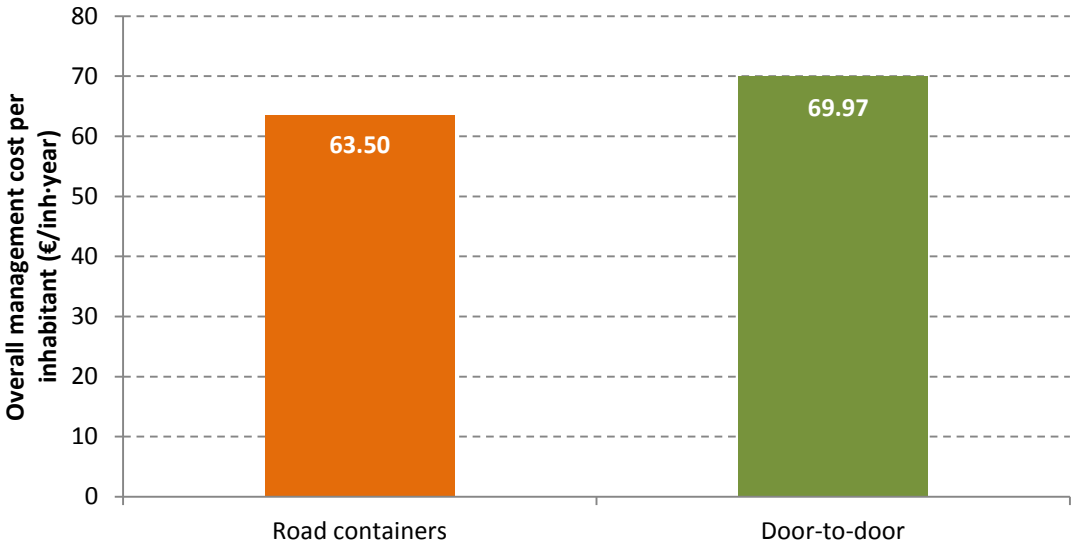
[1] Tax levied in Catalonia on landfill and incineration of waste, which revenue is distributed largely to local authorities on the basis of the waste management results they achieve.

Overall management cost per registered inhabitant, depending on the level of separate collection (simple average of the values in each municipality).



If instead of the registered population of each municipality, we take the equivalent population, which takes into account the seasonal population and registered population that lives in the town, the overall management cost is superior for the door-to-door model. It must be said, however, that the number of observations is rather small in this case (35 municipalities instead of 81), implying that the indicator "overall cost per registered inhabitant" is considered to be more reliable.

Overall management cost per equivalent inhabitant, depending on the collection model (simple average of the values in each municipality).



In addition to these indicators, the cost per tonne of collected waste and cost per tonne of waste collected selectively were also calculated in a complementary way. It was not considered to be appropriate to take them as leading indicators since they introduce bias in

the results. In the first case, the indicator penalises waste prevention and municipalities with door-to-door schemes, which on average collect less waste per capita. In the second case, the indicator considers only separately collected waste rather than all management costs, including those of waste not collected separately.

One of the highlights of the study is the broad dispersion of the data collected, reflected in a high standard deviation of the calculated indicators. Thus, we find that there are municipalities with an overall management cost per inhabitant up to eight times higher than those of other municipalities in the sample.

This is a result of the influence of a wide variety of circumstances and factors affecting the cost of waste management. Local authorities have a chance to influence some of these factors in order to optimise the costs of waste management. Among the possibilities for cost optimisation available to local authorities are:

- ✓ Offering the service at an intermunicipal or regional level
- ✓ Including optimisation criteria in collection contracts
- ✓ Reducing the collection frequency of certain waste fractions
- ✓ Collecting more than one waste category every day
- ✓ Implementing pay-as-you-throw schemes
- ✓ Using small vehicles for certain waste fractions
- ✓ Collecting waste in the daytime
- ✓ Concentrating collection days on weekdays

The work has shown the difficulty of getting information on the costs of waste management and a significant lack of harmonisation regarding the calculation of these costs as well as data fragmentation derived from the fact that in many cases the service or a part thereof is delegated.

Having this information is important in order to make informed decisions about one model or another. Thus, it would be advisable to make a systematic collection of data on the costs of waste management and to publish these data periodically.

1 Introduction and objective of the study

Municipal waste management is one of the main expenditures of local authorities. In the context of the crisis in which we find ourselves, this factor is crucial when considering the implementation of any model of waste management.

Unlike the case with other aspects of waste management, currently there is no systematic collection of data on the costs of various waste management operations. Nor is there any methodology for calculating these costs to integrate the variety of circumstances that occur, and local authorities have no guidelines on how to manage financial information in a homogeneous and comparable way.

Having actual and accurate information about the overall cost of different collection models for local authorities (including treatment costs and income derived) can help policymakers make decisions on a more objective economic basis when choosing one model or another.

This paper compares the costs of the waste management model of selective door-to-door (DtD) collection with the model of collection in road containers (CONT) based on actual data from a sample of Catalan municipalities. Currently, no such detailed study in the Spanish context has addressed this issue. There is an interesting precedent in Italy (Ribaudo et al., 2010), which offers suggestions about the factors that may explain the costs of waste management by comparing the DtD and CONT models based on data on 1,200 municipalities.

2 Data and methodology

For the study, data on the actual costs and revenues of the waste management services of 81 Catalan municipalities of up to 20,000 inhabitants, of which 41 were DtD waste collection and 40 had CONT waste collection, were compiled.

The limitation on the number of inhabitants is given by the fact that all Catalan municipalities that collect waste DtD have fewer than 20,000 inhabitants. We limited the sample of CONT municipalities to 20,000 inhabitants because we wanted to ensure that the data were comparable to prevent size introducing bias into the input data. The data and conclusions of this study therefore refer to Catalan towns of up to 20,000 inhabitants, representing 93% of municipalities and 30% of the population of Catalonia. Although it is likely that the comparative findings on these two collection systems could be extrapolated to larger municipalities, no direct observations allow comparisons for Catalonia.[2]

Table 1. Municipalities of the study area compared with all Catalan municipalities.

	Number of municipalities	Population
Municipalities < 20,000 inhabitants	884	2,244,887
TOTAL Catalonia	947	7,570,908
% Municipalities < 20,000 inhabitants	93.3%	29.7%

The data used for the study were provided directly by the local authorities responsible for collection via a web form (see Annex 1). For the selection of municipalities, the following criteria were applied:

- Only municipalities where one of the two collection models was predominant were considered, and mixed municipalities were, therefore, excluded. The approach was to consider municipalities in which one of the models served a minimum of 90% of the inhabitants of the municipality.

- A homogeneous representation of various sizes of municipalities was assured. For the application of this criterion, three population strata for each model were initially defined in order to study 40 municipalities of each type of collection (Table 2).

[2] However, Ribaudo et al. (2010) confirm that this comparison could be extrapolated to municipalities with over 20,000 inhabitants.

Table 2. Population strata in which the sample of surveyed municipalities was divided.

Stratum	Population (inhabitants)	Number of municipalities selected for each collection model (DtD and CONT)
Stratum 1	Up to 1,500	14
Stratum 2	Between 1,501 and 5,000	13
Stratum 3	Between 5,001 and 20,000	13
TOTAL		**40**

- A maximum of three municipalities belonging to the same intermunicipal association or consortium were placed in the same stratum.

- Municipalities for which data were already available from a previous study[3] were prioritised. This approach, which facilitated data collection, is not considered to have produced any bias in the data, as municipalities were selected randomly in the mentioned study.

- For municipalities with DtD collection, those belonging to the Catalan Association of Municipalities for Selective Door-to-Door Collection were prioritised in order to maximise positive response options. This option was taken considering that there was no reason to think that this could bias the results (the fact of belonging to the Association is unlikely to be related to the fact that management cost is higher or lower).

- The gaps left in each strata were filled by random selection from all Catalan municipalities of the corresponding strata.

In terms of territorial representation, including a criterion in this regard was considered, but given that DtD municipalities are mostly located in the provinces of Barcelona and Tarragona, it was not possible to have a homogeneous representation of municipalities for this model. Therefore, applying this criterion to CONT municipalities was discarded.

To request data, the Catalan Waste Agency sent letters to the mayors of each municipality. The ENT Foundation team carried out the continuous monitoring of data collection, both by e-mail and by phone, to ensure that the data arrived on time and were complete.

[3] The study "*Les taxes d'escombraries a Catalunya*" (Waste charges in Catalonia) was commissioned in 2011 by the Waste Agency of Catalonia to ENT Environment and Management. Of participating municipalities, 20 provided data for this study. In some cases, they provided updates, and in others they provided only the data that they had not provided in the previous study (in particular those relating to the characteristics of the waste management system). In the latter case, economic data were updated according to the CPI.

Since a minimum of 40 responses were needed, more municipalities were included in each block in case some did not reply. A total of 97 municipalities were invited to participate, of which 84 (43 DtD and 41 CONT) filled out the form.

Data were provided in most cases via a web form. In some cases, local authorities returned the form by e-mail and these data were added to the database by ENT.

As ENT received the forms, a thorough review of the data was carried out to ensure that they contained no errors. In cases where the data generated doubts or were incomplete, ENT contacted the respective local authorities to clear up doubts or request more information. In two cases, municipalities that had reported data had to be excluded because the data were incomplete and could not be remedied in time.

Finally, 81 municipalities (41 DtD and 40 CONT) were included in the study. The list of these municipalities is shown in Table 3.

Table 3. List of municipalities included in the study.

DtD			CONT		
No.	**Municipality**	**Inhabitants (2012)**	**No.**	**Municipality**	**Inhabitants (2012)**
1	La Masó [1]	296	**42**	Sant Ferriol [7]	222
2	Tagamanent	322	**43**	Oliola	219
3	Garcia	592	**44**	El Molar	296
4	La Torre de l'Espanyol	681	**45**	Vilanova de Sau [8]	328
5	Vilabella [1]	829	**46**	La Pera	428
6	Santa Maria d'Oló	1,066	**47**	Freginals	482
7	Sant Martí de Centelles [2]	1,048	**48**	Llambilles [9]	713
8	Viladrau [2]	1,087	**49**	Os de Balaguer	991
9	Figaró-Montmany [2]	1,103	**50**	Botarell	1,126
10	Castellserà	1,089	**51**	Vilanova de la Barca [10]	1,160
11	Santa Eulàlia de Riuprimer [2]	1,199	**52**	Vilanova de Bellpuig	1,213
12	Riudecanyes	1,183	**53**	Verges [11]	1,193
13	Vilajuïga[3]	1,177	**54**	Benissanet	1,280
14	Vila-rodona	1,280	**55**	Portbou [12]	1,296
15	Artesa de Lleida	1,507	**56**	La Secuita [13]	1,607
16	Tivissa [4]	1,818	**57**	Castellví de la Marca [14]	1,650
17	Folgueroles [2]	2,230	**58**	Golmés	1,741
18	Santa Eugènia de Berga [5]	2,269	**59**	Naut Aran [15]	1,758
19	El Pla de Santa Maria	2,375	**60**	Albatàrrec [10]	2,113
20	Calldetenes	2,441	**61**	Sant Pere Pescador	2,161
21	Aiguafreda [2]	2,478	**62**	Fornells de la Selva [9]	2,449
22	Sant Jaume dels Domenys	2,491	**63**	La Pobla de Montornès [13]	2,897
23	Falset [4]	2,894	**64**	Juneda [16]	3,490
24	Gandesa	3,162	**65**	Calaf	3,538
25	La Bisbal del Penedès	3,373	**66**	El Papiol	4,014

DtD			CONT		
No.	**Municipality**	**Inhabitants (2012)**	**No.**	**Municipality**	**Inhabitants (2012)**
26	Olèrdola	3,621	**67**	Flix [4]	3,961
27	Balenyà [2]	3,714	**68**	Porqueres [17]	4,491
28	Collbató	4,287	**69**	La Selva del Camp	5,619
29	Martorelles	4,927	**70**	Agramunt	5,633
30	L'Arboç	5,486	**71**	Maçanet de la Selva	7,175
31	Sant Antoni de Vilamajor	5,699	**72**	Alcarràs [10]	8,755
32	Torrelles de Llobregat	5,740	**73**	Cervelló	8,660
33	Taradell [2]	6,212	**74**	Solsona	9,201
34	Lliçà de Vall	6,394	**75**	Ripoll [18]	10,904
35	Tiana	8,151	**76**	Mont-Roig del Camp [19]	12,702
36	Santa Eulàlia de Ronçana	7,009	**77**	Cunit	12,626
37	Santpedor [6]	7,187	**78**	Vallirana	14,549
38	Tona [2]	8,108	**79**	Sant Celoni	17,076
39	Matadepera	8,669	**80**	Les Franqueses del Vallès	19,023
40	Sant Sadurní d'Anoia	12,482	**81**	Banyoles [17]	19,341
41	Palau-solità i Plegamans	14,484			

[1] Data provided by *Consell Comarcal de l'Alt Camp*. [2] Data provided by *Mancomunitat La Plana*. [3] Data provided by *Consell Comarcal de l'Alt Empordà*. [4] Data provided by *Consorci per a la Gestió dels Residus de les Comarques de la Ribera d'Ebre, el Priorat i la Terra Alta*. [5] Data provided by Recollida de Residus d'Osona S.L. [6] Data provided by Corporación CLD. [7] Data provided by Consell Comarcal de la Garrotxa. [8] Data provided by the City council and by *Recollida de Residus d'Osona S.L.* [9] Data provided by *Consell Comarcal del Gironès*. [10] Data provided by *Consell Comarcal del Segrià*. [11] Data provided by the City Council and by *Consell Comarcal de l'Alt Empordà*. [12] Data provided by *Consell Comarcal de l'Alt Empordà*. [13] Data provided by *Consell Comarcal del Tarragonès*. [14] Data provided by *Mancomunitat Penedès-Garraf*. [15] Data provided by *Conselh Generau d'Aran*. [16] Data provided by *Consell Comarcal de les Garrigues*. [17] Data provided by *Consell Comarcal del Pla de l'Estany*. [18] Data provided by *Consell Comarcal del Ripollès*. [19] Data provided by SECOMSA.

In those cases where the data provided by local authorities corresponded to years prior to 2012, prices were updated to 2012 according to the annual CPI Catalan (published by the Statistical Institute of Catalonia IDESCAT).

As discussed in the conclusions, data dispersion is large for diverse reasons. Consequently, it was decided to use them all, as no single value could be considered to be extreme to eliminate it from the beginning.

Table 4 describes the sample of municipalities used for the calculation of the indicators.

Table 4. Characteristics of municipalities participating in the study.

Variable	DtD Municipalities	CONT Municipalities	TOTAL
Number of municipalities	41	40	81
Municipalities that collect biowaste separately	41	34	75
Municipalities that collect commercial waste separately	15	11	26
Average days of collection of biowaste	3.5	3.3	3.4
Average days of collection of mixed waste	1.4	4.4	2.9
Average total number of days of collection per week[1]	7.76	11.4	9.6
Average waste generation per capita (kg/inh·day)	1.22	1.50	1.36
Average selective collection rate	67.2%	37.5%	52.8%
Geographical jurisdiction of the municipality			
Metropolitan area	14	6	20
Area of Girona	1	11	12
Area of Tarragona	9	7	16
Ebre river basin	4	3	7
Western area	2	9	11
Central area	11	3	14
Pyrenees and Aran area	0	1	1
TOTAL	**41**	**40**	**81**

[1] Includes the collection of organic matter, paper/cardboard, glass, cans and mixed waste.

As for municipalities with DtD collection, Figure 1 shows the number of DtD waste fractions collected and the type of truck used for collection.

Figure 1. Distribution of DtD municipalities participating in the study according to the number of DtD waste fractions collected.

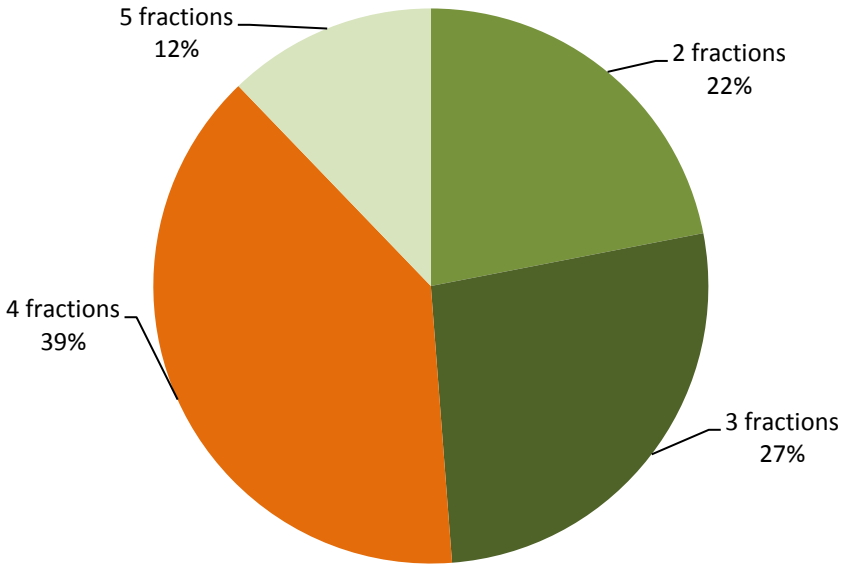
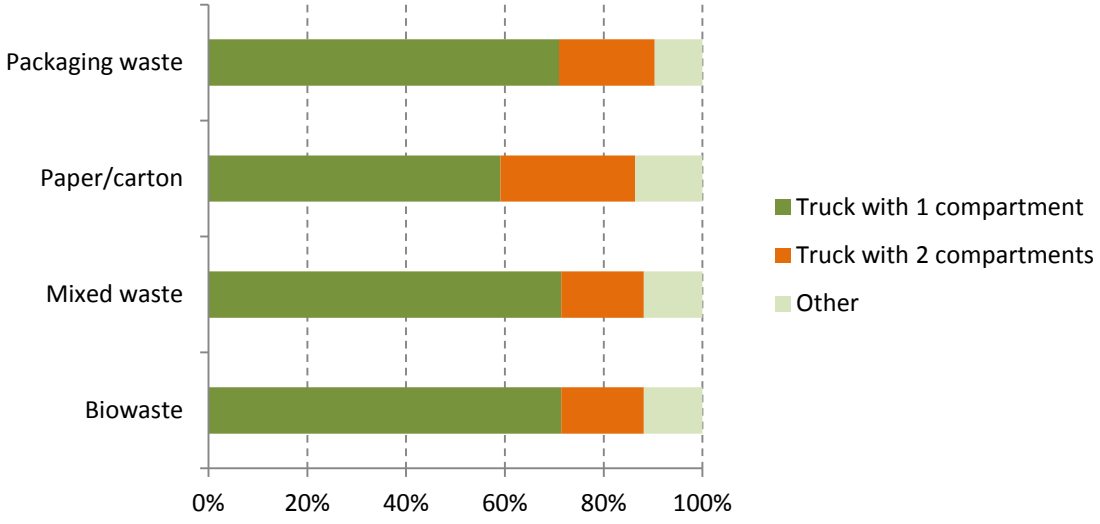


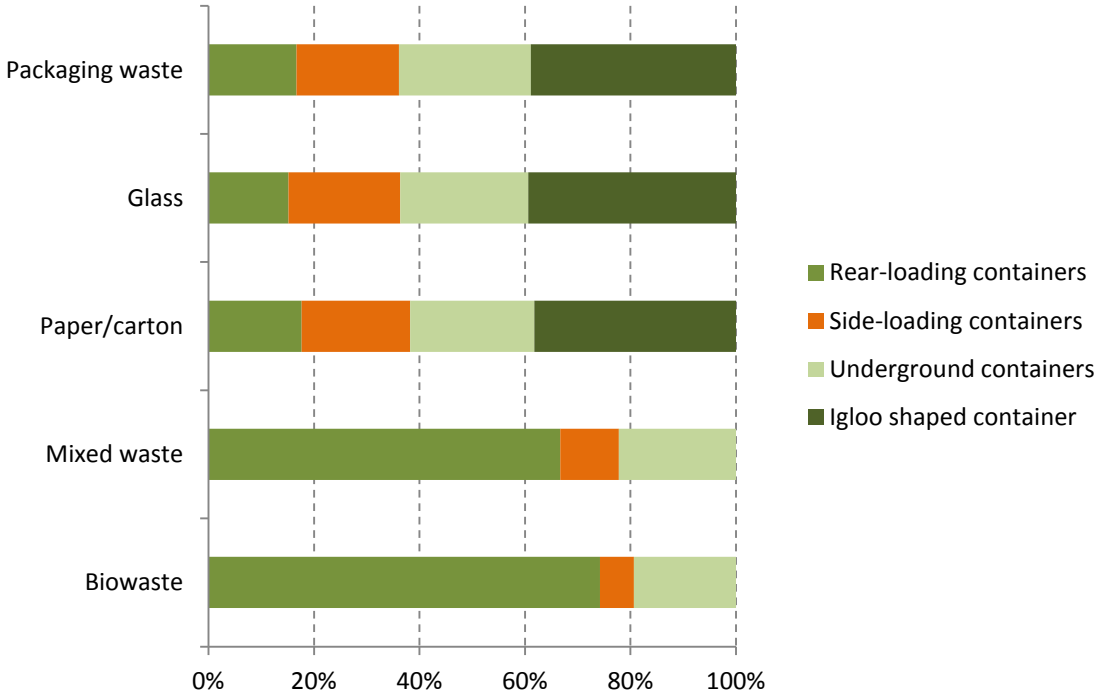
Figure 2. Distribution of DtD municipalities participating in the study according to the type of truck used to collect different waste fractions



Note: "Other" includes different collection systems than trucks such as tractors.

As for CONT municipalities, Figure 3 shows the distribution by type of container used for collection.

Figure 3. Distribution of CONT municipalities participating in the study according to the type of container used to collect different waste fractions.



3 Results

In this section, the results of the study are discussed with respect to the indicators considered. The results for the main indicator are presented first and then those for additional indicators.

3.1 Main indicator: overall management cost per registered inhabitant

This indicator is considered to be most appropriate to compare the cost of waste management since it incorporates not only the cost of collection, but also the cost of treatment and incomes associated with the service. The indicator thus reflects the economic balance that waste management has for local authorities.

The variable "overall cost of waste management", which provides comprehensive information about the cost of waste management for local authorities, has been used. It is calculated as follows:

Overall Management Cost = Collection costs + treatment costs - income

Where *collection costs* include:

- ✓ The cost of the general collection of municipal waste (domestic and commercial), including the fractions paper/cardboard, packaging waste, glass, biowaste and mixed waste
- ✓ The cost of the special collection of other municipal waste (bulky, pruning, used oil, etc.)
- ✓ The cost of managing the recycling centre
- ✓ The cost of waste transfer
- ✓ The depreciation of collection elements (containers, trucks, etc.).

Where *treatment costs* include:

- ✓ The cost of the treatment of mixed waste (including entrance fee to the facility-mechanical-biological treatment, incineration or landfill and the tax on the disposal or the incineration of waste)
- ✓ The cost of the treatment of organic waste
- ✓ The cost of treating other waste fractions (bulky, hazardous waste, used oil, etc.)

And where *income* includes:

- ✓ Revenues from the sale of materials (paper/cardboard, scrap, etc.).
- ✓ Incomes from integrated management systems (ECOEMBES, Ecovidrio, etc.)
- ✓ The waste tax rebate

This indicator therefore considers not only the actual cost of the collection and transport of waste, but also the costs associated with its treatment and the income derived from the service, i.e., the overall balance of municipal waste management for the local authority.

As for the number of inhabitants, we used data on the inhabitants registered in the municipality, which were obtained from the Statistical Institute of Catalonia. In each case, we took the registered population in the year for which data on cost are available.

As discussed in Section 2, the data used for the study are real data, i.e., the costs are actually paid or paid in by local authorities. Only in the case of the municipalities of the Metropolitan Area of Barcelona (3 in this study) the cost of treatment was estimated, as these municipalities do not pay for this service (the Metropolitan Area charges it directly to citizens through the Metropolitan Waste Treatment Charge).[4]

Figure 4 shows the dispersion of the main indicator depending on the size of the municipality. Since no clear correlation between the two variables was found, all data are presented aggregately and not by population strata. That is, no averages are presented for population strata.

Figure 4. Overall cost of management per registered inhabitant and the size of the municipality.

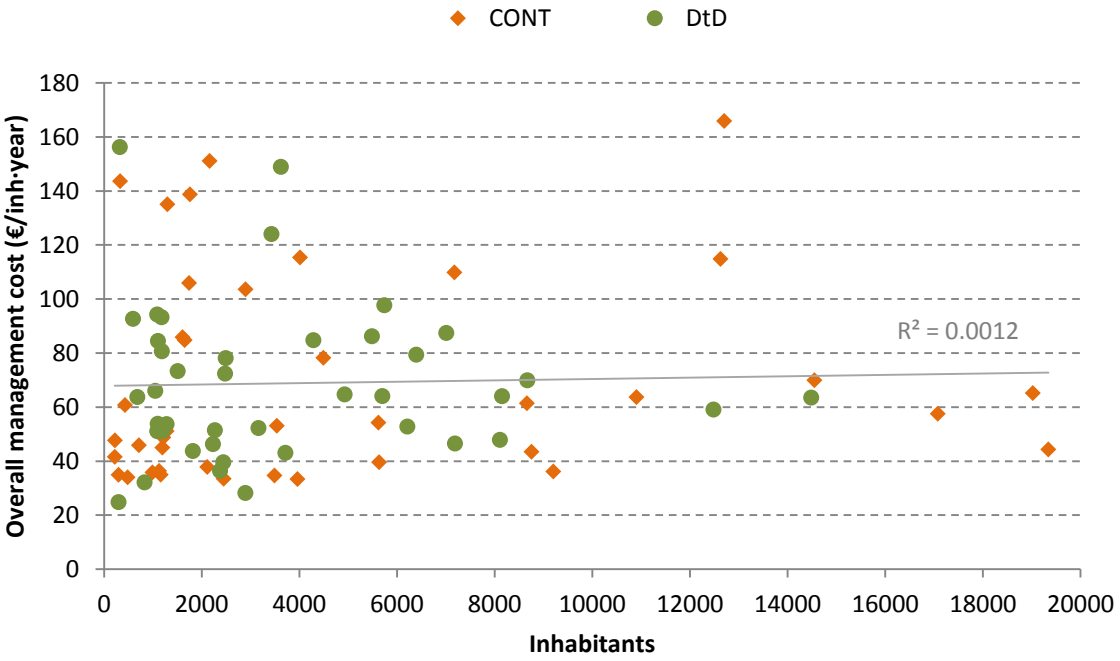
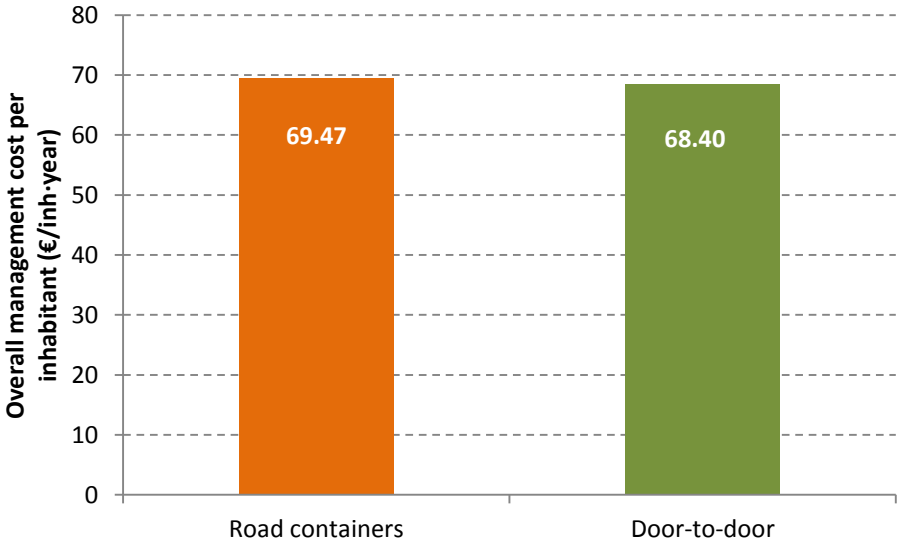


Figure 5 shows the result of the study in relation to the main indicator, depending on the collection model.

[4] This estimate was based on the amount of waste collected and entrance fees to treatment plants.

Figure 5. Overall management cost per registered inhabitant according to the collection model (simple average of the values in each municipality).



The main statistics of the sample are shown in Table 5.

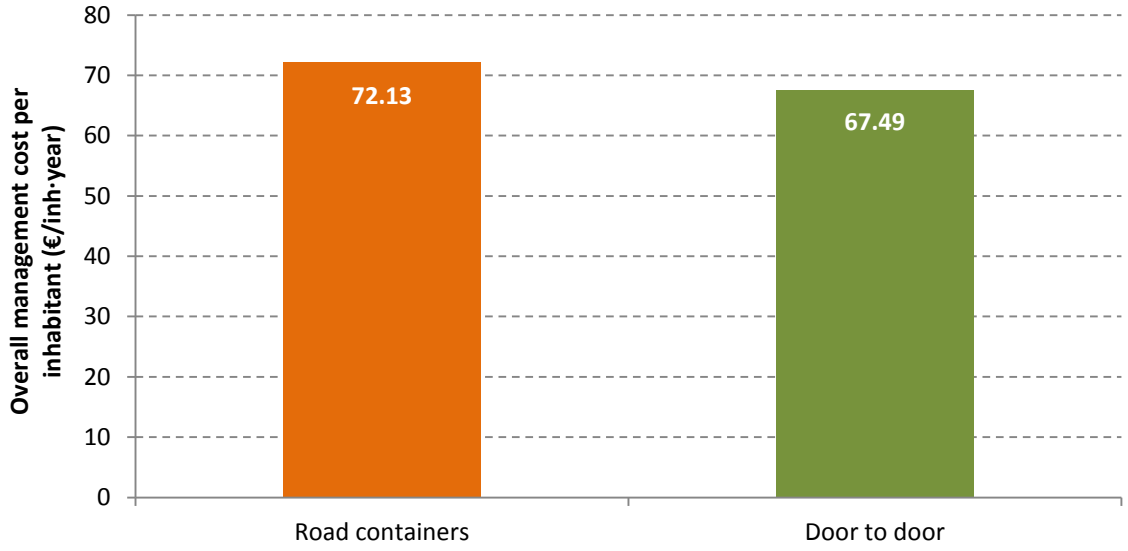
Table 5. Main statistics of the main indicator (simple average of the values in each municipality).

Statistic	DtD	CONT
Number of observations	41	40
Average (€/inhabitant·year)	68.40	69.47
Standard deviation (€/inhabitant·year)	28.72	38.38
Variation coefficient (%)	41.93	55.25
Minimum (€/inhabitant·year)	24.84	33.36
Maximum (€/inhabitant·year)	156.29	165.93

As can be seen in Figure 5 and Table 5, there are no significant differences between the two models. The DtD model has a slightly lower average overall cost, but the difference is negligible (just over 1%). By contrast, the standard deviation in the values of both systems is quite high, although significantly more pronounced for CONT municipalities.

The average of the overall management cost after the data were weighted according to the population of each municipality is presented in Figure 6, showing that the difference between the two models is somewhat higher than that for the averages previously shown. This could indicate that in CONT municipalities those who have more population also have higher management costs, which makes the average rise.

Figure 6. Overall management cost per registered inhabitant depending on the collection model (average weighted by population).



3.2 Breakdown of the main indicator into concepts

To assess how each concept that makes up the main indicator contributes to it, Figure 7 was created. It must be taken into account, however, that not all municipalities provided disaggregated data, meaning that the sample used[5] to prepare this graph is smaller. This also explains why the values of the overall indicator that would be obtained in Figure 7 do not exactly match those shown in Figure 5, although there are no significant differences.

Figure 7. Overall management cost per registered inhabitant, broken down into concepts, depending on the model collection (simple average of the values in each municipality).

Note: The number of municipalities considered is 54.

[5] In total, 54 municipalities, of which 24 are CONT and 30 DtD.

This graph shows how the DtD model has, on average, slightly higher costs of collection (4.2% higher), which are offset by the lower costs of treatment (27.9% lower) and higher income (25.0% higher).

3.3 Variation in the main indicator according to the separate collection rate

Figure 8 shows the dispersion of the overall management cost according to the separate collection rate. To calculate this indicator, data on selective collection published by the Waste Agency of Catalonia was used, taking in each case the percentage corresponding to the year for which data on cost are available. In the graph, DtD and CONT municipalities are in different colours. As can be seen, most DtD municipalities have a separate collection rate above 50%. Further, there is no clear correlation between the total cost and the percentage of separate collection, but there is a large variation of values ranging from around 20 to over 160 euros per inhabitant per year.

Figure 8. Overall management cost per registered inhabitant and ratio of selective collection.

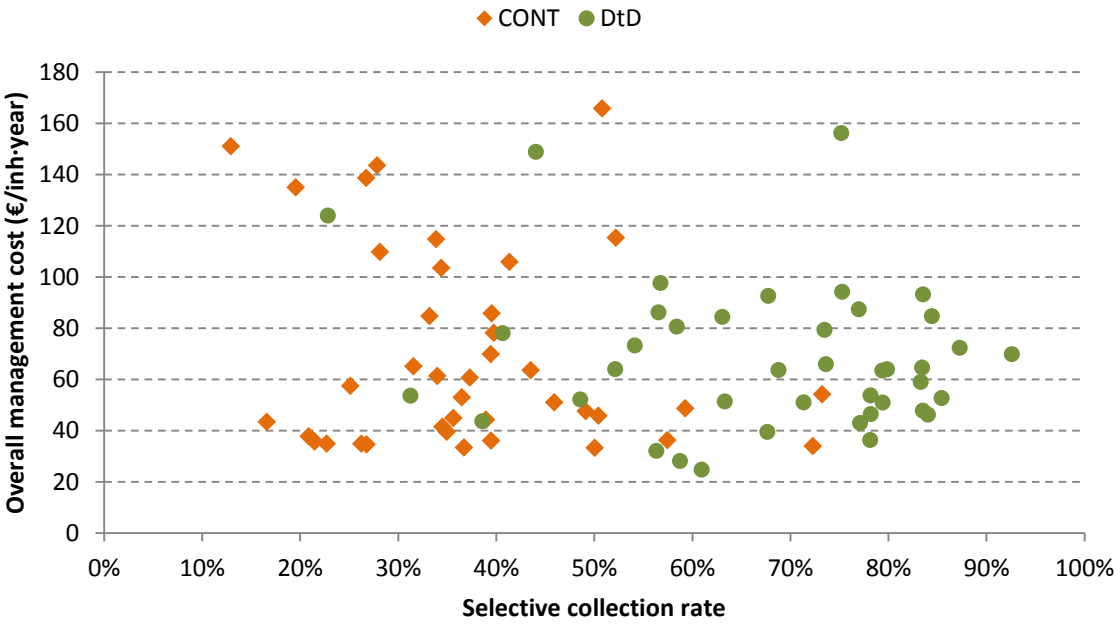
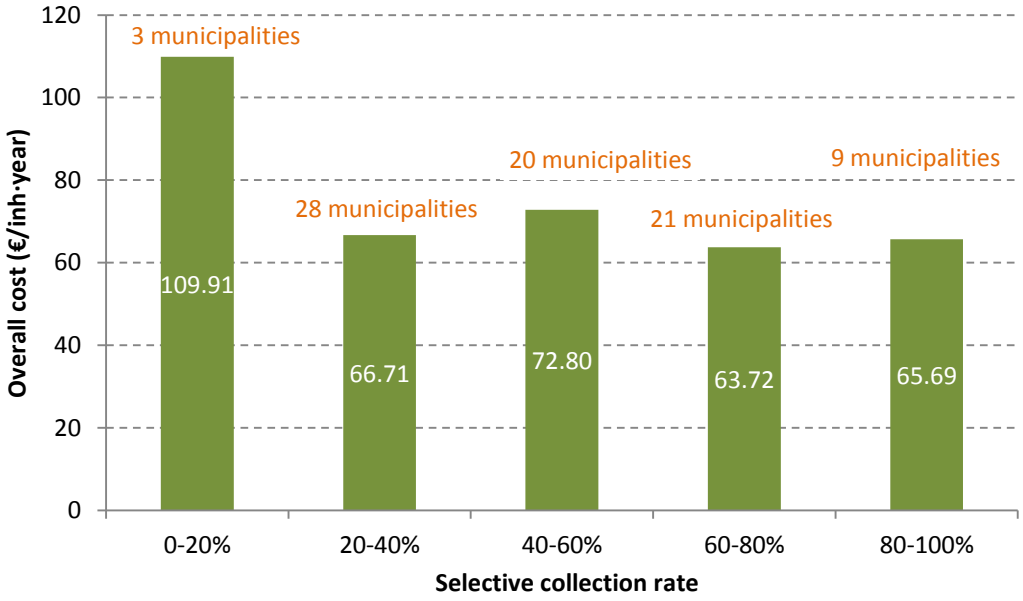


Figure 9 shows how the overall cost varies depending on the percentage of waste collected separately, regardless of the collection system used. It must be taken into account that for some intervals of selective collection, there are few municipalities, as shown in the chart. In addition, for the interval of up to 20% of separate collection, all municipalities are CONT, while for the interval between 80% and 100%, all are DtD. Moreover, for the interval of 0–20% separate collection, there is a town with very specific characteristics, since it is very touristy, which means a significant influence on the outcome of the group.

Figure 9. Overall management cost per registered inhabitant, depending on the level of separate collection (simple average of the values in each municipality).

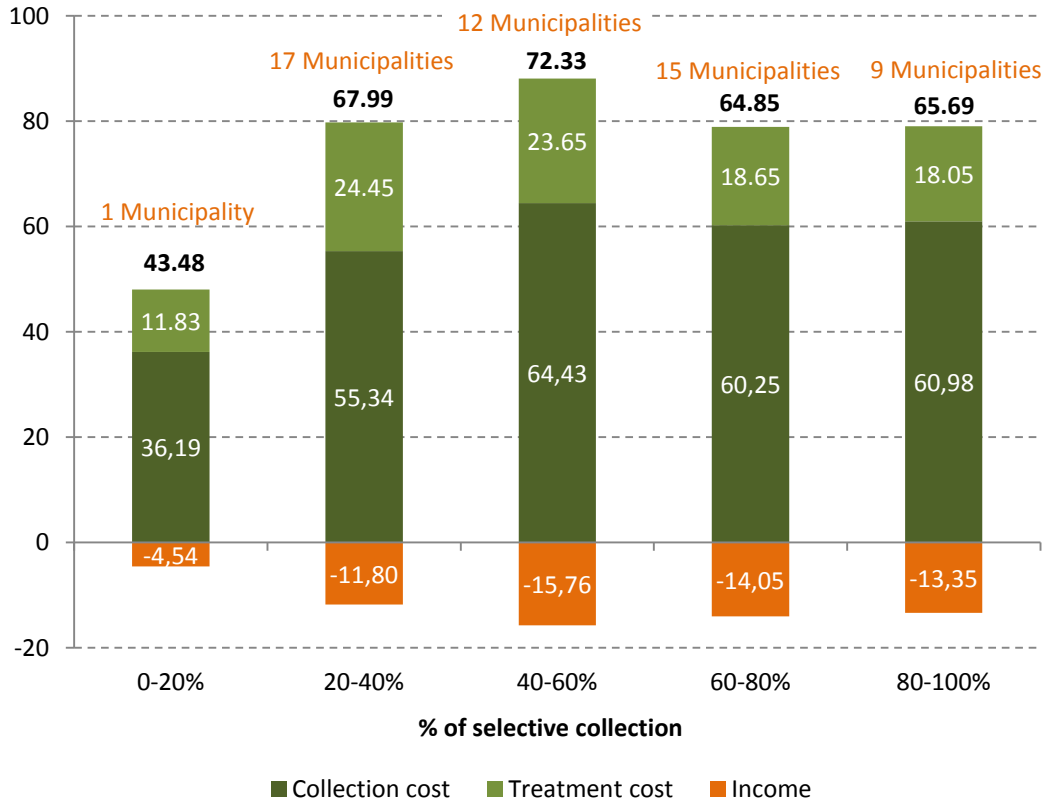


Notes: The number of municipalities considered is 81. For sections, the distribution between models is as follows: 0–20%: 3 CONT municipalities; 20–40%: 25 CONT municipalities and 3 DtD municipalities; 40–60%: 10 CONT municipalities and 10 DtD municipalities; 60–80% 2 CONT municipalities and 19 DtD municipalities; 80–100%: 9 DtD municipalities.

Except for the first section, which has little significance, the average cost for the other sections is very similar and shows no clear correlation.

Figure 10 shows how the contribution of each concept to the overall cost varies for the same sections of separate collection. In this case, we must also take into account that the starting sample is much smaller than the original sample (54 municipalities instead of 81), resulting in some sections of separate collection having few municipalities (including only one in the first section). Thus, the results do not match those of Figure 9.

Figure 10. Overall management cost per registered inhabitant and breakdown, based on the level of separate collection (simple average of the values in each municipality).



Notes: The number of municipalities considered is 54. For sections, the distribution between models is as follows: 0–20%: 1 CONT municipality; 20–40%: 15 CONT municipalities and 2 DtD municipalities; 40–60%: 7 CONT municipalities and 5 DtD municipalities; 60–80%: 1 CONT municipality and 14 DtD municipalities; 80–100%: 9 DtD municipalities.

Figure 10 shows how, up to a certain level of separate collection, the greater the ratio, the higher are collection costs and revenues. Treatment costs also increase, probably because of the need to treat biowaste, although once a certain threshold is exceeded, those costs fall, perhaps because there is less mixed waste to deal with. It also shows how from a certain ratio the costs of collection do not increase. It is surprising not to observe a more proportional component relative to income. The latter may result from the separate collection in recycling centres, which increases the ratio of selective collection but does not always result in higher revenue; on the contrary, in some cases, treatment costs increase. Specifically, in municipalities with DtD collection, which predominate in the sections with the highest percentage of separate collection, the contributions to recycling centres tend to be higher.

3.4 Overall management cost per equivalent inhabitant

Since the seasonal population has a significant effect on waste generation, the main indicator was also calculated in relation to the equivalent populations of municipalities. In fact, it can be argued that the equivalent population is more relevant to reflect the "real burden" of waste to be handled by a municipality than the registered population; however, as discussed before, these data are not always available.

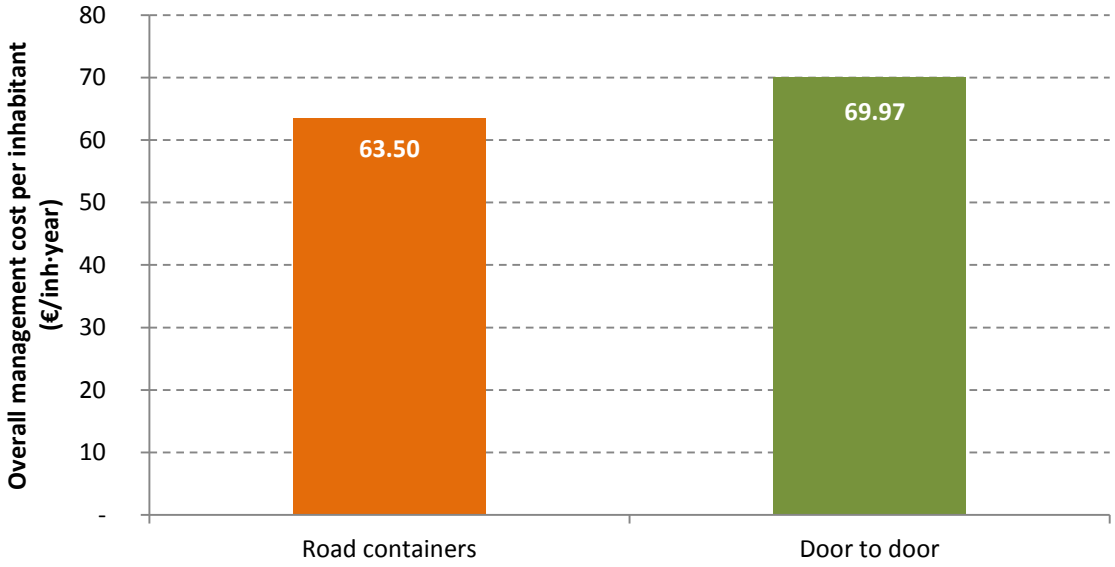
For this calculation, we used the variable "annual full-time equivalent population" from IDESCAT.[6] This variable, however, is only available for municipalities with more than 2,500 inhabitants,[7] meaning that the sample reduced to 37 municipalities. Since reducing the number of observations removes the robustness of the results, it was not considered appropriate to use this indicator as the main one.

The estimates of seasonal population comprise estimates of the amount of people that each municipality hosts and measure the number of people in a township (annual average). People who have some connection or relationship with the municipality because they live, work, study or holiday there (either in their own homes and in the homes of relatives or friends/tourist establishments such as hotels, campsites, apartments, etc.), are included in the calculation. The unit of the measurement of seasonal population estimates is annual full-time equivalent persons. Every day a person is present in a city equals to 1/365 annual full-time equivalent persons. Figure 11 shows the result of the indicator by type of collection.

[6] The possibility of using the variable "population equivalent to waste" was also considered. This variable is calculated by dividing the generation of each municipality by average per capita generation in Catalonia, but it results in a value proportional to the indicator cost per tonne, presented in Section 3.5.

[7] On its website, IDESCAT only publishes data on municipalities over 5,000 inhabitants. To obtain data from the municipalities between 2,500 and 5,000 an information request was made.

Figure 11 Overall management cost per equivalent inhabitant, depending on the model of collection (simple average of the values in each municipality).



Note: The number of municipalities considered is 36.

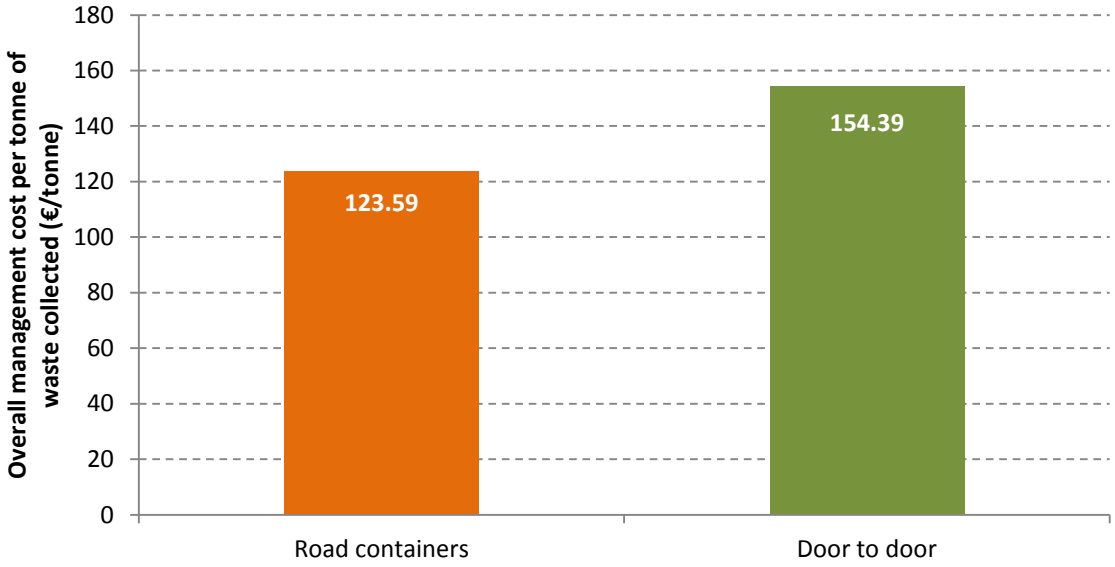
In this case, the average overall cost is superior for DtD municipalities by an appreciable amount of approximately 10%. The difference with the previously discussed results could be explained because some CONT municipalities included in the sample are quite touristy and, therefore, have more seasonal visitors. In fact, the characteristics of the DtD collection make the most touristy towns not so likely to opt for this model.

3.5 Overall management cost per tonne of waste collected

The overall management cost per tonne of waste collected is another indicator that was considered interesting to calculate complementarily. It was not considered appropriate to be the main indicator because it introduces bias in the sense that it penalises waste prevention in the DtD model, since DtD municipalities tend to have lower waste generation (as shown in Table 4, DtD municipalities participating in the study have an average waste generation 18% lower than CONT municipalities).

To calculate this indicator, data on waste collection published by the Waste Agency of Catalonia was used. Figure 12 shows the result of the indicator according to the type of collection. As expected (given the difference in per capita generation), the cost per tonne collected is higher in DtD municipalities.

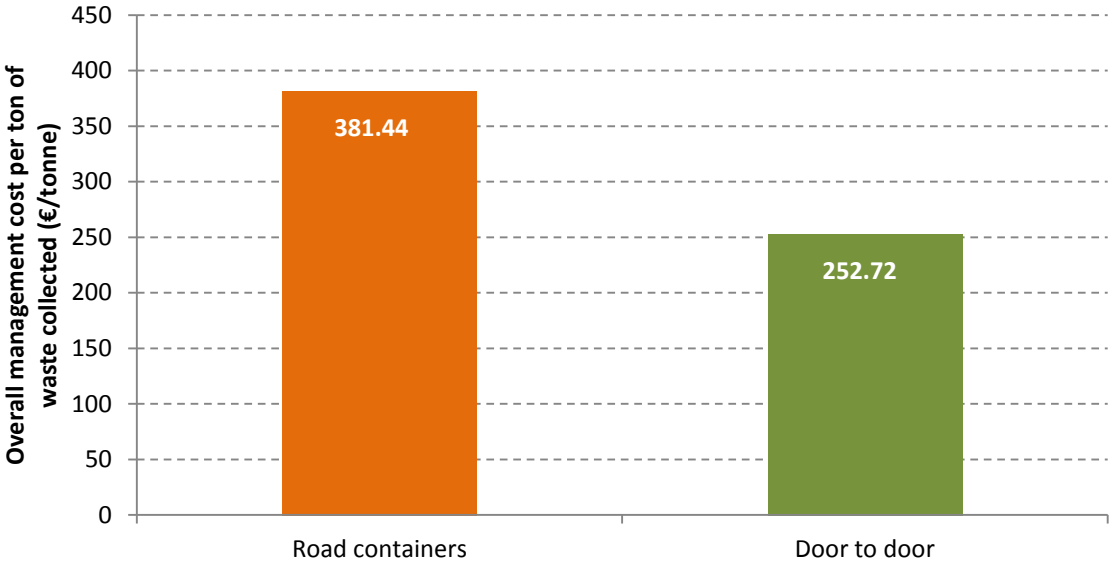
Figure 12. Overall management cost per tonne of waste collected, depending on the collection model (simple average of the values in each municipality).



3.6 Overall management cost per tonne of waste selectively collected

As a variant of the previous indicator, another indicator was calculated. This one takes into account only the waste collected separately (both in CONT/DtD, in recycling centres and through special collections). Since there are official recycling targets, the value of this indicator is used to assess the unit costs of the separate collection levels achieved. However, the indicator introduces bias in the results in the sense that it takes into account only some of the waste collected instead of all management costs, including those of waste not collected selectively.

Figure 13. Overall management cost per tonne of waste selectively collected, depending on the collection model (simple average of the values in each municipality).



To calculate this indicator, data compiled by the Catalan Waste Agency on collected waste was also used. Since DtD municipalities reach considerably higher levels of selective collection, the overall cost per tonne selectively collected is significantly lower for this model.

4 Discussion

For the main indicator (the overall management cost per registered inhabitant), no significant differences between the two collection models were observed (Figure 5). This is because although the DtD model leads to higher average collection costs, it achieves a higher level of separate collection, which results in lower treatment costs and higher income, as shown in Figure 7. Overall, therefore, this additional cost is offset.

Another noteworthy aspect of the main indicator is the large dispersion of the data. Figure 4 shows how, for both the overall model and each collection model, some municipalities have an overall management cost up to eight times higher than others.

Regarding the cost of collection, a number of factors that derive from the great diversity of situations may explain this variability. Some of these factors could be:

- ✓ The varying dispersion of the population in the municipality
- ✓ The provision of the collection service at a supra-municipal level
- ✓ Collection frequency
- ✓ The existence of the segregated collection of commercial waste
- ✓ Date of the collection contract
- ✓ Distance to waste treatment plants
- ✓ The different bargaining power of local authorities at the time of pricing the contract
- ✓ Territorial differences in collective wage agreements governing service contracts

In addition, for CONT municipalities, there is also the influence of the types of containers used for the collection and the containerisation rate (number of inhabitants per container).

As for the cost of treatment, variability depends on the type of facility where the waste is treated as well as on the entrance fee of the facility. For example, in the case of biowaste, there is a wide range of fees in Catalonia ranging from 25 to 105 €/t.[8] As for mixed waste, the destination to landfill, incineration plant or mechanical-biological treatment plant largely determines the cost of treatment, which in Catalonia ranges between 18 and 71 €/t for landfill, 35 and 70 €/t for incineration and 54 and 90 €/t for mechanical biological treatment.[9]

Finally, revenues depend largely on the level of separate collection reached, since sales revenue, the contributions of integrated management systems and the rebate of the waste tax depend on this. However, Figure 10 shows that for sections from 60% to 80% and from 80% to 100% of selective collection, average earnings are slightly lower than those for the previous section. In this regard, it should be noted that in some cases, local authorities who have the responsibility of collecting and processing waste do not transfer revenues to municipalities, but they internalise them in the cost of the service (both in the collection service and in the entrance fees).

The relationship between the income of municipalities and their results in terms of selective collection require further research because the income distribution may not be creating

[8] Information provided by the Catalan Waste Agency.

[9] Idem.

incentives for which it is designed. The same could also be occurring in the design of treatment costs.

The study shows that the size of the municipality is not decisive for the costs of waste management, which a priori may be surprising and contradicts the principle of economies of scale. One likely explanation for this finding is that small towns are usually grouped into supra-municipal associations or consortia to provide the service together. This association allows greater economies of scale and a distribution of the costs between municipalities.

In fact, often these supra-local authorities distribute management costs to municipalities not based on the actual cost that represents the service, but according to the number of inhabitants, by means of a unit rate for the entire management area.

Another factor that could explain this is that small municipalities generally have a service with fewer features (lower collection frequency, no commercial collections, no recycling centres, etc.).

Moreover, it must be taken into account that the study included only municipalities with up to 20,000 inhabitants. If larger municipalities were included, the effect of economies of scale could be assessed.

As for the items comprising the overall cost, the cost of collection (which represents 69% of total costs in the CONT model and 77% in the DtD model) stands out well above the cost of treatment (Figure 7). This is more pronounced in the DtD model, although in this case, income is also higher. However, this highlights the fact that revenue represents only a small part of the cost in both models.

Figure 8 shows that most DtD municipalities have selective collection rates above 50%. This has a clear influence on the management cost and helps improve the economic balance of the service.

Regarding the indicator "global management cost per equivalent inhabitant", the results must be taken with caution, since there is a limited number of observations. Nonetheless, conceptually, it is an even more important indicator than the registered population indicator. The result shows a higher cost for the DtD model in relation to the CONT model, which, as already mentioned in Section 3.4, can be derived from the lower presence of seasonal visitors in DtD municipalities compared with CONT municipalities.

The indicator "cost per tonne of collected waste" is also (significantly) lower for CONT municipalities (Figure 12). In this case, it must be taken into account that the introduction of DtD collection generally involves a reduction of the total amount of collected waste. In the municipalities of the sample, the average generation of DtD municipalities is, in fact, significantly lower than that of CONT municipalities (Table 4). This would explain why DtD municipalities have a higher cost per tonne.

Instead, for the indicator "cost per tonne of waste collected selectively" the result is, as expected, the opposite, since DtD municipalities have, on average, much higher levels of separate collection than CONT municipalities.

5 Proposals for optimising the costs of DtD collection systems

As discussed in Section 4, a number of factors influence the cost of the provision of a waste collection service. Among these, there are some, such as the dispersion of the population of the municipality or collective wage agreements in the sector, on which local authorities do not have room for manoeuvre.

However, there are other factors on which they do have some possibilities to optimise costs. These factors are associated with both the management of the waste collection service and the collection characteristics. Below some of these are identified.

As for the actual management of the service, the scope of the service has an obvious effect on its cost. **The joint provision of a service at a supra-municipal or county level** makes economies of scale possible, particularly in relatively small towns such as those included in this study. This includes aspects such as the more intensive use of collection equipment and human resources, the minimisation of download times and greater bargaining power with third parties.

During the preparation of the study, it was found that, in many cases, the provision of the service at the supra-municipal level is performed only for some waste fractions, particularly for classic selective fractions or those that were first implemented (paper/cardboard, glass and packaging waste). This is because, in general, before the implementation of these collections, municipalities provided a general waste collection (one single waste fraction) and the county councils, associations of municipalities or consortia assumed the management of selective waste fractions.

In this regard, the provision of a comprehensive waste collection service at the supra-municipal level that would include all waste fractions would permit the further optimisation of the service.

When the service is performed indirectly through a concession, there is considerable scope for optimisation in the process of **contract bidding**. Within this area, there are several aspects to consider to ensure that the service is delivered in the best conditions and at an optimum cost to the local authority:

- ✓ Scope of the contract: generally, including a street cleaning service in the contract optimises costs because it makes it possible to optimise the dedication of staff. Moreover, the fact that the same company takes responsibility for both services can help resolve incidents more quickly, thus reducing the number of complaints. For example, if they are broken bags or bags outside buckets, the same collection team can proceed to clean the space, or at least make the first intervention. In addition, the waste collection and street cleaning services can be unified, which can help detect, for example, bags deposited in buckets, allowing action to resolve these issues. Moreover, the inclusion of street cleaning in the contract increases flexibility and may allow changes during the term of the contract. However, it is essential not to mix the costs of street cleaning with those of waste collection in order to enable a separate analysis of the costs of waste management. To that end, if street cleaning and waste

management are included in the same contract, it must be made clear that the respective costs should be clearly identified and differentiated.

- ✓ Contract length: the longer a contract, the longer is the amortisation period of the equipment and lower is the amount allocated annually, but the greater are the associated financial costs. The optimal duration tends to be considered to be the period of amortisation of equipment, particularly collection vehicles, which is typically between 10 and 12 years. It must be kept in mind that excessively long contracts take away flexibility for adopting significant technological or logistical changes.

- ✓ Conducting a study to prepare technical specifications: it is recommended that prior to bidding, an audit service is performed to identify opportunities for optimisation. These studies can test whether the time allocated by the concessionaire to the service is what was envisaged in the bidding process, and thus adjust the new tender.

- ✓ Inclusion of quality indicators: indicators of service quality not only ensure that the service is carried out under the best conditions, but also ensure the delivery of the revenue associated with the service (derived from the sale of materials, contributions of integrated management systems and waste tax rebate) and make payment conditional on the achievement of these indicators. Thus, the costs of providing the service are optimised, since they go from fixed to variables costs according to the results.

- ✓ Inclusion of efficiency criteria: including criteria for the evaluation of bids based on service efficiency not only ensures a better starting price, but also avoids additional costs during the duration of the contract. In addition, these criteria can also be applied as a condition for the payment of the service once the contract has been awarded.

- ✓ Inclusion of tools for service monitoring: a number of tools allow real-time tracking of the service and contrasting contract performance by local authorities; these tools are available on the market. Among these tools are GPS or satellite tracking systems, radio frequency identification for containers and bins (that help track when a container has been emptied) and systems for detecting how full containers are. These elements can be integrated into Internet-based platforms by city council technicians; from there, they can manage billing and adjust payment to the actual performance of the service.

These last three aspects can be associated with the definition of a non-fixed price contract as well as on the fixing of a price range based on the actual results of the service. Furthermore, they can be supplemented with the inclusion of flexibility clauses in the contract, under which they could introduce improvements or changes to the service as long as the established minimum and maximum thresholds of remuneration are not exceeded.

Although it may be easier for a local authority to include service improvements at the time of bidding for a new contract, there is also the possibility of introducing changes throughout the term, provided that the contract is flexible or given that the changes are agreed with the company. However, this option is more complicated, so it is recommendable to prepare tenders well and to predict what might happen over the years of the concession.

As for specific service features, it must be kept in mind that in the DtD model, the main expense is personnel costs,[10] which can represent between 55% and 65% of the cost of the collection service (see Table 6).

Table 6. Disaggregated expenses of the DtD collection service.

Concept	Expense (%)
Collection personnel: drivers and workers (including tools and clothes)	55–65%
Purchase and tenancy of collection vehicles: depreciation, financing, insurances, taxes, etc.	10–15%
Consumption and maintenance of collection vehicles: fuel, lubricants, maintenance, cleaning, tyres, etc.	10–15%
Other expenses: cleaning and replacement of containers, administrative personnel, etc.	5–25%
TOTAL	100%

Source: Puig et al. (2008).

One of the most obvious possibilities for cost optimisation is to **reduce the collection frequency of certain waste fractions**.

There is no consensus on what is the minimum frequency of collection needed in a door-to-door model, and indeed we must take into account the specific conditions of each municipality. For example, in inland and mountain towns the frequency of biowaste collection can be reduced, particularly in winter, while in municipalities of warmer climate or with a strong presence of seasonal population it is necessary to increase frequency of collection. Moreover, in municipalities that collect door to door only two waste fractions (biowaste and mixed waste), it is recommended to minimise the frequency of mixed waste collection to prevent recyclables being delivered with this waste fraction instead of taking them to the recycling areas.

In the case of biowaste, which is the critical waste fraction due to its characteristics (rapid degradability, odours, etc.), it is recommendable that as well as adjusting collection frequency, aerated bins and compostable bags are introduced. Among other advantages, they prevent odours and delay decomposition.

As for nappies, if the total number of collection days is reduced, it is recommendable to provide a solution for the temporary storage of this waste, such as the location of airtight containers in nurseries or residential homes, or near them.

It must also be kept in mind that the frequency of emptying emergency areas and recycling areas (in those DtD models that collect some waste fraction in containers) must be higher than the frequency of DtD collection to avoid problems of waste piling up on the street. As a guide, the following collection frequencies can be applied (Table 7).

[10] Because of this, the generation of jobs is higher than in CONT models.

Table 7. Weekly reference collection frequency in DtD models.

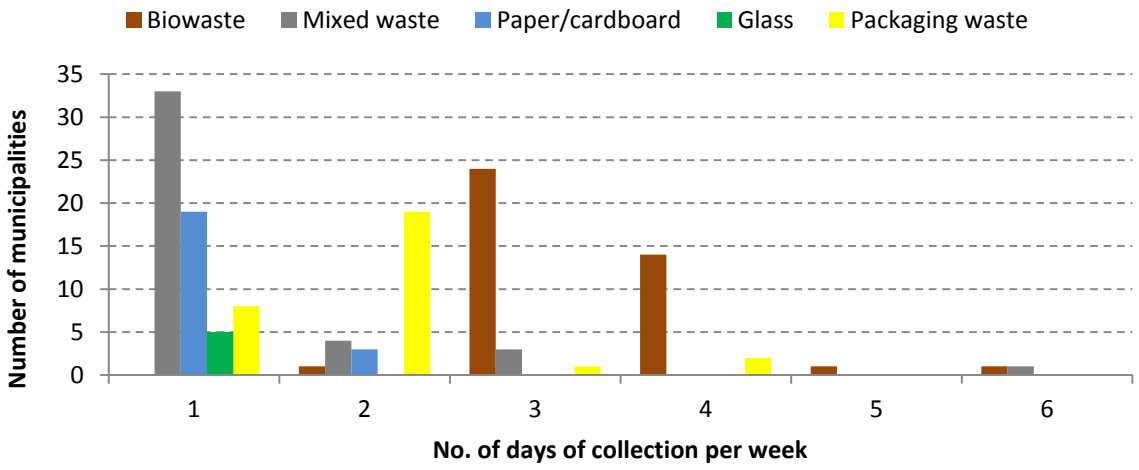
	Household and commercial waste collection		Extra commercial collection	Emergency areas and recycling areas
Waste fraction	Winter	Summer		
Biowaste	2/3	3/4	1	4
Paper/cardboard	1	1	1	1
Glass	0.5/1	0.5/1	-	0.5
Packaging waste	2	2	-	2
Mixed waste	0.5/1	0.5/1	1	4
Multiproduct (paper + packaging waste)	2	2	-	2
FIRM (inorganic waste)	2	2	-	3

Source: Own elaboration from Puig et al. (2008).

In Table 7, it is assumed that household and commercial collections are performed within the same circuit, since this is the usual case in DtD municipalities. Where there are separate circuits, their unification also allows us to optimise the costs of collection. From the point of view of costs, this option is generally better (supplemented with extra commercial collections) than segregated circuits.

Figure 14 shows the collection frequency of each waste fraction in DtD municipalities. As can be seen, there is some room for optimisation, particularly for mixed waste, biowaste and packaging waste.

Figure 14. Number of days of collection of each waste fraction in DtD municipalities.



Notes: In municipalities that collect FIRM, its collection frequency has been included in the collection frequency of mixed waste. In municipalities that collect multi-products, their collection frequency has been included in the collection frequency of packaging waste.

One way of reducing the number of days of collection is **to collect more than one waste fraction each day**. In the case of small municipalities, the same truck can do more than one route per day, and in the case of larger municipalities, it can do the same route but picking up more than one waste fraction at the same time (by using a two-compartment truck). In both cases, the number of days of collection can be reduced and so can the staff costs associated with the service. Using a two-compartment truck is especially recommended when the distance between treatment plants is not too high. However, as seen in Figure 2, the percentage of municipalities using two-compartment trucks is quite low among those participating in the study.

Since collection time directly influences cost, another measure that optimises cost is **the implementation of pay-as-you-throw (PAYT) systems in which the charge depends on the volume**. In a PAYT system, users pay according to the number of times they throw away. This can be done by pay per container systems, by means of containers with labels or chips and a device that can record the collected items, or by pay per bag systems, in which bags are standardised by the local authority and the user must purchase them to deliver his/her waste.

The main advantage of PAYT systems based on volume is that they optimise waste collection, as users tend to deliver waste only when containers are full. In addition, the system creates an incentive for waste prevention and source separation, particularly if this charging system is applied to mixed waste and packaging waste.

Regarding collection teams, in the case of small municipalities or waste fractions such as organic or mixed waste, **the use of vehicles under 3,500 kg** can be considered. Besides being less expensive vehicles (both to acquire and to maintain), it is not necessary to have a C driver's license in order to drive them (just B), which reduces driver costs.

Another aspect that clearly affects personnel costs is the pick-up time. In this sense, **moving from night to day collections** is another way to reduce costs**.** However, this option is not always recommended, and can be logistically complex. We must take into account the characteristics of the municipality, especially if leaving buckets or containers on the street during the day would disturb neighbours (e.g. if pavements are narrow) or businesses (if there is an important commercial activity).

Another option would be to **concentrate collection days on working days** rather than weekends. In this way, the staff benefit and overall costs are reduced. In this case, we must also take into account the particularities of each municipality, especially if there is a significant seasonal presence. In any case, regardless of the timing of collection, **not collecting on public holidays** can help avoid additional costs.

6 Conclusions

This work used the data provided by local authorities to compare the costs of municipal waste management from a strictly economic perspective and from the perspective of local authorities, namely the economic burden waste management represents for them.

The general conclusion is that **the costs of DtD to local authorities are, on average, similar to those of the CONT system**; indeed, they are virtually identical if measured in relation to the registered population.

If we consider the equivalent population, the overall cost of the DtD model is about 10% higher. Although this indicator is more relevant in theory, it offers less reliable results because it has been calculated for a much smaller number of municipalities, and therefore this result should be taken with caution.

As for the items comprising the overall cost of waste management, it can be concluded that **the cost of collection makes a greater contribution to the overall cost of management,** well above the cost of treatment. Further, in the DtD model, the higher cost of collection is offset by lower treatment costs and higher revenues, both of which are derived from the higher levels of separate collection in relation to the CONT model.

Although not used in this study owing to a lack of sufficient disaggregated data, because of its configuration, **both the existence and the intensity of the waste tax in force in Catalonia, and its rebate to local entities** affect waste management costs. Specifically, the purpose of the tax, which is defined as an eco-tax, is to discourage waste treatment options that are in the lower echelons of the legal hierarchy of waste management. Thus, a municipality with good results for the selective collection rate saves money in the payment of this tax and increases its income through the return received, even making it possible to achieve a positive balance.

This fact, together with the revenue that local authorities receive from the sale of materials and from integrated management systems, aims to ensure that municipalities achieving good environmental outcomes are not financially penalised, in line with a waste policy that internalises environmental costs and considers not only the economic costs that waste management represents to society.

In this sense, **if we want to move towards higher levels of collection, it is necessary to maintain and probably reinforce this incentive**, the effect of which depends on the level of the tax waste and of the associated rebate, and to translate the incentive to local authorities appropriately.

As for the possibilities of optimising the costs of collection in DtD municipalities, it is concluded that there are some elements on which local authorities have no ability to influence, **but there is great scope for cost optimisation**. Many of these possibilities relate to tendering contracts, a process at which we should put the utmost care, as well as to optimising the collection frequency of certain waste fractions, which may vary throughout the year depending on the weather conditions.

This work has shown the **difficulty of getting information on the costs of waste management**. A significant lack of harmonisation in terms of the computational costs of waste management

and data fragmentation, which derives from delegating the service or a part thereof, were noticed.

Making this information available, as mentioned at the beginning of the report, is important in order to make informed decisions about one model or another, decisions that will have a direct impact on the outcome in terms of selective collection. Therefore, **it would be advisable to conduct a systematic data collection of waste management costs** and to publish these data periodically. If this were done, a methodology should be applied to ensure that data are comparable. This should define the concepts included in waste management costs, who bears this cost (the municipality or local entity having the delegated competence), what year the data refer to, if the cost was finally transferred to the municipality and if it moved it to the citizen or business activity that ultimately receives the incentive towards the reduction and source separation of waste. It would also be advisable to separate these costs by waste category and concept (collection/treatment) as far as possible.

The work has also helped collect an amount of data that would allow us to analyse the relationship between the cost of waste management and a number of factors as well as build a model to explain this cost. This would provide us with a **better understanding of the costs of waste management and identify more efficient optimisation options**.

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Annex 1: Data Collection Form

Data entry form for the study of the global costs of municipal waste management commissioned by the Catalan Waste Agency

Instructions

The present form is intended to collect data on municipal waste management from a sample of Catalan municipalities to provide accurate information that can help make decisions on the implementation of a management model or on introducing changes to it.

The data requested are comprehensive and in some cases, they may not be available. In this case, we would appreciate you mention it in the space reserved for comments at the end of the form. You can also enter any observations that allow a good interpretation of the data in order to conduct a rigorous study.

You can access the form from the following address:

http://xurl.es/xl9tj

Requested Data

Municipality

Indicate the municipality for which you enter the data. If it is a consortium or supra-municipal organism, fill in a form for each municipality for which we request data.

Name of the person who enters the data

Contact phone of the person who enters the data

E-mail address of the person who enters the data

Year for which data are entered

Enter the data for the latest year available (the latest possible).

a. Characteristics of general municipal waste collection

Excludes the separate collection of commercial waste or large producers, which is requested below.

Number of emergency areas (Only municipalities with DtD collection)

a.1 Biowaste

Collection frequency — Days/week

If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

How is the collection carried out? — Door to door

Specify the type of truck used for the collection

- Two-compartment truck
- One-compartment truck

In containers

Specify the type of container used for the collection

- Rear-loading container
- Side-loading container
- Underground container
- Pneumatic collection

a.2 Mixed waste

Collection frequency — Days/week

If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

How is the collection carried out? — Door to door

Specify the type of truck used for the collection

- Two-compartment truck
- One-compartment truck

In containers

Specify the type of container used for the collection

- Rear-loading container
- Side-loading container
- Underground container
- Pneumatic collection

a.3 Paperboard

Collection frequency — Days/week

If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

How is the collection carried out? — Door to door

Specify the type of truck used for the collection

- Two-compartment truck
- One-compartment truck

In containers

Specify the type of container used for the collection

- Rear-loading container
- Side-loading container
- Underground container
- Pneumatic collection

a.4 Glass

Collection frequency — Days/week

If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

Door to door

Specify the type of truck used for the collection

Two-compartment truck

One-compartment truck

In containers

Specify the type of container used for the collection

Rear-loading container

Side-loading container

Underground container

Pneumatic collection

a.5 Packaging waste

Collection frequency

Days/Week

If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

Door to door

Specify the type of truck used for the collection

Two-compartment truck

One-compartment truck

In containers

Specify the type of container used for the collection

Rear-loading container

Side-loading container

Underground container

Pneumatic collection

b) Features of the separate collection of commercial and/or industrial waste (large generators)

This section refers to the separate collection of commercial waste or equivalent, which is conducted DtD. It does not include commercial and similar waste collected together with household waste.

Do you carry out a separate collection of commercial and/or industrial waste (large generators)?

Yes

No — Go directly to section c)

Number of generators served	Bars and restaurants
	Retailers
	Equipment (schools, retirement homes, etc.)
	Others
	Total (if there is no disaggregated data)

b.1 Organic waste

Collection frequency	Days/week
	If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

b.2 Mixed waste

Collection frequency	Days/week
	If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

b.3 Paperboard

Collection frequency	Days/week
	If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

b.4 Glass

Collection frequency	Days/week
	If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

b.5 Packaging collection

Collection frequency	Days/week
	If the frequency is less than weekly, state the fraction (for example, for a fortnightly collection, put 0.5)

c. Costs of the municipal waste management service

Do not include the cost of street cleaning and other costs not directly related to the collection and transportation of waste.

c.1 Cost of general municipal waste collection (do not include the treatment cost).

Domestic and non-segregated commercial waste		€/year
Segregated commercial waste		€/year
TOTAL (if disaggregated costs are not available)		€/year

c.2 Cost of collection of other waste (bulky, pruning, used oil, etc.) *Do not include the treatment cost.*		€/year
c.3 Costs of running the recycling centre *Do not include the treatment cost.*		€/year

d. Costs of waste treatment

Destination of mixed waste		Controlled landfill
		Incinerator
		Mechanical/biological treatment plant
d.1 Cost of the treatment of mixed waste (including waste tax)		€/year
Destination of biowaste		Composting plant
		Anaerobic digestion plant
		Self-composting (mark only in the case of exclusive management)
d.2 Cost of the treatment of biowaste		€/year
d.3 Cost of the treatment of other waste fractions *Bulky, special waste, used oil, etc.*		€/year

e. Income from waste management

e.1 Income from the sale of materials

Paper/paperboard		€/year
Metal scrap		€/year
Other waste		€/year
TOTAL (if disaggregated costs are not available)		€/year

e.2 Income of integrated management systems

Ecoembes		€/year
Ecovidrio		€/year

WEEE		€/year
TOTAL (if disaggregated costs are not available)		€/year

e.3 Waste tax rebate | | €/year

Include in this concept only the rebate received directly by the City Council.

Annex 2: Ratio of selective collection and waste fractions collected by the municipalities participating in the study

DtD municipalities			
No.	**Municipality**	**Selective collection (2011)**	**DtD waste fractions collected[1]**
1	La Masó	52.67%	4
2	Tagamanent	72.10%	4
3	Garcia	63.27%	5
4	La Torre de l'Espanyol	68.16%	5
5	Vilabella	48.71%	4
6	Santa Maria d'Oló	72.68%	4
7	Sant Martí de Centelles	74.29%	3
8	Viladrau	70.73%	3
9	Figaró-Montmany	61.46%	3
10	Castellserà	57.58%	4
11	Santa Eulàlia de Riuprimer	73.74%	3
12	Riudecanyes	46.27%	4
13	Vilajuïga	74.32%	5
14	Vila-rodona	24.06%	4
15	Artesa de Lleida	52.44%	4
16	Tivissa	35.36%	2
17	Folgueroles	81.00%	3
18	Santa Eugènia de Berga	63.29%	3
19	El Pla de Santa Maria	47.82%	5
20	Calldetenes	57.04%	4
21	Aiguafreda	53.63%	3
22	Sant Jaume dels Domenys	34.54%	2
23	Falset	45.09%	4
24	Gandesa	47.88%	4
25	La Bisbal del Penedès	10.80%	4
26	Olèrdola	16.41%	2

DtD municipalities			
No.	**Municipality**	**Selective collection (2011)**	**DtD waste fractions collected[1]**
27	Balenyà	68.48%	3
28	Collbató	37.81%	2
29	Martorelles	49.62%	2
30	L'Arboç	52.51%	2
31	Sant Antoni de Vilamajor	38.51%	4
32	Torrelles de Llobregat	27.29%	3
33	Taradell	72.64%	3
34	Lliçà de Vall	55.10%	2
35	Tiana	33.73%	2
36	Santa Eulàlia de Ronçana	50.76%	4
37	Santpedor	57.34%	4
38	Tona	69.01%	3
39	Matadepera	56.93%	5
40	Sant Sadurní d'Anoia	52.77%	4
41	Palau-solità i Plegamans	54.72%	2

[1] All DtD municipalities participating in the study have implemented the selective collection of biowaste.

CONT municipalities			
No.	**Municipality**	**Selective collection (2011)**	**Selective collection of biowaste?**
42	Sant Ferriol	15.50%	No
43	Oliola	32.40%	Yes
44	El Molar	26.14%	No
45	Vilanova de Sau	27.83%	No
46	La Pera	35.88%	Yes
47	Freginals	33.85%	Yes
48	Llambilles	16.70%	Yes
49	Os de Balaguer	20.47%	Yes
50	Botarell	34.94%	Yesí
51	Vilanova de la Barca	15.81%	Yes
52	Vilanova de Bellpuig	55.79%	Yes
53	Verges	26.90%	Yesí
54	Benissanet	33.20%	Yes
55	Portbou	13.44%	No
56	La Secuita	16.04%	No
57	Castellví de la Marca	31.99%	Yes
58	Golmés	39.15%	Yes
59	Naut Aran	10.73%	No
60	Albatàrrec	17.26%	Yes
61	Sant Pere Pescador	12.89%	No
62	Fornells de la Selva	35.38%	Yes
63	La Pobla de Montornès	5.14%	No
64	Juneda	25.31%	Yes
65	Calaf	32.72%	Yes
66	El Papiol	19.43%	Yes
67	Flix	34.32%	Yes

CONT municipalities			
No.	**Municipality**	**Selective collection (2011)**	**Selective collection of biowaste?**
68	Porqueres	22.11%	Yes
69	La Selva del Camp	40.83%	Yes
70	Agramunt	18.15%	Yes
71	Maçanet de la Selva	19.09%	Yes
72	Alcarràs	15.09%	Yes
73	Cervelló	14.96%	Yes
74	Solsona	32.33%	Yes
75	Ripoll	21.15%	Yes
76	Mont-Roig del Camp	17.34%	Yes
77	Cunit	12.85%	Yes
78	Vallirana	20.98%	Yes
79	Sant Celoni	18.16%	Yes
80	Les Franqueses del Vallès	11.36%	Yes
81	Banyoles	24.47%	Yes