

Øystein Skullerud and Svein Erik Stave

**Waste Generation in the
Service Industry Sector in
Norway 1999**

Results and Methodology based on
Exploitation of Waste Data from a
Private Recycling Company

Rapporter

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Abstract

Øystein Skullerud and Svein Erik Stave

Waste Generation in the Service Industry Sector in Norway 1999

Results and Methodology based on Exploitation of Waste Data from a Private Recycling Company

Reports 2002/24 • Statistics Norway 2002

Waste statistics for the service industries in Norway has up to now consisted of indirect and shaky estimates in the Norwegian waste accounts. This project was designed to extend the Norwegian waste statistics with an important industrial sector. At the same time, we wanted to exploit a hitherto unused source for statistical data: The database of a large, private recycling enterprise.

Data from Norway's largest recycling enterprise, Norsk Gjenvinning AS, were obtained and national waste statistics for the Service Industries in Norway 1999 were estimated therefrom.

The sample initially contained detailed waste data for 10 500 establishments. Large parts of the initial sample had to be excluded, however, due to insufficient establishment identification (often only by informal names), risk of double counting (establishments delivering waste produced by other establishments) or because the actual establishments appeared to have initiated or terminated their customership with Norsk Gjenvinning during the year so that the data did not reflect a whole year's waste generation. After this extensive exclusion process, a final sample of 1 189 establishments remained, constituting only 0,7 per cent of the total number of establishments in the service industry sector, but representing 3,4 per cent of the total number of employees. Out of these, two establishments showed such an extreme waste generation that they were singled out from the sample and given weight 1. The rest of the sample was inflated to national figures with employment statistics as auxiliary.

Inspection of the data suggested a two-termed model with one (small) constant and one (large) employment-dependent term.

The sample was divided into seven NACE groups, not two-digit groups as originally intended. This reduced splitting-up was chosen in order to have sufficiently large sample for each NACE group.

With this method, it was estimated that the service industries in Norway generated 767 000 tonnes of waste in 1999, of which 37 per cent was paper and 43 per cent was mixed waste. The material composition of the mixed waste has been estimated. The main results correspond well with estimates in the waste accounts for Norway

Acknowledgement: We thank Eurostat for financial support, and Norsk Gjenvinning for access to their data register and kind cooperation throughout the project.

Sammendrag

Øystein Skullerud and Svein Erik Stave

Avfall fra tjenesteytende næringer i 1999

Metode og resultater basert på data fra et privat gjenvinningselskap

Rapporter 2002/24 • Statistisk sentralbyrå 2002

Avfallsmengder fra tjenesteytende næringer (NACE G-Q) har lenge vært et svakt ledd i SSBs avfallsstatistikk. Dette er problematisk siden det dreier seg om betydelige avfallsmengder som kommer fra det offentlige og store deler av det private næringslivet. Oversikt på dette feltet har inntil nå vært en av de vesentligste manglene i SSBs avfallsregnskap. I tillegg er vår nåværende kunnskap om avfall i de tjenesteytende næringene ikke tilstrekkelig til å oppfylle de nye kravene som forventes å komme i EUs forordning for avfallsstatistikk.

På grunnlag av dette ble det i 1999 startet et prosjekt for å bedre kunnskapen om avfallsmengder fra tjenesteytende sektor. Den endelige målsetningen med prosjektet var å kartlegge hvor mye avfall av ulike materialer som hvert år blir generert i de tjenesteytende næringene, og hvordan dette avfallet blir behandlet/disponert. Metoden som ble valgt, var å skaffe et datagrunnlag fra et egnet avfallsbehandlingsfirma og benytte det som grunnlag for oppblåsing til landstall sammen med tilhørende bedriftsspesifikke tall for økonomisk aktivitet og/eller sysselsetting.

Det ble tatt kontakt med Norsk Gjenvinning AS (NG), som stilte hele sitt kunderegister med tilhørende statistikk til disposisjon. Dette omfattet for 1999 10 500 bedrifter. Før oppblåsing, ble datagrunnlaget gjennomgått og kvalitetssikret:

- Bedriftene ble identifisert med korrekt bedriftsnummer og alle som ikke lot seg identifisere til bedriftsnummer ved hjelp av navn og adresse, ble ekskludert fra utvalget.
- Bedrifter som det var grunn til å anta bare hadde vært kunder hos NG i deler av året, ble ekskludert.
- Bedrifter som etter all sannsynlighet hadde levert avfall generert i andre bedrifter, ble ekskludert. Dette dreide seg om bedrifter i næringsgruppene 51.57 (engroshandel med avfall og skrap), 60 (landtransport), 70 (eiendomsdrift) og 90 (renovasjon). For sikkerhets skyld ble alle bedrifter i disse næringsgruppene ekskludert.
- Bedrifter uten registrerte ansatte ble ekskludert da dette tydet på feilidentifisering av bedriftene.

Etter disse prosessene, utgjorde utvalget 1189 bedrifter. Av disse ble to bedrifter med ekstremt store avfallsmengder plukket ut og gitt vekt 1.

Utvalget ble delt opp i sju næringsgrupperinger

Næringsgruppering	SN 94-grupper	Utvalget		Populasjonen		Representativitet	
		Antall ansatte	Antall bedrifter	Antall ansatte	Antall bedrifter	Ansatte	Bedrifter
I alt	50-93	47 679	1 189	1 396 166	18 2001	3,4 %	0,7 %
1	50	3 858	191	49 335	9 475	7,8 %	2,0 %
2	51 ¹	7 761	269	104 218	19 399	7,4 %	1,4 %
3	52	4 075	281	149 521	33 990	2,7 %	0,8 %
4	55	3 030	82	68 305	9 217	4,4 %	0,9 %
5	61-63 ²	1 928	42	61 497	5 197	3,1 %	0,8 %
6	64-74 ³	10 864	139	251 869	44 938	4,3 %	0,3 %
7	75-93 ⁴	16 163	185	711 421	59 785	2,3 %	0,3 %

¹ Unntatt 51.57 Engroshandel med avfall og skrap

² Næring 60 Landtransport er utelatt

³ Unntatt 70 Eiendomsdrift

⁴ Unntatt 90 Renovasjon

Det ble valgt å benytte antall ansatte som hjelpevariabel til oppblåsning. En gjennomgang av datamaterialet i utvalget viste at små bedrifter genererte betydelig mer avfall per ansatt enn store. Dette ble forsøkt kompensert ved å blåse opp utvalget etter en modell med to ledd: Et konstant (uavhengig av antall ansatte) ledd og et avhengig ledd. Det konstante leddet ble satt lik gjennomsnittlig mengde avfall per ansatt i de ti største bedriftene i hver næringsgruppe. Oppblåsningen ble dermed gjennomført slik Likning 1 viser:

Likning 1

$$Avfall = Avfall_{10}/Ansatte_{10} * bedrifter_{pop} + (avfall_{utvalg}/Ansatte_{utvalg} - Avfall_{10}/Ansatte_{10}) * Ansatte_{pop}$$

10 - De 10 største bedriftene i utvalget

pop - Hele populasjonen

utvalg- Hele utvalget

Hovedresultatene er gitt i tabell 1.

Tabell 1. Avfall fra tjenesteytende næringer i Norge. Etter næringsgruppering og materiale. 1999. Tonn

NACE-gruppe	I alt	Rest-avfall	Ee-avfall	Glass	Plast	Rene masser	Papir	Metall	Tre	Våtorganisk avfall	Spesial-avfall
I alt	766 902	332 979	5 599	21 043	1 247	520	281 155	11 223	31 287	77 168	4 681
50	53 778	29 597	34	28	1	5	17 821	2 734	1 334	250	1 976
51	82 812	33 508	58	4 317	396	63	28 388	5 908	9 230	705	240
52	245 164	107 808	98	1 562	244	196	66 254	285	3 060	65 546	108
herav 52.11	119 076	45 380	0	209	101	0	34 779	50	145	38 384	29
55	29 091	10697	0	3 409	1	166	5 849	17	4	8 934	13
61-63	68 427	30 000	2	10 721	234	0	19 154	470	7 031	0	815
64-74	101596	46 624	122	748	372	90	45 235	1 436	6 567	254	148
75-93	186 037	74 745	5 285	258	0	0	98 453	373	4 061	1 480	1 381

Prosjektstøtte: Prosjektet er delvis finansiert av Eurostat. Vi vil også takke Norsk gjennvinning for tilgangen til deres kunderegister og for godt samarbeid under hele prosjektet.

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Preface

This report contains the results from a project initiated in 2000 under the Eurostat grants programme for 2000-2001, contract number 200071200004 between Eurostat and Statistics Norway.

The report is written by the project leaders, Øystein Skullerud and Svein Erik Stave. Barbara Kupis Frøyen and Håkon Skullerud, executive officers at Division for Environmental Statistics, Statistics Norway have assisted in the processing of data.

Kongsvinger, 30. April 2002

1. Introduction

1.1. Background

One of the groups for which the coming European Parliament and Council regulation on waste statistics requests statistics, is the Nace 50-99, Service industries. So far, the international statistics on waste from service industries are scarce and difficult to compare. Table 1.1 illustrates the difficulties. Data are taken from the 1999 OECD Environmental Data Compendium.

Apart from some preliminary attempts, statistics on waste from the Norwegian service industries have not been developed. A core issue in Statistics Norway's strategy on waste statistics is to develop comprehensive waste accounts for all major waste materials by product, sector of origin and treatment/disposal method. Prior to the project presented here, information on waste generation in the service industries (NACE G-Q) constituted the largest hole in the national waste accounts.

In 1995 Statistics Norway conducted a pilot survey of selected parts of the NACE sections Public administration, Education and Health care (Statistics Norway 1996). The experience from this discouraged extended surveys covering all service industries.

In 1999, Statistics Norway made a second attempt to work out waste statistics for the service industries, this time with a different methodological approach, based on waste generation coefficients. Non-specialized retail sale, NACE 52.11, was chosen as a test class. The results encouraged further use of this methodology for all service industries (Statistics Norway 2001b).

1.2. Objectives

The main objectives of the present project were:

- to identify and assess problems and possibilities related to the exploitation of establishment-level waste data from private recycling companies for statistical purposes
- to estimate the total waste amounts for different materials generated in the service industries, classified according to two-digit NACE codes. In addition, as far as possible, information on disposal and treatment of the generated waste was to be collected.

Table 1.1. Waste from service industries in selected countries. Last available year

Country	Population (1000)	Waste from service industries (1000 tonnes)	Waste from service industries (kg/cap)
Japan	126 430	74 690	591
Austria	8 290	13 690	1 651
Denmark	5 330	810	152
Germany	82 690	940	11
Netherlands	15 870	2 640	166
Switzerland	7 410	190	26
UK	59 450	66 000	1 110

1.3. Definitions

This project covers the NACE 50-93 except the following:

- 51.57 Wholesale of waste and scrap
- 60 Land transport; Transport via pipes
- 70 Real estate activities
- 90 Sewage and refuse disposal, sanitation and similar activities

The reason for these omissions is explained in chapter 2.

In this study we operate with 7 NACE categories consisting of 4 single two-digit NACE groups and three merged groups:

- 50 Sale, maintenance and repair of motor vehicles, motorcycles; Retail sale of automotive fuel
- 51 Wholesale trade and commission trade, except of motor vehicles and motorcycles
- 52 Retail trade, except of motor vehicles and motorcycles; Repair of personal and household goods
- 55 Hotels and restaurants
- 61-63 Transport activities
- 64-74 Post and telecommunications; Financial intermediation; Real estate, renting and business activities
- 75-93 Public administration and defence; Compulsory social security; Education; Health and social work; Other community, social and personal service activities

With the term "Establishment", we mean local kind-of-activity unit. Waste data and auxiliary data are given at establishment level.

2. Methodology

2.1. The waste data

Waste quantity data for 10 469 establishments in 1999 were obtained from the register of Norway's largest private recycling company - Norsk Gjenvinning (NG). This particular register was selected as the primary data source due to its size and its detailed content compared with other recycling companies.

The register contains waste quantity data for each establishment by material. The establishments are registered with name, organizational number, 5-digit NACE code and county (of delivery), of which NG is represented in 16 out of a total of 19. The registered organizational numbers, and thus the NACE codes, proved however in most cases to be inconsistent with the official business register. The main reason for this was that most establishments were registered by their enterprise's organizational number and not by their unique establishment organizational number.

2.2. Identification of establishment organizational numbers

The organizational numbers attached to the establishments in NG's register proved to be so inconsistent with the official business register that it was decided to re-identify all numbers on basis of the establishment's name and locations.

A data program for this purpose was obtained from Statistics Norway's division for Business Register, and was further developed to suit particular problems attributed to the names in NG's register. After several modifications of the program, a total of 5 354 establishments were identified with organizational numbers, and thus with correct 5 digit NACE codes.

Although 5 354 establishments constituted a relatively large sample in total, many of the establishments delivered only a few materials, making it uncertain whether their registered waste quantities represented their total waste generation or not. To be able to employ the total sample of establishments, it was initially made an attempt to develop a relatively sophisticated estimation method based on a range of pre-assumptions on the representativity of different materials in

the sample. This method proved, however, to be highly uncertain, and it was decided that further information was needed to revise the method and to increase the reliability of the results. Therefore, another approach was chosen.

2.3. Revision and modifications of the sample

Exclusion of partial customers

First priority in the revision process was to identify establishments that delivered all their waste to NG ("total customers"). This was necessary to avoid the fragile pre-assumptions of which the initial methodological attempt was based. Consultations with NG representatives revealed that establishments that delivered mixed waste with a high degree of certainty could be considered as total customers. The total sample of establishments was then reduced to approximately 2000.

Exclusion of waste handlers

In addition, a large number of the establishments in NACE 60 and 70 appeared to be establishments that most likely handled waste for other establishments, possibly also representing establishments of non-service industrial sectors. The majority of these establishments were either transport companies collecting and transporting waste generated by others, but registered in NG's register as waste from the transporting company (NACE 60), or estate management companies responsible for handling waste for a sample of establishments, e.g. in shopping centres. To avoid double counting, it was decided to exclude all establishments from NACE 60 and 70 from the sample.

Exclusion of enterprises with no employees registered

Some of the establishments had no employees according to the labour statistics. This phenomenon might occur in cases where waste production does not follow the administrative organization of establishments, in cases of establishment bankruptcy, or due to errors in the employment statistics. It may also indicate an error in the establishment identification process. Clearly, when waste arises, one or more employees have done the work causing the waste. Therefore, zero-employment-establishments were excluded from the sample.

Table 2.1. The final sample by NACE categories

Category	NACE	The sample		The population		Representativity	
		No. of employees	No. of establishments	No. of employees	No. of establishments	Employees	Establishments
Total	50-93	47 679	1 189	1 396 166	182 001	3.4 %	0.7 %
1	50	3 858	191	49 335	9 475	7.8 %	2.0 %
2	51 ¹	7 761	269	104 218	19 399	7.4 %	1.4 %
3	52	4 075	281	149 521	33 990	2.7 %	0.8 %
4	55	3 030	82	68 305	9 217	4.4 %	0.9 %
5	61-63 ²	1 928	42	61 497	5 197	3.1 %	0.8 %
6	64-74 ³	10 864	139	251 869	44 938	4.3 %	0.3 %
7	75-93 ⁴	16 163	185	711 421	59 785	2.3 %	0.3 %

¹ Except 51.57 Wholesale of waste and scrap

² Except 60 Land transport; Transport via pipes

³ Except 70 Real estate activities

⁴ Except 90 Sewage and refuse disposal, sanitation and similar activities

The same error might of course occur with establishments with one or very few employees as well. However, it was difficult to assess in every such case if it was a result of establishment identification error or not. Therefore, we chose to keep establishments with one or more employees in the sample.

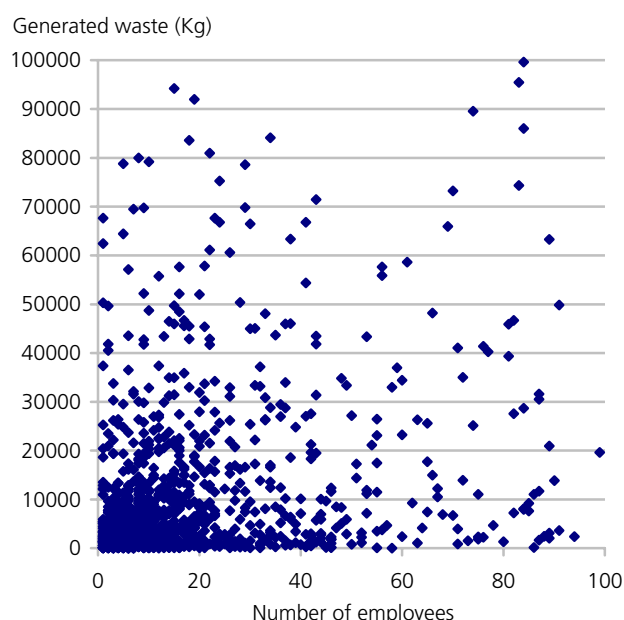
Checking for extremes

Lastly, the remaining sample was searched for establishments with extreme total waste generation or generation per employee. Such establishments were either excluded or given weight 1 and added to the estimated total quantities separately, depending on consideration of every case (see next section).

These revisions of the initial sample of establishments, gave a final total sample of 1 189 establishments, constituting only 0,7 per cent of the total number of establishments in the service industry sector (excluding NACE 51.57, 60, 70 and 90), but representing 3,4 per cent of the total number of employees in the sector.

The relatively large reduction of establishments compared to the original sample, made it necessary to reduce the number of NACE categories in order to ensure a minimum level of representativity in the categories. Initially the aim was to estimate generated waste for every 2 digit NACE group. Finally this was modified to 7 categories based on NACE codes and assumed homogeneity in waste production with regards to materials (table 2).

An exception from the general employment of this sample had to be made for hazardous waste and biodegradables because NG did not receive such types of waste in all counties in 1999. Thus, the sample of which the estimated waste quantities for these two materials are based, consists only of the establishments located in counties in which NG received hazardous and biodegradable waste.

Figure 2.1. The relationship between waste generation and the number of employees for the establishments in the sample

2.4. Inflation of the sample

The initial methodological idea to develop waste generation coefficients assumed a clear relationship between waste generation and economic turnover or number of employees in the establishments. Figure 2.1 shows that such a relationship hardly exists in our sample. Thus, the conversion of waste quantities in the sample into national figures had to be carried out by simple inflation based on the representativity of the sample for each of the seven Nace groups.

A general rule of thumb is that a sample should constitute more than 1 per cent of the total population in order to be applicable for simple inflation. Our sample does not meet this requirement with regards to the number of establishments, but does so with regards to the number of employees in the establishments. Thus, the sample consists of larger establishments than the average of the service industry sector (table 2).

In order to compensate for the bias in the sample, it was decided to use the number of employees as basis for inflation rather than the number of establishments. The reason why economic turnover was ruled out as basis for inflation was lack of establishment-level turnover data for many of the Nace groups. Besides, it appeared that in the Nace groups where we had both economic turnover and employment for individual establishments, they correlated very much with each other. In other words, the choice between turnover and employment had little effect on the results. For simplicity, we chose to use employment for all Nace groups. Another important reason for the use of employment was that the data material indicated that smaller establishments generated relatively more waste per employee than larger establishments. In fact, it seemed that there existed a lower limit for waste generation for any establishment regardless of the number of employees (figure 2). By closer consideration this phenomenon may not be surprising, as some waste will clearly be related to the initiation and existence of an establishment rather than to size. For example the existence of an establishment requires a minimum selection of goods to be sold, a minimum activity of administration and a minimum set of office or store facilities, which all generate a certain amount of waste.

Thus, it was concluded to develop two separate inflation factors: one constant factor, representing the minimum waste generation by any enterprise, and one dependent factor representing the generated waste per employee (table 3). The general equation of inflation can then be expressed as:

Equation 1

$$\text{Waste} = \text{Waste}_{x1emp} / \text{Employees}_{x1emp} - \text{Waste}_{sample} / \text{Employees}_{sample} * \text{Establishments}_{pop} + \text{Waste}_{sample} / \text{Employees}_{sample} * \text{Employees}_{pop}$$

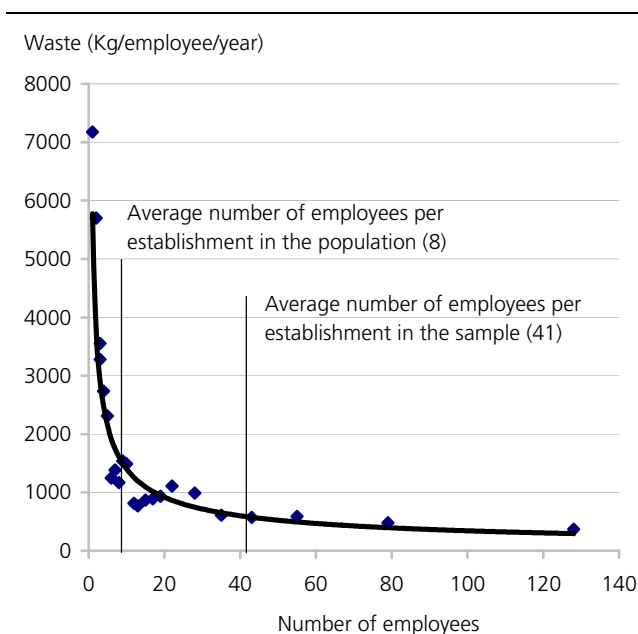
$x1emp$ - establishments in the sample with one employee

pop - The whole population

$sample$ - The whole sample

Table 2.1 shows the waste factors calculated in this project, in kg per employee per year. For the retail trade sector (NACE 52), we had the opportunity to compare our factors with the recently published Danish factors from the Danish EPA (Danish EPA 2002). Our total waste factor amounts to 1 640 kg per employee per year. In comparison, the Danish factor was calculated to 98 kg per employee per week corresponding to 5 096 kg per employee per year, much higher than our factor. However, in the Danish analysis, but not in ours, employment data are converted to full-time employment. Secondly, the variability of waste factors is large in both analyses, but we have a far larger sample. Thirdly, there is the possibility that some of the waste from the Norwegian establishments in the sample has been delivered elsewhere than to Norsk gjenvinning. In

Figure 2.2. Average waste generation by size of establishments*



* Dots represent the average of 50 establishments categorised by increasing number of employees.

Table 2.2. Constant and dependent waste factors (excluding biodegradables and hazardous waste). Norway. 1999

NACE group	Constant factor (kg/establishment/year)	Dependent factor (kg/employee/year)
50	463.4	959.7
51	664.6	624.5
52	1 214.0	998.9
55	333.4	263.8
61-63	402.9	956.3
64-74	124.1	379.7
75-93	117.9	247.7

that case, we have too small waste factors. In the Danish project, this was not a problem. Finally, in the Danish project, it was reported some cases where private persons dumped their waste into the containers of enterprises.

2.5. The calculation procedure

With regards to the considerations presented on the previous pages, estimation of national figures for waste generation in the service industries can be described in the following steps:

1. Estimation of generated waste by material and by NACE category for all materials except biodegradables and hazardous waste
- Estimation of the constant waste generation factor is done by calculating the average total (excluded biodegradables and hazardous waste) waste quantity generated per employee for the 10 per cent largest (by number of employees) establishments in each NACE category of the sample. This factor is then multiplied with the total number of establishments in the national population of each NACE category (equation 2).

In theory the constant waste generation factor should better be estimated by finding the average waste amounts generated by the smallest establishments, preferable the establishments with only one employee (equation 1). However due to the heavy bias of large establishments in our sample, this method clearly gave too high factors. Thus, the opposite approach based on waste generation per employee in the largest establishments, were considered as the best alternative in this project (equation 2).

- Estimation of the dependent waste generation factor is done by dividing the total (excluded biodegradables and hazardous waste) waste quantities of each NACE category by the total number of employees in the category, giving an average waste generation factor for each NACE category in the sample. This factor is then multiplied with the total number of employees in the national population of establishments for each category (equation 2)

Equation 2

$$\text{Waste} = \text{Waste}_{10}/\text{Employees}_{10} * \text{Establishments}_{pop} + (\text{Waste}_{sample}/\text{Employees}_{sample} - \text{Waste}_{10}/\text{Employees}_{10}) * \text{Employees}_{pop}$$

10 - The 10 largest establishments

pop - The whole population

sample - The whole sample

- The total generated waste (excluded biodegradables and hazardous waste) for each NACE category is then calculated by adding the constant and the dependent waste quantities of each category.
- Finally, the total waste quantities are distributed by materials on basis of the percentage of each material compared with the total of each category.

2. Estimation of generated biodegradables and hazardous waste by NACE category

- Estimation of constant and dependent waste generation factors for biodegradables and hazardous waste respectively carried out according to the procedure described above. Biodegradables and hazardous waste is treated separately due to smaller samples consisting only of the enterprises of the counties in which NG collects the two materials.
- The quantities of biodegradables and hazardous waste are added to the quantities of the other materials estimated in step one to give a total for all materials.

3. Inclusion of the waste quantities generated by establishments given weight 1, and estimation of the total generated waste by material and NACE category for all materials.

- The waste quantities of establishments given weight 1 in the sample are finally added to their respective NACE categories, and the total generated waste by material and by NACE category for all materials are given.

3. Results

3.1. Main findings

Table 3.1 shows the main results of the project. According to the results, the Norwegian service industries generated 767 000 tonnes of waste in 1999. Comparing with table 1, this corresponds to 171 kg per capita. NACE 51.57, 60, 70 and 90 are not included in the figures. Scrapped vehicles are also not included.

Figure 3.1 shows that the waste consists of 37 per cent paper, 10 per cent biodegradables, 4 per cent wood, 3 per cent glass, 43 per cent mixed waste (see chapter 3.3) and 3 per cent other materials.

Almost one third of the waste (245 000 tonnes) originated in the retail trade sector (NACE 52), of which 119 000 tonnes in retail sale of food, beverages and tobacco (Nace 52.11). Also the public service sector appears to be an important waste generator, with about 24 per cent.

Figure 3.1. Waste from service industries in Norway. By material. 1999. Per cent

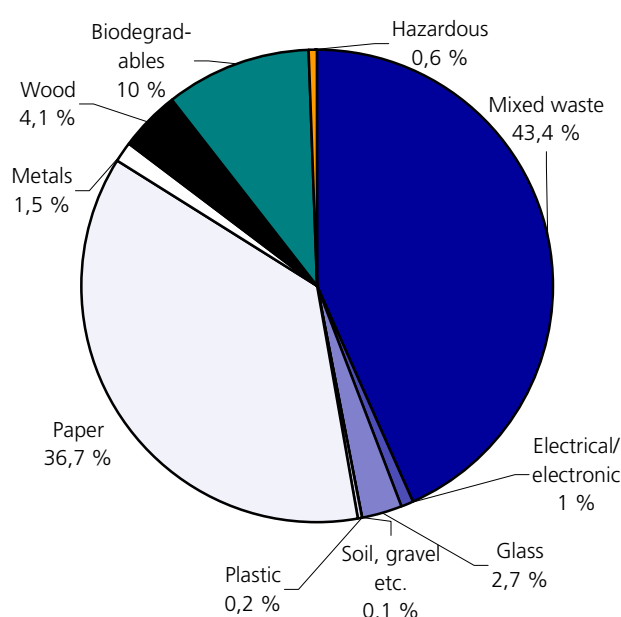


Table 3.1. Waste from service industries in Norway. By Nace category and material. 1999. Tonnes

NACE category	Total	Mixed waste	Electrical/electronic	Glass	Plastic	Soil, gravel etc.	Paper	Metals	Wood	Bio-degradables	Hazardous
Total	766 902	332 979	5 599	21 043	1 247	520	281 155	11 223	31 287	77 168	4 681
50	53 778	29 597	34	28	1	5	17 821	2 734	1 334	250	1 976
51	82 812	33 508	58	4 317	396	63	28 388	5 908	9 230	705	240
52	245 164	107 808	98	1 562	244	196	66 254	285	3 060	65 546	108
of which 52.11	119 076	45 380	0	209	101	0	34 779	50	145	38 384	29
55	29 091	10 697	0	3 409	1	166	5 849	17	4	8 934	13
61-63	68 427	30 000	2	10 721	234	0	19 154	470	7 031	0	815
64-74	101 596	46 624	122	748	372	90	45 235	1 436	6 567	254	148
75-93	186 037	74 745	5 285	258	0	0	98 453	373	4 061	1 480	1 381

Table 3.2. Waste in service industries in Norway. Estimates in the waste accounts. Tonnes

Nace category	Electrical/electronic	Glass	Plastic	Soil, gravel etc.	Paper	Metals	Wood	Biodegradables	Hazardous	Other materials	Total
50-99	25 000	19 000	104 000	n.a.	350 000	132 000	47 000	103 000	40 000	123 000	943 000

3.2. Consistency with other waste statistics

Table 3.2 shows the amount of waste generated in the service industries as estimated in the Norwegian waste accounts. In most cases the waste from the service industries has been estimated as (total waste - household waste - manufacturing waste - waste from the construction and demolition industries). The remaining waste is then assigned to the remaining industry divisions according to number of employees. This means that the waste accounts estimates are rather crude and uncertain. Nevertheless, the two different sources seem to agree fairly well for many of the material fractions. When comparing the two, one must bear in mind that the mixed waste contains all kinds of materials, but that sorting practice varies greatly between the different material fractions. Discrepancies are largest for plastic and metals. For plastic, the explanation probably lies in the fact that little plastic was sorted out back in 1999. Therefore, we consider that a great deal of the missing plastic was hidden in the mixed waste. In addition, some plastic in the waste accounts originated from scrapped vehicles. For metals, by far the most important explanation factor is scrapped vehicles. One must also bear in mind that NACE 51.57, 60, 70 and 90 are not included in this project, but are included in the waste accounts. The reason why we have got higher figures for glass in this project, may lie in the way we have assigned the building and construction (B&C) glass in the waste accounts. There, all B&C glass is assigned to the C&D sector, which is a simplification. At least some of the glass delivered to Norsk gjenvinning is B&C glass.

Some of Norway's largest retail trade enterprises (Nace 52.11) have worked out their own waste per million NOK turnover factors. Based on those factors, total waste amounts in Nace 52.11 in 1999 were estimated to 118 000 tonnes. The estimate for the same sector based on our factors, amounts to 119 000 tonnes. This indicates that for the retail trade sector, our total estimates seem satisfactory. Due to the relatively large amount of mixed waste in our figures, there is however considerable variations of the factors attributed to the different materials. From the consistency between the total waste amounts estimated from the enterprises own factors and from our factors, we might conclude that the difference from the Danish project mentioned in chapter 2.3, is caused mainly by the conversion of number of employees into full-time-employees.

3.3. Composition of the mixed waste

Based on the above discussion, we can make some qualified guesses as to the composition of the mixed waste, as shown in table 3.3. This differs clearly from the results in Heie (1998) from 1996, which reports much higher paper content and much less plastic. However, the sorting practice in Norway was much less developed in 1996 than in 1999, especially when considering paper. We therefore do not interpret the great difference as an indication of error in this project.

Table 3.3. Assumed material composition of the mixed waste. Tonnes

Electrical/electronic	19 000	5.8 %
Glass	3000	0.9 %
Plastic	77 000	23.3 %
Paper	97 000	29.1 %
Metals	7 000	2.0 %
Wood	15 000	4.4 %
Other	115 000	34.6 %
Total	333 000	100.0 %

3.4. Recycling percentage

In Norway, like in other countries, the private waste handler industry has during the last twenty years grown to become a serious alternative to the traditional municipal waste handling scheme for all types of waste (except for household waste). The idea behind the private waste handler industry is to utilize the resources still present in the waste to maximum extent (maximum recycling - minimum landfilling).

The percentage of waste delivered to NG as mixed waste was found from the initial total dataset to be 22 per cent. However, NG has its own sorting facilities for mixed waste. Based on interview with NG operators, we assume that all sorted waste is recycled and that 75 per cent of the mixed waste is recycled and 25 per cent is landfilled.

We assume similar recycling practice among other private recyclers. There has however not been a similarly strong emphasis on recycling in the municipal waste scheme. Waste from service industries may be delivered to either municipal or private waste handlers. Therefore, there is no reason to assume that the NG recycling percentage is representative for the national service industry establishment population. Thus, we need some additional information from municipal waste statistics to assess the recycling percentage.

In 1998, the recycling percentage for industrial municipal waste¹ in Norway was 12,5. We have little reason to believe that this percentage changed significantly from 1998 to 1999. From the same statistics, we estimate that the amount of waste from service industries in municipal waste in 1999 was about 350 000 tonnes. We assume equal recycling percentage for all industrial municipal waste, i.e. that the 12,5 per cent recycling rate applies to the municipal service industry waste.

¹ A brief description of the Norwegian municipal waste system may be necessary to understand the reasoning here: In Norway, the municipal authorities are obliged to take care of all household waste. In addition, they may take care of industrial waste (from whatever NACE group), but have no obligation to do so. The private waste handlers are free to compete with the municipal for the industrial waste. This has led to a situation where the private handlers generally take care of big waste streams and municipal authorities take care of the small flows, especially in peripheral districts.

Based on this additional information and assumptions, we estimate the overall recycling rate to be $((350\,000 * 0,125) + (417\,000 * 0,22 * 0,75) + (417\,000 * 0,78)) * 100 / 767\,000 = 57$ per cent. This includes both material recovery and energy recovery.

4. Conclusions and recommendations

4.1. General conclusion

The experiences from this project have shown that waste data from private recycling companies can be good and cost-efficient data sources for production of statistics on waste generation (given provided they fulfil some basic requirements as discussed below), but that they have clear limitations as the only data source when it comes to statistics on waste disposal and treatment. In combination with other sources of data however, it can provide substantial contributions to such statistics as well.

4.2. Main experiences on the exploitation of establishment waste data from private recycling companies

The main problems and opportunities regarding the exploitation of establishment waste data from private recycling companies for statistical purposes, gained in this study, can be summarized as follows:

Main problems:

- The waste/employees ratios for different establishments within NACE groups show large variability, excluding the possibility to develop general waste generation coefficients for the NACE groups as wholes based on small samples of establishments.
- Establishments that deliver their waste to recycling companies tend to be larger than the national average, giving unreasonable high amounts when using a simple inflation method based on the number of establishments in the population, rather than size dependent auxiliary statistics such as the number of employees.
- Partial customers, delivering only selected material types, constitute a danger for underestimation of the total waste amounts. The same problem can be experienced if establishments have been delivering waste for only parts of the year. In this project we were able to exclude such establishments in the Oslo region, which is the largest, but not in the other counties.
- It can be difficult to avoid double counting in cases when the establishments registered as customer with the recycling company handle and deliver waste on behalf of other establishments. In this pro-

ject this was a substantial problem in NACE 60 (transport companies) and NACE 70 (estate management companies).

- The utilisation of waste data from the registers of recycling companies requires a good business register and a common identity attribute in the sample data to be able to link the waste amounts with the correct auxiliary statistics on establishment-level.

Main possibilities:

- The final results from the chosen methodology show consistency with comparable statistics and general expectations, which indicates an acceptable quality on the data from the recycling company in spite of the limited final sample compared with the initial sample obtained from the company. Both the amounts of waste delivered to recycling companies as well as the quality of their registers, have improved further since 1999. This, in combination with collection of data from more recycling companies, should create optimism for further use of the approach.
- Compared with traditional data collection methods, the exploitation of data from recycling companies requires relatively small efforts, if the mentioned basic requirements of a business register and identification attributes are met.

4.3. Recommendations

To maximize the potential of the waste data from private recycling companies for statistical purposes, we give the following recommendations:

- Try to establish mutual benefit cooperation agreements with private recycling companies by offering to identify NACE codes attributed to the establishments in their registers. This will provide an important pre-condition for obtaining large samples of establishments, which is a fundamental advantage due to the large variability in waste/employees ratios between the establishments. At the same time it will offer the recycling companies an opportunity to carry out detailed market analyses based on their own registers.

- A methodology to exploit data from recycling companies should be based on sufficiently large samples, due to the large waste/employees variability.
- Identify and exploit only data from establishments that deliver all their waste to the recycling companies, to avoid material fractional biases.
- Be aware of NACE groups that may contain establishments that handle waste on behalf of other establishments, and thus are liable to cause double counting or to include waste from other industrial sectors. NACE 51.57 and 90 should always be excluded. In the service industry sector NACE 60 and 70 may in particular contain such establishments.
- Be aware of organisational arrangements between enterprises and their establishments, which may cause large waste/employees ratios, i.e. some enterprises collect and deliver waste on behalf of their establishments.
- Make use of employees, economic turnover or other size dependent auxiliary statistics to inflate the samples, as establishments that deliver their waste to recycling companies tend to be larger than the average.
- Always cross check the results with other statistics where possible, and consult the operators of the recycling company to gain insight in discrepancies and other special features.

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