National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

The environmental impact of EUR 85 billion in annual procurement by all Dutch governments

A study that helps to prioritise in sustainable public procurement (SPP)

RIVM report 2021-0220

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METABOLIC

PURFACTS
MEET ALLES OVER UW INKOOP

Colophon

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Synopsis

The Dutch government's €85 billion spend and its environmental impact
Support for choosing focus for Sustainable Public Procurement (SPP)

In the transition to a circular economy, the Dutch government is committed to reducing its environmental burden. To this end, it is necessary to know which of the products and services purchased by the Dutch government have a large impact on the environment. The RIVM therefore investigated the total expenditure of Dutch government organisations for 2019, the products and services it was spent on and their environmental impact. This information can help the government make informed choices and thus reduce its environmental impact.

In 2019, the Dutch government procured products and services to the tune of €85 billion, 12% of the total amount spent on products and services in the Netherlands. The related impact on climate change is also around 12% of the overall carbon footprint for consumption expenditure in the Netherlands: approximately 22 megatonnes.

The use of products and services in the Netherlands has an environmental impact, as do their production, transport and processing to waste worldwide. Environmental impact is expressed in three themes: the land use required to produce, use and dispose products, the use of mineral resources and the impact on climate change. About 13% of mineral resource use and 5% of the land use due to consumption in the Netherlands can be attributed to the Dutch government's procurement activities.

The environmental effects vary greatly according to product group. The construction and maintenance of buildings and roads is an important product group for all three themes. The product groups energy and transport have considerable impact on climate change, catering is responsible for the use of a great deal of land and the construction of machinery and electronics requires large quantities of minerals.

RIVM, in cooperation with the consultancies Metabolic and Purfacts, looked into the procurement of the central government, provinces, municipalities, water boards, schools, academic hospitals and special sector companies. All purchases made by these public sector agencies have been categorised in 12 product groups, such as construction, transport & mobility, catering and energy.

Keywords: procurement, spend, SPP, environmental impact, circular, climate, biodiversity

Publiekssamenvatting

De milieu-impact van de jaarlijkse 85 miljard euro aan inkoop door alle Nederlandse overheden
Een studie die helpt bij prioriteren voor maatschappelijke verantwoord inkopen (MVI)

In de overgang naar een circulaire economie wil de Nederlandse overheid ook zelf het milieu minder belasten. Daarvoor is het nodig om inzicht te hebben in welke producten en diensten die de overheid inkoopt veel impact op het milieu hebben. Het RIVM heeft daarom uitgezocht hoeveel overheidsorganisaties in totaal uitgeven, aan welke producten en diensten en wat de milieu-impact daarvan is. Dit is gedaan voor 2019. Met de informatie kan de overheid gericht keuzes maken om de milieu-impact te verkleinen.

De Nederlandse overheid heeft in 2019 voor 85 miljard euro producten en diensten ingekocht. Dit is 12 procent van de totale inkoop van producten en diensten in Nederland. De klimaatimpact hiervan is zo'n 12 procent van de totale impact van Nederlandse consumptieve bestedingen: zo'n 22 mega ton CO_2-equivalenten. Naast de klimaatimpact is naar twee andere thema's gekeken: het landgebruik dat nodig is om producten te maken en het gebruik van grondstoffen. De inkoop van de overheid omvat zo'n 13 procent van het minerale grondstoffenverbruik en 5 procent van het landgebruik van alle inkoop in Nederland.

Het onderzoek laat zien dat de overheid via haar inkoop ook zelf veel kan bijdragen om de energietransitie en circulaire economie te realiseren, én het verlies aan biodiversiteit terug te dringen.

Bij dit onderzoek is gekeken naar milieu-impacts in de hele keten die nodig is om het product of de dienst te leveren: de productie, het transport en de verwerking van afval.

De milieu-impacts verschillen sterk per productgroep. Met de aanleg en het onderhoud van gebouwen en wegen blijkt de bouw veel effect te hebben op alle drie de thema's. De productgroepen energie en transport hebben veel effect op het klimaat. Wat betreft landgebruik draagt catering veel bij. Op het grondstoffenverbruik hebben onder andere machinerie en elektronica veel effect.

Het RIVM heeft dit overzicht in samenwerking met de adviesbureaus Metabolic en Purfacts gemaakt. Zij hebben gekeken naar de inkoop van de rijksoverheid, provincies, gemeenten, waterschappen, scholen, academische ziekenhuizen en speciale-sectorbedrijven. Ontwikkelen van de methode stond centraal.

Kernwoorden: inkopen, spend, MVI, milieu-impact, circulair, klimaat

Contents

Summary

Through Sustainable Public Procurement (SPP), the Dutch government aims to use its purchasing power to work towards a climate neutral, circular and socially inclusive economy. This study provides insight into the total public procurement spend (2019) and shows its environmental impact. This involves an analysis of the total public procurement by the central government, provinces, municipalities, water boards, schools, academic hospitals and special sector companies. The results of this study can help the authorities make targeted choices to reduce their environmental impact through Sustainable Public Procurement (SPP).

In 2019, total public procurement amounted to approximately €85 billion.
Figure 1 shows that the largest part of this was accounted for by municipalities (€33 billion), followed by public services (€15 billion). Major product groups are construction and infrastructure (€25 billion), followed by commercial services such as accounting or dredging (€23 billion) and transport and mobility (€8 billion).

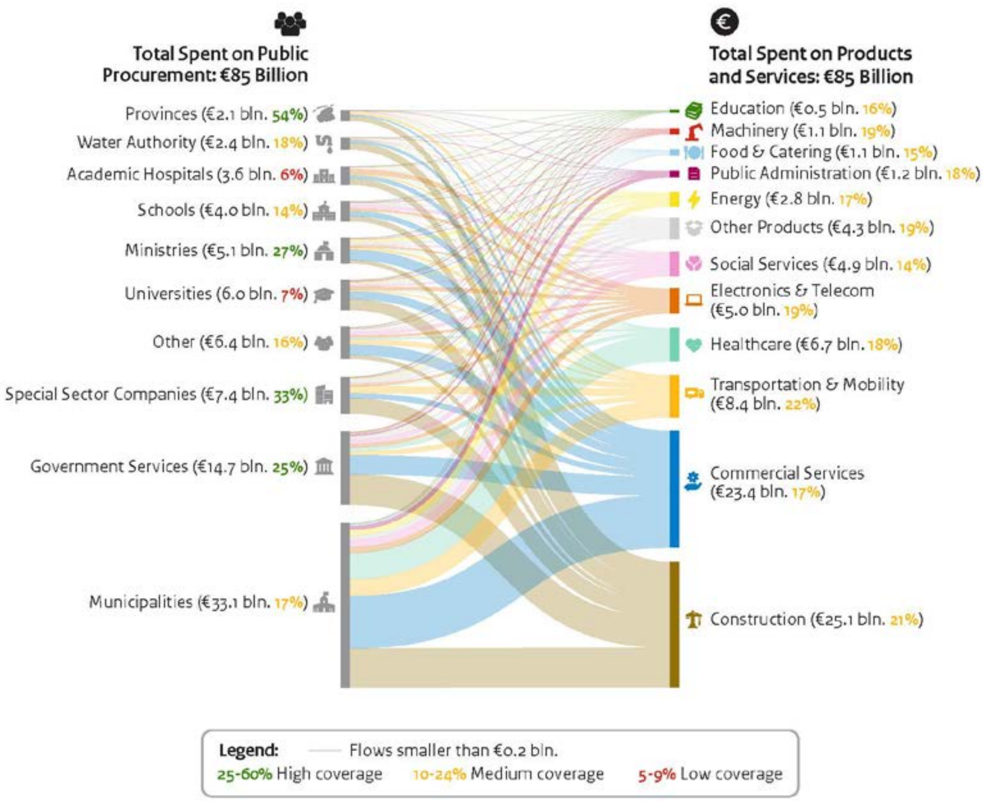

Figure 1 Sankey diagram of purchasing amounts per type of government organisation and per product group.

The environmental impact of public procurement has been analysed for its contribution to climate change, resource consumption and land use.
This shows that the product group *construction and infrastructure* makes a major contribution to all these environmental effects. In addition, the *energy* and *transportation* product groups account for a large contribution towards the climate footprint. The *catering* product group makes an important contribution in terms of land use. In terms of resource consumption, *products* and *electronics* are high-impact product groups as well. Other themes, such as social inclusiveness and toxicity, are not included in this analysis.

This analysis examines the entire lifespan of products.
This therefore not only concerns the impact of the use of products and services in the Netherlands, but also the impact of production, transport, use and processing into waste at the end of the life cycle. These emissions, land use and mineral resource consumption therefore take place all over the world, in the places where activities take place for the purpose of procurement by the government in the Netherlands. The results of this analysis are summarised in Figure 2.

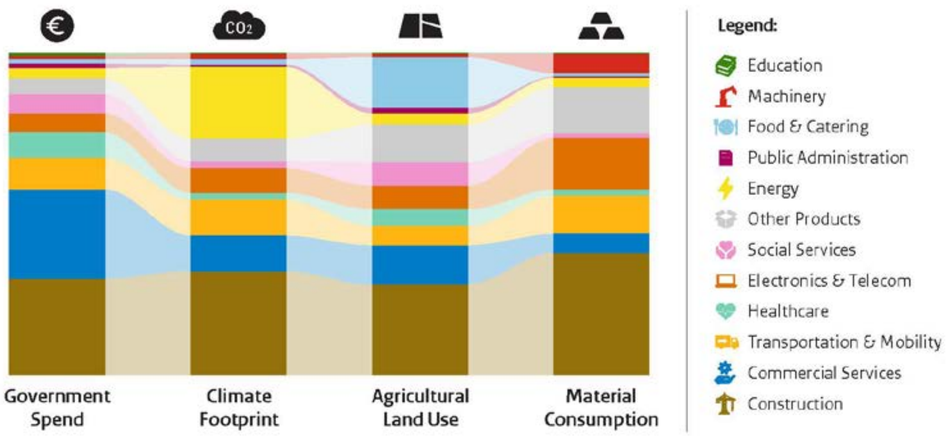

Figure 2 Overview of the shares of expenditure, climate footprint, land use and resource consumption as a percentage of the total impact, broken down by product group.

Several conclusions can be drawn from the analysis of the purchasing data,
among which:

- At €85 billion, public procurement accounts for 12% of the total purchase sum of products and services in the Netherlands.
- The climate impact of public procurement amounts to about 12% of the total climate footprint for consumption expenditure in the Netherlands: 22 megatons (± 3.4 megatons). In addition, public procurement accounts for about 13% of resource consumption and 5% of land use. The impact throughout the entire life cycle has been taken into account. It therefore concerns all raw materials that are needed over the entire lifespan of the products, from extraction, processing, transport and use to

disposal. The same applies to land use. Although services make up a large share of public procurement, the government share in the climate footprint for consumption expenditure and resource consumption (12% and 13% respectively), compared to the share in expenditure (12%), still is substantial. This is largely due to the public responsibility for many buildings and for much of the infrastructure.

- The type of environmental effects of the various product groups differs greatly. Whereas construction has a major impact on mineral resource consumption, catering has a relatively greater impact on land use and energy has a relatively strong impact on CO_2 emissions. This shows that the importance of SPP themes differs per product group and that these should therefore be prioritised product-group specifically in procurement and contract management.
- The type of environmental effect per Euro spent also differs greatly per product group. The climate impact per Euro is greatest for the energy product group (around 1.74 kg CO_2 eq/€), followed by product groups such as catering, machinery and electronics (~0.3 kg CO_2 eq/€). Product groups with a focus on services, such as education and commercial services, have the smallest footprint per Euro (~0.1 kg CO_2 eq/€).

Different research methods and data sources have been combined to determine the purchasing volume.
First of all, a method of Significant has been built on for estimating the total expenditure on public procurement, making use of data from Statistics Netherlands and annual reports of various government organisations. Based on a European database with information about public tenders (TED data) and a widely used coding in tenders (CPV coding), a subdivision into product groups was made, which was then extrapolated to the total purchasing volume per type of government organisation.

To gain insight into the environmental impact of procurement, two common methods have been combined: input-output analysis (IOA) and life cycle analysis (LCA). The IOA approach provides a complete picture of the impact based on market averages per product group, based on the Exiobase database. However, because this method does not sufficiently distinguish between sustainable and non-sustainable products or services, product-specific life cycle analyses (LCAs) were subsequently used for two product groups (energy carriers and construction) to provide insight into the action perspectives aimed at achieving a reduced environmental impact.

A sensitivity analysis was performed to map out uncertainties caused by choices that were necessary due to a lack of data.
This includes both the coverage of the purchasing data and the link between the CPV codes and the energy carriers product group. Since the coverage varies per product group and per type of government organisation, the range of the results differs as well, from ±8% for the construction product group to ±22% for the energy carriers product group.

There are several ways to extend and deepen this analysis:

- adding other themes such as social return, toxicity or nitrogen emissions. Other important SPP themes such as social inclusiveness could also be explored, but are expected to be difficult to add, since the methods and data to clarify their impact are not yet sufficiently available;
- specific analysis per type of government organisation or type of action perspective for the various product groups. For municipalities, for example, to gain more detailed insights into product groups that are important to them, such as the contribution to the environmental impact of infrastructure, waste processing and public transport. With the detailed description of the method, we invite parties to conduct follow-up research into their specific situation;
- deriving impact per euro for known product group classifications, such as the PIANOo purchasing packages and the applied subdivision of the product groups by www.mvicriteria.nl;
- developing a dashboard that can be used to zoom in on the results of this study based on interest in the type of government organisation and product groups. This can be framed in existing initiatives such as the SPP Self Evaluation Tool (SPP SET) or the development of the Raw Materials Information System (RMIS).
- performing an analysis for the entire purchase sum of all government organisations in Europe (€2 trillion per year). This not only provides EU-wide insight for choosing focus, but also differences between countries, which can help when making agreements on collaboration.

The main results have been made available in the form of a visualisation.
This can help raise awareness of the importance of SPP and choosing the focus in the strategy on how to get started with SPP.

This report is aimed at making available the methods and data used.
The steps taken and data used are described in this report in detail, targeting researchers and consultants who calculate the effects of the energy transition and circular economy, with a focus on procurement. The report also contains all detailed results and a reflection on how the method can be improved, such as a proposal for a dashboard based on the results and the more professional use of CPV codes and the administration of tenders.

1 Introduction

1.1 Occasion

Through Sustainable Public Procurement (SPP), the Dutch government wants to use its purchasing power to make a positive impact. By looking beyond the cost side of a tender and considering environmental and social impact as well, the government can contribute to the ambitions and policy targets for a climate neutral, circular and fair economy. However, properly organising SPP within organisations takes time and resources and it is therefore important that these are used as effectively as possible. To achieve this, we need to know what the effects are of the procurement processes and tenders on those SPP themes. Which product groups have the greatest impact on climate? Where are most materials used? Insight into this will help prioritise where SPP can best be deployed and focused on. This with the aim of contributing to achieving and, where possible, tightening up the SPP policy targets as effectively as possible.

1.2 Purpose of this study

The Ministry of Infrastructure and Water Management has asked RIVM, Metabolic and Purfacts to develop a method to map out the impact per Euro of government tenders in the Netherlands. Secondary objectives were to gain insight into the total expenditure of the Dutch governments (i.e. both the central government and the local authorities), the product groups on which the funds are spent and the overall impact of this in the field of climate impact, material consumption and land use. Other environmental and social themes may be added at a later stage.

The approach applied is a combination of three methods. First, a spend analysis to gain insight into the expenditure of Dutch government organisations on products, services and works. A spend analysis is providing insight into and categorising those expenditures on products, services and works. Two methods were then applied to gain insight into the environmental impact of these expenditures in the entire chain or life cycle of the purchased products and services. This involved that a top-down and a bottom-up approach has been opted for. Both methods have been assessed on their advantages and disadvantages. The top-down approach, based on an input-output analysis (IOA, more information on this in chapter 3) has the advantage that it provides a complete picture of the impact, but the disadvantage that it is usually not specific enough to distinguish between, for example, a more or a less sustainable product or service, for example, furniture that will last 10 or 20 years. The bottom-up approach, based on a life cycle analysis (LCA, more information about this in chapter 4), has the advantage that it contains enough detail to provide insight into action perspectives, but the disadvantage that it takes a lot of time to collect the data and that the results often produce an incomplete picture of the impact. Ultimately, the two methods (IOA and LCA) were not applied as a non-hybrid approach, but separately. The results of the LCA have been used to validate and verify the results of the IOA.

The results of this research provide insight into the financial scope and environmental effects (climate, resource consumption and land use) of the tenders of the Dutch government organisations. These have also been incorporated in a visualisation (link to the visualisation). In addition, the results of this study provide insight into the possibilities and limitations of the three applied methods, where further research is needed and what the quality is of the available data for both the spend analysis and the associated analyses on greenhouse gas emissions, land use and resource consumption.

1.3 Scope

This study is about procurement throughout the Dutch government. The same demarcation has been chosen as in a previous study by Significant on the total expenditure of the Dutch government (Significant, 2016). This concerns: the central government, provinces, municipalities, water boards, schools, universities, academic hospitals and special sector companies (such as for public transport).

SPP in the Netherlands deals with various environmental and social themes. Three themes were chosen for this study: climate, raw materials and land use. The chosen themes relate to the climate agreement (climate change), the national circular ambitions (resource scarcity) and the sharp decline in biodiversity (land use). These three themes together correlate with most other environmental themes (e.g. more impact from land use usually also means more impact from eutrophication). Other themes are relevant too. The choice is limited to these three themes due to a combination of four process-related reasons: budget, data availability, maturity of the method for effect monitoring and relevance. Each extra theme requires extra time to check the data (which is not sufficiently available for each category in the databases used) and to interpret and communicate the results.

1.4 Target audience

This research is primarily a methodological study in which we applied three different methods to determine the expenditure and impact of the procurement activities of the Dutch governments. The steps taken and data used are described in this report, targeting researchers and consultants who calculate the effects of the energy transition and circular economy, with a focus on procurement.

Secondly, the results of this research are relevant for various government organisations. In particular for smaller tiers of government with fewer resources to conduct extensive studies of their expenditure and the associated impact. The results, presented in the visualisation, provide insight into the magnitude of the different impact events associated with the different product groups, on which the authorities spend their money. This can help directly in strategy formation, determining prioritisation in upcoming tenders or evaluating the procurement processes of recent years.

1.5 Reader's guide

In chapter 2, we first provide insight into the spend analysis: the method to gain insight into the expenditure of the Dutch government

and the subdivision into product groups and the results found. Next, in chapters 3 and 4, we describe the methods that provide insight into the environmental impact of procurement by the Dutch government.
Chapter 3 describes the basic method: input-output analysis and the sensitivity analysis that has been performed. In chapter 4, we discuss the way in which we performed detailed analyses based on life cycle analyses for two product groups: construction materials and energy carriers.
We end this study with discussion, conclusions and recommendations about the three components of the method, use of the results found and process improvements to improve the quality of the data for the future.
A list of commonly used abbreviations and terms can be found after chapter 5.

2 Spend Analysis – Expenditure by procurement

2.1 Introduction

The term 'spend' refers to the expenditure of organisations in the field of purchasing products, services and works. This is not about paying wages and paying subsidies and interest on loans, so spend is not the same as the total expenditure of an organisation. A spend analysis is providing insight into and categorising those expenditures on products, services and works. A spend analysis is usually performed to test and improve the purchasing policy of an organisation. There are three basic objectives to which a spend analysis can contribute: professionalising, realising savings and monitoring changes (inkoperscafe.nl, 2021). In this study, a spend analysis was applied in combination with an environmental impact analysis to answer the following question: 'What are the largest expenditures and environmental impact events in public procurement?'. In this chapter, we examine the expenditure of the Dutch governments, broken down per type of government organisation. The results of the impact analysis can serve as a basis for the impact analysis.

In 2016, Significant, the consultancy firm, investigated the spend of the Dutch governments in 2015 (Significant, 2016). The reason for this study was to contribute to the Improved Tendering process, which aimed to improve the application of the tendering rules. To demonstrate the importance of tendering and its urgency, Significant's client, the Ministry of Economic Affairs, wanted insight into the total purchasing volume of the Dutch government. An update of this study by Significant is expected to be available in 2021.

Although Significant's approach is useful for creating an overview of the spend, the categorisation of purchasing expenditure has not been carried out in such a way that it forms a strong basis for creating insight into the expenditure per product group and calculating the environmental impact. The approach by Significant can therefore be used to update the total spend per type of purchasing organisation to a more recent year, but an additional method is needed to perform an impact analysis based on insight into expenditure.

The purpose of this chapter is to answer the following question: What is the (estimated) total expenditure per type of Dutch government organisation on the various product groups in 2019? And how can the analysis be carried out in such a way that the results form a basis for an environmental impact analysis? To answer this question, the following analysis steps were completed:

1. Estimating the purchasing volume of the entire government and per type of purchasing organisation (section 2.2.1).
2. Opting for a product classification into different product groups in order to be able to establish a suitable link between product groups and environmental data (section 2.2.2).
3. Exploration of purchasing data based on a choice for the product classification (section 2.2.3).

4. Developing an estimation method for supplementing missing data (imputation) for total expenditure on product group per type of government organisation (section 2.2.4).

The corresponding results are presented in each step and, in conclusion, we discuss the approach and results of the total spend analysis.

2.2 Method

2.2.1 Estimate of public purchasing volume

In this section, we discuss the method for determining the total spend of the Dutch governments and the data sources used for this in more detail. We also present the results for the past few years, so as to reveal any trends.

Approach by Significant

Significant, commissioned by the Ministry of Economic Affairs, made an estimate in 2016 of the purchasing volume of the total Dutch government (Significant, 2016). They calculated a total amount of €73.3 billion for 2015. To create this overview, Significant split the purchasing volume into five parts:

Figure 2.1 Estimated purchasing volume according to Significant (2016).

- **Operating expenses**: this is the intermediate consumption, i.e. goods that are consumed in the (production) processes at the authorities. Examples include raw materials, semi-finished products, communication services, cleaning services and services by external accountants.
- **Investments**: these are the investments that the authorities have made in, for example, homes, commercial buildings, civil and hydraulic engineering works, means of transport, computers, telecommunications equipment, machines and systems.
- **Social provisions in kind**: this concerns purchases by, among others, the Social Support Act and the Youth Act.
- **Special sector companies**: these are purchases by, for example, the drinking water companies, energy companies and transport services such as Schiphol Airport and the Dutch Railways/ProRail.
- **Academic hospitals**: these are the purchases by the academic hospitals.

Significant's methods and sources are well documented in a report (Significant, 2016). For this study, these steps have been repeated for the year 2019, but also for the years 2015 to 2018, as much as possible. The following sources were used for this:

- Operating expenses: Data by Statistics Netherlands on government expenditure; transactions and public sectors (Statistics Netherlands, 2021).
- Investments: Data by Statistics Netherlands on government expenditure on investments in fixed assets (Statistics Netherlands, 2020a; Statistics Netherlands, 2020b).
- Social provisions in kind: Data by Statistics Netherlands on government expenditure on youth care, the Social Support Act (WMO) and school transport (Statistics Netherlands, 2020c).
- Special sector companies: estimate based on tender data in the Tender Electronic Daily (TED) database (Significant, 2016; EU Open Data Portal, 2018).
- Academic hospitals: annual reports of the hospitals affiliated to the Dutch Federation of University Medical Centres (NFU).[1]

Compared to the study by Significant, this study includes two additional cost items from the academic hospitals, namely:

- the general costs, which include administrative costs, communication costs and management costs and matters such as insurance and audiovisual equipment and supplies;
- investments in buildings, machines, systems and equipment.

On the basis of this data, the spend per year and its breakdown in components were then calculated for the years 2015 to 2019 (see Table 2.1).

Results for the entire government
According to this study, the estimated purchasing volume of the Dutch government rose from €77.6 billion in 2015 to €84.8 billion in 2019. This increase is attributable to an increase in both operating expenses and government investments, see Table 2.1.

[1] These can also be found as DigiMV files at www.jaarverantwoordingzorg.nl

Table 2.1 Breakdown of total purchasing volume of the Dutch government over the period 2015 to 2019 (billions of euros).

Euro x million.	2015	2016	2017	2018	2019	Source
Total purchasing volume Dutch government	77,608	82,534	79,064	82,138	84,825	
Operating expenses	41,065	41,235	41,983	44,953	46,434	
+ Intermediate consumption	43,482	42,765	43,339	46,105	47,716	Statistics Netherlands
- Correction of attributed banking services	1,517	1,530	1,356	1,152	1,282	Statistics Netherlands
+ D41 Interest	8,980	8,151	7,396	6,933	6,220	Statistics Netherlands
- Actual interest	10,497	9,681	8,752	8,085	7,502	Statistics Netherlands
- Correction healthcare system	900	-	-	-	-	Unknown
Investments	20,207	19,990	20,704	21,324	22,031	
+ Gross investments in fixed assets	24,580	24,696	25,412	26,459	27,291	Statistics Netherlands
+ Correction for sale of used fixed assets	1,249	968	1,180	1,080	78	Statistics Netherlands
- Correction investments own management	5,622	5,674	5,888	6,215	6,238	Statistics Netherlands
Social provisions in kind	8,121	8,270	8,616	9,375	9,874	Statistics Netherlands
Youth care	2,663	2,738	2,936	3,283	3,475	Statistics Netherlands
School transport	193	194	199	212	257	Statistics Netherlands
Social Support Act	5,265	5,338	5,481	5,880	6,142	Statistics Netherlands
Special sector companies	4,521	9,188	4,257	2,856	2,493	TED estimate
Academic hospitals	2,203	2,339	2,420	2,559	2,789	DigiMV files
General costs academic hospital	503	538	516	546	566	Additional cost item
Academic hospital investments	988	974	569	525	638	Additional cost item

Results per type of government organisation
Table 2.2 shows how expenditure is divided over the various types of government organisations.

Table 2.2 Overview of purchasing volume in 2015 and 2019 per type of government organisation in billions of euros and percentage of the total amount.

Total purchase sum per type of government organisation	2015 billion euros	2015 %	2019 billion euros	2019 %
1. National government Total	22.3	30%	25.8	30%
1a. Central government	12.9	18%	14.9	18%
1b. Other national government	9.5	13%	10.9	13%
2. Local government Total	41.5	57%	47.0	55%
2a. Provinces	2.2	3%	2.1	2%
2b. Municipalities	25.0	34%	28.8	34%
2c. Joint arrangements	2.3	3%	3.1	4%
2d. Water boards	2.4	3%	2.4	3%
2e. Other local government	9.6	13%	10.6	12%
3. Social security funds	0.8	1%	1.0	1%
3a. Social security funds	0.8	1%	1.0	1%
4. Supplements Total	8.6	12%	11.0	13%
4a. Academic hospitals	2.3	3%	3.6	4%
4b. Special sector companies	6.4	9%	7.4	9%
Grand total	**73.3**	**100%**	**84.8**	**100%**

Most types of government organisations show an increase in expenditure compared to 2015. This can largely be attributed to inflation. The ratio between expenditure by the various types of government organisations is virtually the same for 2015 and 2019. Notable are the water boards and provinces where purchasing has remained the same or has even fallen slightly. The reason for this has not been investigated, but may have to do with the timing of major projects such as Room for the River. Relatively speaking, the largest increase in expenditure can be seen at academic hospitals. This is largely due to the inclusion of two additional cost items amounting to €1.2 billion.

Comparison of current results with Significant
The results for 2015 of both studies were compared to check whether these new calculations are consistent with the calculations of Significant (Significant, 2016).

The estimate of the amount for 2015 in this study is €4.3 billion (= 5.9%) higher than in the original Significant study. This is because Significant worked with provisional figures at the time, which were adjusted later on, and because we included two additional cost items from academic hospitals in this study.
Significant also repeated the study from 2016 on behalf of the Ministry of Economic Affairs. At the time of publication of this study, the results

were not yet final and public. We know from communications with Significant that there will be minor differences between our estimates and those by Significant. This is because Significant further investigated a number of cost items and made minor adjustments based on that. These differences are not expected to have any meaningful consequences for the practice-oriented interpretation of the results of our study into the impact of procurement by the Dutch governments (see sections 2.3, 2.4 and chapter 3).

2.2.2 Choice of product classification

Determining the impact of purchasing requires a proper product classification. In practice, many different classifications are used. The requirements and wishes we set for a proper classification in this study were:

- Scope: the classification covers all types of product groups that are purchased by the government, so that it has sufficient scope to reach users from the target groups.
- Practical: the classification must be practical for this study and thus widely applied in available tender databases and other spend analysis sources.
- Detail: the classification must be sufficiently detailed, so that suppliers or products within a group are sufficiently homogeneous or comparable to be able to make a connection with data available to analyse the impact.

The five most common product classifications have been explored on the basis of the requirements and wishes. A detailed description for each of those product classifications, with their advantages and disadvantages, is discussed in Appendix A. The results are summarised in Table 2.3.

Table 2.3 Overview of different product classifications for purchasing.

Classification	Scope	Practical	Detail
Government procurement categories	-	-	-
SPP criteria tool	+	-	-
Central government purchasing data	+	+	-
PIANOo purchasing packages	++	+	+
CPV codes	++	++	++

In this study, it was decided to work with CPV coding, because it allows to make a solid, sufficiently detailed initial estimate that fits within the available time and budget of the project. A classification based on the Common Procurement Value (CPV) is the standard within the EU for (public) tenders above a certain threshold value. Since all tenders are publicly published on the basis of CPV codes, this classification potentially offers also clear insights for strategic and tactical purchasing decisions. How any aggregation to higher product classifications can be done as smartly as possible can be examined at a later stage. Section 5.4.4 discusses the translation to other commonly used classifications, such as the PIANOo purchasing packages.

2.2.3 *Available purchasing data*

An exploration of what was purchased by the governments in 2019 was subsequently conducted on the basis of the Tenders Electronic Daily (TED). The TED is a supplement to the Official Journal of the EU. It contains information on all public procurement in the EU, the European Economic Area and sometimes beyond, which must be announced under the relevant EU rules. You can browse or search in it and sort the tenders by country, region, business sector, etc.[2]

For the period 2015 to 2019, usable amounts are available in TED for 42% of the Dutch awards. As regards the other 58% of the awards, nothing is entered or a fictitious amount, such as €123456 or €999999. The graph in Figure 2.2 shows that the number of data points for which the amounts are known increased in percentage until 2017 (63%), but then started to decrease again.

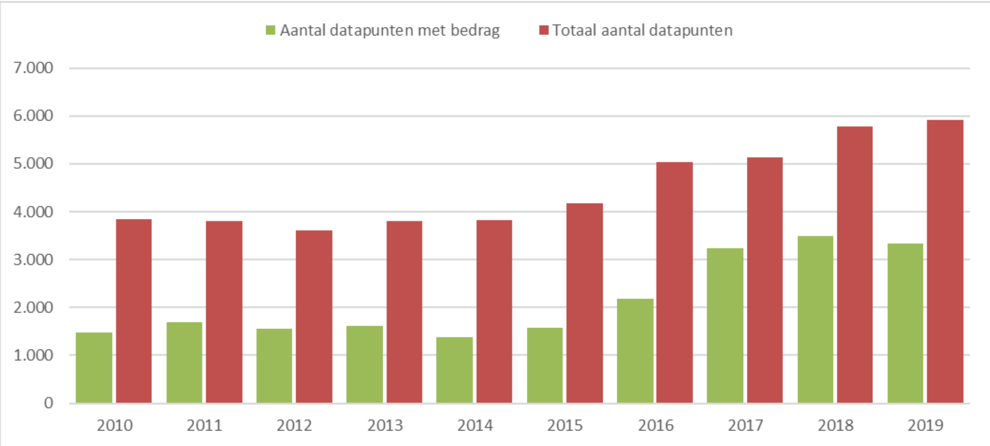

Figure 2.2 Development in the number of Dutch awards with amount versus the total number of data points for the period 2010 to 2019.

2.2.4 *Estimation method for filling in missing data*

Based on the available amounts, an estimate has been made of the total amounts per type of organisation and per product group. To make this estimate more robust, a longer period of data was used, namely amounts available for the period 2010 to 2019 with a total of 40,980 awards.

In order to do this, there were three challenges, which are further described below:

1. What is the basis for determining an 'average' tender?
2. How do we aggregate the large number of different designations for contracting authorities?
3. How do we aggregate the large number of CPV codes applied differently?

Basis for the average tender

When referring to an average tender, it is obvious to also look at the average amounts involved. However, as with income distributions, or

[2] Registered users can also download data in the form of XML packages on the 'XML bulk downloads' page (http://ted.europa.eu/TED/misc/xmlPackagesDownload.do).

purchasing volumes per supplier, you tend to see a Pareto ‘80-20’ ratio rather than a normal distribution of the amounts. For example, a unique and expensive project can, all by itself, significantly raise the average. We can also see these ‘outliers’ in the tenders and can therefore leave too big a mark on an average or expected award amount with another contracting authority. To ignore outliers, the median or middle value of the observations is usually used. Most tenders will be fairly close to this ‘safe’ middle in terms of number, but since 80% of the value is in the top 20%, the median may be an underestimate. To take into account outliers, the average was taken from the median and the average. Experiments have also been carried out with other methods. More about this in the discussion (see section 2.4.1).

Designation type of contracting authority
The next challenge was to work with the enormous number of contracting authorities, which had to be grouped according to the different types of government organisations. The data contained a total of 7,147 different ‘Contracting authorities or entities’ (Cae names). These were somewhat categorised, for example: ‘Ministry or any other national or federal authority, including their regional of local subdivisions’; ‘Regional or local authority’ or ‘Water, energy, transport and telecommunications sectors’. However, this categorisation did not distinguish sufficiently between, for example, municipalities, joint arrangements, provinces or water boards. There are approximately 2,000 contracting authorities in the Netherlands (TenderNed, 2017).

The reason that there are three and a half times as many in the TED database is that the same contracting authorities (CAs) are listed under different names, because CAs sometimes purchase jointly under a partnership *and* because procurement is sometimes carried out by a consultancy firm. Based on keywords and manually going through and classifying the Caes against the largest turnover, more than 5,000 Cae names could be linked to a classification for the type of government organisation that is easily recognisable in the Netherlands. These more than 5,000 Cae names accounted for 93% of the number of data points. The remaining 2,117 are described as not classified (see Table 2.3). For example, Table 2.4 lists 52 different Cae names at academic hospitals, while in reality there are only eight. When delving deeper into the data, it is noted that the Academic Medical Centre (AMC) alone appeared more than fourteen times, separately or together with others such as VUmc, Erasmus, LUMC or UMCG. Municipalities too often tender jointly or this is carried out by a consultancy firm or partnership.

Table 2.4 The number of data points or awards per type of organisation.

Type of organisation	Number of Cae names	Number of data points
Academic hospitals	52	922
National government other	124	1,572
Municipalities	1,982	17,704
JA Joint arrangements	254	1,978
Local government other	412	2,173
Ministries	382	4,090
Not classified	2,117	3,288
Provinces	109	2,108
Public services	176	2,868
Schools	994	3,861
Social security funds	13	104
Special sector companies	308	2,842
Universities	100	1,592
Water boards	124	2,372
Grand total	**7,147**	**47,474**

Large number of different CPV codes
Another challenge was the large number of different CPV codes used in the tenders. Out of the 9,554 codes, 2,925 (30%) occurred once or multiple times. At first glance, this seems a positive observation, because the more accurately one chooses the product, the more accurately the impact can be determined. At the same time, this means that less data was available per CPV code for estimating missing numbers on the spend.

Table 2.5 Number of unique or different CPV codes per type of organisation.

Type of organisation	Unique CPV codes	Data points	Average per CPV
Academic hospitals	336	857	2.6
National government other	428	1,466	3.4
Municipalities	1291	16,804	13.0
JA Joint arrangements	506	1,791	3.5
Local government other	614	2,031	3.3
Ministries	987	3,909	4.0
Not classified	786	3,215	4.1
Provinces	507	2,027	4.0
Public services	787	2,678	3.4
Schools	444	3,620	8.2
Social security funds	68	95	1.4
Special sector companies	754	2,644	3.5
Universities	438	1,541	3.5
Water boards	454	2,265	5.0
Grand total	**8400**	**44,943**	**5.4**

Table 2.5 shows that there were a total of 8,400 combinations of the type of government organisation with a unique CPV code. In the middle and far-right column of the table, you will find the total and average number of available data points per type of organisation, respectively. On average, municipalities have the most data points per CPV code (13). There are only few in the case of social security funds (average of 1.4 data points per CPV code). More than half (52%) of the data points have no known amount and therefore the number of usable data points per type/CPV combination is much lower still. To be able to make a reliable estimate of a missing award amount, a minimum of ten known amounts has been used. A large part of the 8,400 combinations could therefore not meet this requirement. To deal with this, the so-called CPV hierarchy was examined.

CPV coding has a strong hierarchical structure (Levels). The 45 Divisions (L0) are subdivided into 272 Groups (L1), which in turn consist of 1,004 Classes (L2), 2,401 Categories (L3), etc. The moment a combination contains too few data points, you can take the total number of data points at a higher level until you have at least ten points with an amount. If even at the highest level fewer than ten data points were available, we calculated the average tender amount for a type of organisation. The latter occurred in 5.4% of the estimates.
As an example, an elaboration of the Division '09 Petroleum Products' under Local government other is set out below. Table 2.6 shows that with the first CPV code (09000000), there were only seven awards with a known amount, fewer than ten and therefore insufficient according to the model used to make a sufficiently reliable estimate. Since this is already the highest level (L0), there is no deviation to a higher level, but only to the entire 09 Division or all 35 values with an amount within this group. The average of this amounted to € 3,591,723 and the median € 1,181,268.

Table 2.6 CPV 09000000 under Local government other.

CPV	Sector	Source estimate	id	Known sum
09000000	Local government other	Known sum	8231248	€ 3,100,000
			6457617	€ 1,200,000
			8377116	€ 1,181,268
			7669842	€ 799,349
			7669849	€ 142,032
			8451835	€ 129,956
			7961380	€ 11,068
		09000000|Local government other	9105769	
			6964646	
			10891406	
			8252839	
			8872951	

In the second group, starting at 09100000, there were again insufficient known amounts (namely seven) to be able to supplement the other three, see Table 2.7. Also the three codes below that, all starting with 0912xxxx, together with only six known amounts, did not have enough data points to arrive at a total of ten. In that case, the model automatically calculates the entire 091xxxxx series, including 0913xxxx with 1 extra value. A total of 14 amounts with an average of € 2,653,501 and a median of € 823,930.

Table 2.7 CPV 091xxxxx under Local government other.

CPV	Sector	Source estimate	id	Known sum
09100000	Local government other	Known sum	3274068	€ 4,000,000
			7835780	€ 2,200,000
			8421878	€ 1,800,000
			10206045	€ 1,200,000
			8639130	€ 1,139,496
			10232141	€ 647,860
			8759255	€ 275,000
		09100000|Local government other	7021211	
			8352591	
			8141717	
09120000	Local government other	09100000|Local government other	6032643	
09122100	Local government other	Known sum	5069999	€ 144,538
09123000	Local government other	Known sum	6066305	€ 24,192,646
			5207351	€ 1,000,000
			8283003	€ 350,000
			7739251	€ 24,979
			8382344	€ 24,500
		09100000|Local government other	7079254	
			8373854	
			7376832	
			5503930	
			5442867	
			6250535	
			7172867	
			6601788	
			8239775	
			6653114	
			10175574	
			6658633	
			6737776	
09134000	Local government other	09100000|Local government other	5245734	
09134220		Known sum	6882586	€ 50,000

CPV	Sector	Source estimate	id	Known sum
	Local government other	09100000|Local government other	10419131	

In the third group, estimation was possible at the 09300000 level: seven known amounts at 0931xxxx, two at 0932xxxx and five at 0933xxxx, together make fourteen data points with an average of € 5,856,972 and a median of € 2,945,180 (see Table 2.8).
What is striking about these three examples is how much the average and median differ from each other: the average is two to three times as high as the median. On a total amount of €99.6 billion in known amounts and 52% in unknown amounts, it thus makes a difference how many times the median amount is added. Hence it was decided to use the average of the two.

Table 2.8 CPV 093xxxxx under Local government other.

CPV	Sector	Source estimate	id	Known sum
09310000	Local government other	*Known sum*	8352593	€ 20,000,000
			6066642	€ 2,790,360
			6991866	€ 2,500,000
			9017047	€ 300,000
			8422981	€ 200,000
			5724208	€ 6,900
			8382352	€ 5,075
		09300000|Local government other	7519508	
			6716702	
			8463889	
			5663500	
			7172865	
			5974288	
			8239776	
			5983654	
			5503907	
			6249972	
09323000	Local government other	*Known sum*	10441291	€ 3,100,000
			6539808	€ 2,660,000
09330000	Local government other	*Known sum*	8543557	€13,000,000
			7889358	€ 6,500,000
			9045449	€ 4,271,474
			7701970	€ 3,499,000
		09300000|Local government other	7753824	
09331000	Local government other	*Known sum*	6894482	€23,164,793
		09300000|Local government other	8799471	

Extrapolation to 2019
Based on the calculated distribution of 1) the total spend per CPV code for 2010-2019 and 2) the total spend per government organisation over the period 2010 to 2019, the estimated €84.8 billion purchase in 2019 has been divided over all combinations CPV product group - type of government organisation, in three steps.

Step 1 was to group the CPV amounts per type of organisation, in the same classification as the 2019 total. This means that a) ministries and public services together come under *1a Central government*; b) schools and unclassified come under *2nd Other local government;* and c) universities come under *1b Other national government*. A 1-to-1 link is possible with the other types.

Step 2 was to divide the total amount of the grouped CPV amounts per organisation by the 2019 procurement total. For each combination (type of government organisation and CPV code), this produced a factor with which the amounts could be converted to 2019.

Step 3 was to convert the available data for 2010-2019 to 2019 based on these factors.

2.3 Results

With the estimation method, an amount could be estimated for 1,171 combinations based on ten or more known amounts. These values were used to complete the missing amounts.

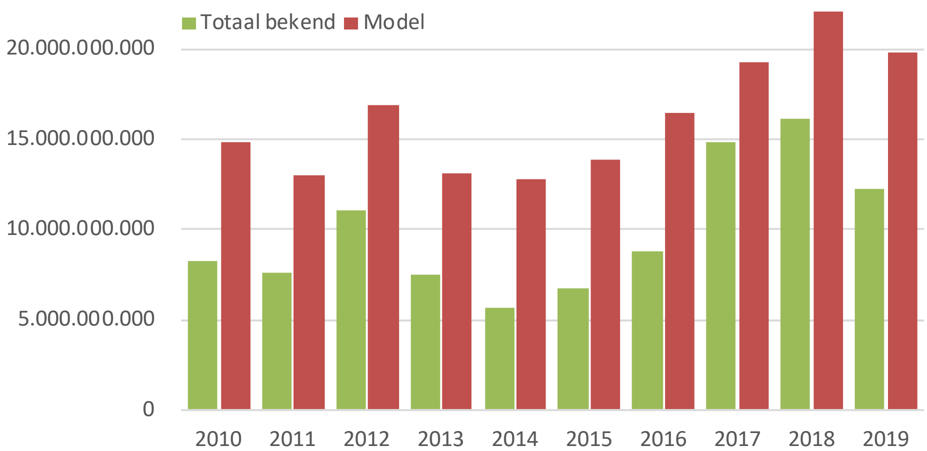

Figure 2.3 Total known purchase sum and total known and estimated purchase sum per year by the Dutch governments (euros).

Application of the model leads to the insight that Dutch procurement comprises a total amount of €162.0 billion for the entire period from 2010 to 2019, see Figure 2.3. Of this, €98.8 billion has been quantified on the basis of reported amounts and €63.2 billion on the basis of estimates. The estimate yielded an average of 64% extra data points. This percentage varies considerably from year to year, from 30% in 2017 to 126% extra data points in 2014.

2.3.1 *Total spend per CPV code in 2010 to 2019*

The total spend (known + estimated) of €162 billion is divided over all 2,925 CPV codes used. Table 2.9 shows the results of this spend per 45 CPV main codes. At the highest level (L0), the ten largest categories account for 78% of the total. The top 3, consisting of construction work (33%), business services (9%) and healthcare and social work (8%) together account for 50%. The remaining 22% is made up by the 35 other L0 categories. The full list of the 45 CPV master codes can be found in Appendix B.

Table 2.9 Top 10 CPV at L0 level, expressed in billions of euros for the period 2010 to 2019 and as a percentage contribution.

CPV L0 name	**€ x billion.**	**%**
Construction work	54.1	33%
Business services	14.3	9%
Healthcare and social work	12.5	8%
Transport equipment and corresponding products	9.1	6%
Financial and insurance services	8.9	5%
Transport services (except waste transport)	8.0	5%
Repair and maintenance services	6.4	4%
IT services	4.7	3%
Waste water, waste, cleaning and environmental services	4.7	3%
Petroleum products, fuel, electricity, etc.	4.4	3%
Other 35 CPV L0	34.8	22%
Total	**162.0**	**100%**

2.3.2 *Total spend per CPV per type of government organisation*

The end result is the estimated 2019 purchase sum per organisation type per CPV product group. Most purchases are carried out by municipalities, followed by the public services and special sector companies (Figure 2.4). In total, most is spent on construction, especially by the municipalities, public services, special sector companies and the provinces. Each product group has a specific group of purchasing organisations that purchase the most. For example, it appears that municipalities are the largest buyers of energy carriers (L0-09), schools and universities are the largest government buyers for office machines (L0-30) and special sector companies purchase the most transport equipment (L0-034). All data on spend per combination of CPV-type government organisation can be found in Appendix C.

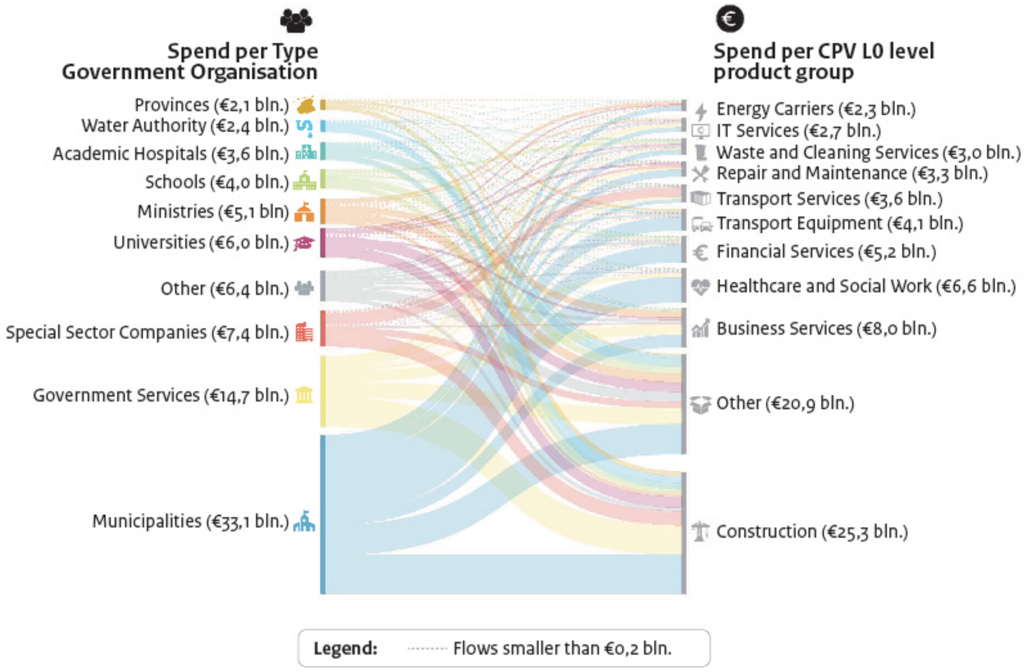

Figure 2.4 Sankey diagram showing the share the different types of government organisations (left) have in the total government spend and what this is spent on at the CPV L0 level (right).

2.4 Discussion

2.4.1 Method used

This chapter has shown that it is possible to make a meaningful estimate of total government procurement *and* of the distribution over the various products and services on which it is spent at a fairly detailed aggregation level.

Estimation method 'average' expenses

In order to have sufficient data to be able to carry out the spend analysis, part of the expenditure was estimated on the basis of available data on expenditure. The approach chosen for this tied in well with the scope of this study. It should be noted that some alternative methods were explored, but they have not been applied for various reasons. These alternatives, and the reasons for deciding against using them, are as follows:

- A first alternative was to calculate an average based on all numbers between, for example, the 10 and 90 percentile, so without the outliers. Implementation across the 44,000 data points appeared to be practically complex and the trade-off between efficiency (using all available information) and robustness (independence from outliers) was not yet clear, which is why this was not chosen.
- A second alternative was to set off the difference between the average and the median using a square root function. By using a square root function, you counterbalance exponential outliers. If the average is twice as high, you multiply the median by 2^0.5 = 1.41. If the average is 4 times as high as the median, you use 4^0.5 = 2.0 x the median as the estimated amount. However, no justification can be found for which factor would be most

suitable, e.g. 2^0.4 or 2^0.6 could also be used as well. Due to this lack of clarity, this alternative was not chosen.

Choosing a different estimation method will always influence the absolute results but based on the exploration, we do not expect the alternatives described below to have consequences for the final conclusions drawn for practical choices in the procurement process: it can be estimated that, for example, the ranking of the impact of product groups remains the same, so the priorities of the practical choices remain the same. No conclusions could be drawn as to whether the alternative estimation methods mentioned here produced better estimates than the method used. We recommend investigating this further. At the same time, the best way for better estimates is to create better source data, and thus administering actual expenditure per tender in TED more consistently.

Distribution of procurement figures
The figures for the distribution of the procurement figures are based on the tenders from 2010 to 2019. Not all types of government organisations are equally represented in the data and in all likelihood, the distribution for 2019 differs slightly from the distribution over the ten-year period. Based on the consistency found in the distribution of expenditure across the different types of government organisations, this is estimated as a realistic assumption, with little influence on the ultimate interpretation of the results.

CPV coding
A more detailed insight into the expenditure perm type of product than currently made available in this study is challenging. The higher the level of detail, the more uncertainty the method creates. The CPV system, with its 2,925 different codes, offers many possibilities for detailed analyses, but the implementation of this system is too flawed to be able to perform these analyses at a more detailed level. This has several reasons. First, the high number of possible CPV codes that can be used means that there are sometimes few applications per CPV organisation combination. As a result, extrapolation of amounts to tenders for which no amount is available is problematic for some combinations.

Second, purchasing practice appears to be more heterogeneous than CPV coding and CPV coding has meanwhile become so extensive that application by the purchaser proves difficult, so a code based on main category is often chosen. The more detail there is, the easier it is to link it to impact, because it is clearer which techniques and materials are involved. At L0 level, for example, take group 09 Petroleum products, fuels and energy. If a level is tendered more specifically (L1), a distinction can be made between fuels, lubricants and electricity. One level deeper (L2) also provides insight into the difference between electricity, hot water (district heating), solar energy and nuclear fuels. Section 4.3 explains that such a distinction has a major effect on the calculated impact. If an analysis at a more detailed level than L0 is desirable, then known amounts at a high level need to be translated to a lower level. This has been experimented with in this study and used, among other things, in the bottom-up analysis (chapter 4). This so-called redistribution from an ‘excessively high’ amount to a lower level has been carried out in three different ways (see section 4.2). If a more detailed hotspot analysis is needed for (part of) government procurement, this approach could be explored further.

However, the main conclusion is that harmonising the application of CPV codes is vital for this type of analysis. A more compact list that is more in line with sustainable options means that future analyses can be performed more accurately. In addition, there are other commonly used classifications in spend analyses, such as the PIANOo purchasing packages. It is worth exploring whether the impact figures can be translated into those classifications, so they become available in a way that fits the administration of the contracting authorities.

Tendering or not
The results show differences per type of government: how much do they spend and on which product groups. In addition, the size of the division factor indicates another important aspect, namely which part of the procurement was made through a public tender and was therefore included in the TED data. Provinces score a 5.4, which means that over the period 2010 to 2019 (ten years), 54% of purchases were awarded through a public tender and included in TED. The rest of the purchases therefore did not go through public tenders.

At the academic hospitals, the division factor is only 0.55. Therefore, 94.5% is not included in TED over those ten years. As regards hospitals, for example, you can imagine that (expensive) medicines and medical products and equipment fall outside the tendering rules because of monopolies, patents and other unique properties. A methodological consequence of this low factor is that the reliability of the estimates will be lower than, for example, in the provinces.

2.4.2 Possibilities to refine the method
One way to refine the method is using other data sources. In addition to the TED data, there are also other sources that can be used to refine the spend analysis. The most promising source for this is the so-called 'Information for third parties' (Iv3). For all water boards, municipalities, joint arrangements and provinces, 122 of these files have been collected and analysed over the 2010 to 2020 period. Each organisation is mentioned separately, but the detail is limited at product level. At the highest level, the costs are broken down into other goods and services, durable goods, social benefits in kind (including home care), third-party personnel, insurance (water boards only) and energy. Unfortunately, they stopped reporting on energy at the municipalities and joint arrangements from 2017 and 2018. This data does nevertheless provide possible points of refinement for refinement. They *were* explored, but were not implemented in the study due to time and budget limitations. Two ways in which this data could be used for refinement are set out below.

Option 1: Refinement of distinction between types of goods based on Iv3 data
Third-party personnel is a large group in all government organisations and can be reasonably easily traced back to the CPV codes in outline, as are social benefits in kind. Then there is the distinction between durable goods versus other goods and services. Durable goods include all goods

the economic life of which is at least one year. This is an accounting term and therefore not related to sustainability themes such as climate and circularity. It does not matter whether the purchase is depreciated at once or in a number of terms.

The table in Appendix D provides an overview of the Iv3 data for 2015 to 2019. By selecting the right underlying cost categories and omitting aspects like rent and taxes, the 2015 data (€32 billion) nearly exactly matches the totals of Significant's study for the year 2015 (Significant, 2016).

This data was then subdivided into durable goods and services, other goods/services, third-party personnel and social benefits in kind, and this subdivision was compared with the results based on the TED data. This approach appears to generate different sub-factors per cost type than the approach based solely on the TED data. This is because the categories are not equally represented in the TED data. Based on the Iv3 data, goods that last longer than a year appear to represent a smaller share of the spend than based on the TED data. Social benefits in kind are generally higher, up to 49% for municipalities. This insight could not be incorporated in the study, because an exact link with CPV codes was not possible. This can be investigated further for a better estimate of the spend.

Option 2: Refinement of spend per organisation based on Iv3 data
In a spend analysis, all booked invoices per supplier are subdivided into a purchasing package, usually in accordance with the PIANOo classification. To test to what extent the actual spend deviates from the estimated amounts, the purchases of a water board were compared with Iv3 data.

Table 2.10 Comparison of spend data of a water board with its Iv3 data.

Type	Category	Eur x 1000			
		2016	2017	2018	2019
Water board	L2.4 Other personnel expenses	2,274	1,904	1,908	2,645
	L2.5 Third-party personnel	11,073	10,137	9,785	10,648
	L3.1 Durable goods	1,737	1,784	2,568	2,392
	L3.10 Other third-party services	27,248	28,436	28,854	31,165
	L3.2 Other durables and consumables	3,922	4,058	4,819	5,012
	L3.3 Energy	11,738	12,178	11,191	16,365
	L3.4 Renting and rights	1,236	1,379	827	1,211
	L3.5 Operational lease	75	87	68	71
	L3.7 Insurance	639	702	803	825
	L3.9 Third-party maintenance	44,983	58,246	56,008	54,489
	L6.5 New construction	53,597	54,747	116,288	13.4100
Grand total		**158,522**	**173,658**	**233,119**	**258,923**
Purchases according to the spend analysis		**158,590**	**169,594**	**231,443**	**253,925**
Difference		**0.0%**	**-2.3%**	**-0.7%**	**-1.9%**

This comparison showed that for 2015, the total amount for the water boards based on the Iv3 data files corresponded to the amount estimated based on the Significant approach. Table 2.10 shows these amounts for the selected water board, with the totals of the spend analyses for 2016 to 2019 underneath. The difference is remarkably small, only a 1 to 2% difference between the purchases at invoice level versus the selected cost categories from Iv3.

In the spend analysis, however, the purchases are properly divided over more than 170 purchasing packages with a much higher accuracy than can be deduced from the TED tenders. Ten of these 170 packages account for two-thirds of the total spend (see Table 2.11).

Table 2.11 Top 10 PIANOo purchasing packages from a water board.

Purchasing Packages	%
8806A Construction and maintenance of flood defences: Construction	32%
8804A Construction and maintenance of the road network: Construction	5%
8811A Construction and maintenance of green areas: Layout	4%
8814A Construction and maintenance of water systems and waterways: Construction	4%
5518 Engineering services	4%
2726A Electricity (supply)	3%

Purchasing Packages	%
8805A Construction and removal of sewers	3%
8803A Test drilling and sampling	3%
8807A Construction and maintenance of water treatment plants: Construction	3%
5511 Ecological research	2%
Other	37%
Total	100%

If more organisations could provide this detailed spend data per type of government organisation, the ratios of expenditure per purchasing package can be used to make estimates for the entire population. This way, the spend analysis of the entire government can be estimated with more detail and certainty. This is not only true for the four groups for which Iv3 files are available. Comparable data is available for all hospitals and healthcare institutions (DigiMV), all educational institutions (DUO) and all ministries (Inkoopdata Rijksoverheid).

2.4.3 *Discussion of results*

With the proposed method, insight has been created for the first time into the expenditures of all Dutch governments in a way that is in line with the product group classification used in SPP. Significant (2016) already showed in 2016 that, thanks to the large amount of public data, making an estimate of the purchase sum of the entire government is possible. This has been further explored in this study by dividing the total expenditure over the various products and services on which it is spent. This insight provides a strong basis for assessing where the greatest opportunities are in terms of effective prioritisation for an optimal effect of SPP. Especially in combination with qualitative insights, such as the insight that energy and resource consumption in electricity, transport and construction work is expected to be considerably higher than in, for example, business services, social work or insurance.

3 Environmental impact - Top-down analysis

3.1 Introduction

This chapter describes how the result of the spend analysis in chapter 2 – the estimated total purchasing expenditure per type of purchasing organisation on product groups in 2019 – was used to calculate the associated environmental footprints based on an Input-Output Analysis (IOA). The Input-Output Analysis (IOA) is a macroeconomic calculation method that can be used to analyse relationships between industries. The result of this chapter will provide insights to answer the general research question of the spend impact analysis: Where is the greatest environmental impact of government procurement, where can the biggest gains be made and could the insights found contribute to the prioritisation of (policy) ambitions at government organisations in the field of circular and climate-neutral procurement? In addition, a bottom-up analysis will be presented for two product groups in the next chapter. This is more accurate, but was too labour-intensive and/or there was insufficient data to do this for all product groups in this study.

First, the IOA as a calculation method will be explained and the analysis steps discussed (section 3.2). The results are discussed in section 3.3. We then reflect on the results and the method in section 3.4.

3.2 Method

3.2.1 Introduction of Input-Output Analysis

The environmentally extended input-output analysis is a method to calculate the environmental footprint of an economy (e.g. a national footprint) or part of an economy (e.g. an economic sector). This way, it is also possible to calculate an environmental footprint of national public procurement using this method. The environmentally extended input-output analysis is a top-down (TD) analysis, which means that a macroeconomic perspective is used to outline a rough overall picture of a situation. A TD analysis is less time-consuming than working towards the overall picture based on the components (products; microanalysis).

An IOA is used to calculate how much production value is needed from different industries in a value chain to generate a particular output. In other words, it is calculated how much activity is needed within the entire chain to meet a demand (product and/or service).

IOA uses an input-output table (IOT). This is a matrix in which the intermediate transactions (between industries) and final transactions (between industries and consuming parties), i.e. all flows of goods, are consolidated. These transactions are usually expressed in monetary value (monetary IOT), but can also be based on physical values (physical IOT) or take on a hybrid form (hybrid IOT). Due to the linking of impact to spend data (i.e. monetary), only the monetary IOT will be discussed.

An IOT also contains production factors (costs of labour, nature, capital and profit) per industry. This allows the added value of an output to be calculated over the entire chain. Similarly, environmental extensions – environmental emissions and/or resource consumption/land use – can be added to the IOT. This makes it also possible to calculate the total environmental effects for a certain output, just as with calculating the required chain activity. This is referred to as an environmentally extended IOA (EE-IOA).

With EE-IOA, impact is linked to monetary transactions. This makes it possible to directly link purchasing or consumption, which is usually expressed in monetary value, to environmental impact. In addition, in an EE-IOT, the relationships between trade, environment and socio-economic factors are contained in a single consistent framework (Potting et al., 2018). This way, EE-IOA makes it possible to carry out an integral sustainability analysis at macro-economic level.

The use of an EE-IOA to calculate an environmental footprint also has weaker aspects attached. As a top-down method, (EE-)IOA is non-specific. In the context of this study, this means EE-IOA is suitable for getting a complete picture of the total environmental impact and to what extent the different product groups contribute to the total. However, the higher the level of detail of the research question, the less reliable the results of an EE-IOA will be. Moreover, the data cannot be traced back to a specific source (for example, an organisation or location), since (EE)IOA computes with aggregated data, such as the national accounts of Statistics Netherlands. This means that many aspects (products and industries) that can differ considerably from each other are grouped under the same denominator. Therefore, based on this method, often no distinction can be made between the (more environmentally-friendly) alternatives within product groups. Bottom-up (BU) studies, such as life cycle analyses, are more suitable for calculating the difference between these alternatives (see chapter 4). Finally, in an IOA, the IOT is often treated as a black box. An extensive exploration of the IOT is generally not within the scope of an IOA due to its high level of complexity. After all, an IOT is a data set in which all global trade flows are consolidated and often also treated for harmonisation (Dawkins et al., 2019). However, deviations or errors in the IOT can have an impact on the IOA results.

Since this study is about creating an overall picture of the impact of purchasing by the Dutch government, EE-IOA is the most suitable instrument to use. The amount of time and data available is insufficient to calculate the impact of procurement as a whole with a bottom-up analysis. However, the IOA can be validated by comparison with BU results. This is explained in more detail in chapter 4.

3.2.2 *Analysis steps*

The top-down analysis consists of the following five steps:

1. Choice of EE-IOT and impact categories.
2. Linking spend data with EE-IOT.
3. Calculating environmental footprint.
4. Refining results.
5. Sensitivity analysis.

The steps are further elaborated below.`

Step 1: Choice of EE-IOT and impact categories
From the options of various EE-IO tables, the choice was made for the product-by-product multi-regional EE-IO data set Exiobase version 3.8 (Stadler et al., 2018a).[3] Exiobase offers a harmonised IOT with a higher resolution compared to other global tables. This IOT is a product-by-product matrix, divided over 200 products for 49 countries and regions. Exiobase v3 contains a wide range of environmental extensions (662 categories for raw material extraction and material use; 417 types of environmental emissions), allowing multiple impact categories to be included in the analysis.

Exiobase v3 is also a relatively future-proof EE-IOT and suitable for follow-up analyses. First, because the data sets are kept up to date. In addition, Statistics Netherlands can integrate more accurate or more recent data into Exiobase based on System of National Accounts (Walker et al., 2017). This may also become available for these types of studies in the future.

The Exiobase v3 product-by-product data set is available for the years 1995 to 2022. The IOA works with the data set for 2018, because this year was initially the reference year for the spend analysis. The use of the data set for 2018 instead of 2019 is expected to have a limited effect on the results. This expectation is firstly based on the fact that the environmental extensions themselves are based on data from 2018 or earlier. Between 2018 and 2019, the impact is based on an extrapolation of the monetary outputs and thus the same impact coefficients (impact per euro) have been applied. Second, this study assumes that no disruptive event occurred between 2018 and 2019 that drastically changed the macroeconomic data (trade flows).

In order to translate the environmental extensions, in terms of emissions and resource consumption, into environmental effects, characterisation factors of IMPACT World+ have been applied.[4] IMPACT World+ is a method that has been designed for use in a life cycle impact assessment (LCIA), but can also be used for environmental impact calculations in IOA. There are a total of 16 impact themes within IMPACT World+, which in turn are subdivided into 36 different impact categories. This study is limited to the impact categories climate change, resource scarcity and land use. This demarcation had a substantive and process-related reason. The substantive reason is that these three impact categories together correlate with most other types of environmental impact (e.g. more impact from land use usually also means more impact from eutrophication). The process-related reason is that each additional impact category requires extra time to check the data, which is not sufficiently available for each category in Exiobase or other EE-IOTs, and to interpret and communicate the results. Therefore, based on a combination of relevance, data availability and budget, the following three different impact categories have been selected (Table 3.1):

[3] Data sets consulted at: https://zenodo.org/record/4277368#.YDgP9uhKhPY
[4] Data set consulted at: https://zenodo.org/record/3890339#.YDdWV-hKhPY

Table 3.1 The three chosen impact themes and associated impact categories.

Impact theme	Impact category	Unit	Examples of characterised environmental extensions
Climate change	Long-term climate footprint	kg CO_2 equivalent	e.g. emissions to air of CO_2, N_2O and CH_4
Resource scarcity	Mineral resource consumption	kg	including extraction of iron ore and fertiliser minerals
Land use	Agricultural land use	m^2 of arable land equivalent.year	e.g. cropland and permanent pastures

The chosen impact themes relate to the climate agreement (climate change), the national circular ambitions (resource scarcity) and the sharp decline in biodiversity (land use).

Step 2: Link spend data and EE-IOT classification
To calculate the environmental footprint with IOA, it is necessary to set up a *final demand vector* with the government spend data. Therefore, this new final demand vector consists of the total governmental expenditure on the types of product groups expressed in millions of euros.
In order to draw up a final demand vector for only the procurement of the Dutch governments, a link has been made between the results of the spend analysis based on the CPV codes (chapter 2) and the 200 Exiobase v3 product codes. Both CPV and the Exiobase product classification are based on the NACE rev.1.1 companies database. However, the link between the two is not always obvious. The CPV coding is based on previous versions of the CPA classification, which in turn evolved from a combination of CPC and NACE rev.1.1, which means correspondence between NACE and CPV (European Commission, n.d.) is not fully covering. The Exiobase industry and product classifications too are based on NACE rev.1.1, but the ultimate supply of data is based on the balance between level of detail and quality of the mutual harmonisation between the national accounts of the different countries. The fact is, for a greater level of detail, national accounts of which little detail is known must be disaggregated on the basis of assumptions. These assumptions result in less reliable numbers. So based on this trade-off between detail and quality, a unique classification has been prepared for Exiobase based on NACE rev.1.1 as well.

Thus, both similarities and differences are to be expected between the Exiobase classification and CPV coding; similarities due to their common ground on NACE rev1.1 and differences by their departures from NACE rev1.1 to enhance their respective usefulness. Hence a correspondence table between CPV and Exiobase has been prepared for this study.

When linking the CPV coding with the Exiobase classification, eight types of matches (correspondences) were identified. These are described in Table 3.2. Compatible correspondence applies to two of them. Rules have been drawn up for the four incompatible correspondences in order to be able to make the necessary link.

Table 3.2 Overview of the type of compatibility and the applied correspondence rule.

Type of (in)compatibility	Observation	Correspondence rule	% of total spend
Direct compatibility	For part of the total expenditure, there appears to be a direct match between the classifications of CPV and Exiobase. This mainly concerns product groups that consist of services, such as care services.	Not applicable	~44%
Many-to-one compatibility	For part of the total spend, various CPV codes could be matched with aggregated product categories from Exiobase. This is especially the case for final goods, such as different types of equipment, all of which come under the single code 'Electrical apparatus and machinery not elsewhere classified'.	Not applicable. This is a correspondence that loses detail compared to the CPV format.	~13%
Incompatibility due to unclear distribution of services or physical flows	In Exiobase, a clear distinction is made between products (physical material flows) and services. Expenditure can, however, be classified in CPV coding in unclear categories such as 'construction work' and 'systems'. This also applies to gas and electricity; there is uncertainty as to whether the expenditure on related services (such as installation costs) is also included in the expenditure on gas and/or electricity.	It is plausible that a large part of the costs involves a service and that the expenditure does not represent physical purchasing alone. It is less plausible that the expenditure is entirely about physical purchasing. It has been decided to place the expenditure under these CPV codes under the related services, assuming that the underestimate of 100% allocation to services is closer to the realistic value than 100% allocation to physical flows.	~33%

Type of (in)compatibility	Observation	Correspondence rule	% of total spend
One-to-many incompatibility	In some cases, there are CPV codes that clearly apply to physical products that, in the absence of a suitable product category, must be composed with multiple Exiobase codes (also referred as a one-to-many link). This, for example, is the case for the expenditure items electricity and concrete. The difficult part about this is that the composition of concrete and electricity is often expressed on the basis of physical value; mass ratios between sand, cement and water, and a mix of electricity in kWh.	There is no single approach for all the different product categories with a one-to-many link. The connection between CPV and Exiobase will ideally be based on BU research. Due to time constraints, the BU research results for energy carriers were used to simulate the distribution (chapter 4). In addition, a relatively simple breakdown between cement, sand and stone was used for some large expenditures on concrete. In other similar cases, no breakdown has been applied and the expected more dominant Exiobase code has been chosen based on expert judgment.	~1%
Incompatibility due to unclear basis of physical flows	In other cases, it is necessary for the link to know what the basis of the energy or material flow is. As regards the purchase of electricity, for example, it is not always indicated whether it concerns green or grey electricity. Another example is the expenditure on pipelines; it is unclear whether it concerns a concrete, plastic or steel pipeline.	This ambiguity exists for many CPV codes and cannot be sorted out for every case. That is why a choice has been made of the most probable, based on expert judgement. As an exception, findings from the BU study have been used for electricity and this information (step 5) has been used to carry out a sensitivity analysis.	~5%
Level allocation	Expenditure can be booked at a higher level – a parent category instead of the lowest subcategory. For part of the CPV data, this does not matter for the link with Exiobase when Exiobase itself does not offer a more specific product level. However, sometimes, a further breakdown to lower levels is necessary for the link.	The spend data in parent categories is divided over the lowest subcategories. This reallocation is based on a set of assumptions and can therefore deviate from the actual spend distributions (see chapter 2).	~3%

Step 3: Environmental footprint calculation
The calculation of an environmental footprint is a matrix calculation that can be performed in several ways, such as in a spreadsheet or with a programming language (Miller & Blair, 2009). In this case, the calculation is programmed in Python and performed with the 'pymrio' module (Stadler, 2018b). First, the impact coefficients are calculated for the total final demand for the Netherlands. This includes the demand by all consumers, which includes not only the government expenditure, but also expenditure of households, not-for-profit organisations and investments, amongst others. This results in impact coefficients for each product group per country or region where it is produced. Then, the weighted average for each product group is calculated on the basis of the Dutch consumption mix, adopted from from the final demand in Exiobase. Since the government spend data (estimated in Chapter 2) does not provide information on the origin of the products, there is no specific consumption mix available for a more representative calculation. Finally, the weighted average impact coefficients are multiplied with the new final demand vector containing the spend data to calculate the footprints.

Step 4: Refining based on outliers
To verify whether the result of the link between Exiobase and CPV yields a realistic result, the total expenditure allocated to the Exiobase product categories has been compared with the total Dutch final demand in Exiobase. The total final demand does not only represent expenditure by governments, but also that by households, not-for-profit organisations and investments. The sum of the final demand thus indicates a maximum range. The spend of the Dutch governments cannot exceed the total final demand or (almost) completely fill it, if this cannot be plausible on the basis of data on the entire economy. Where it does, it is referred to as outliers.

These outliers are corrected when a) spend data is higher than the final demand and b) when the impact based on spend data accounts for a significant part of the total impact. For eleven of the 83 booked categories, the spend data turned out to be higher than the total final demand. For land use, these outliers do not make a significant contribution to the total impact, but *do* for two of the eleven outliers for the climate footprint and for one of the eleven outliers for resource consumption. One of these outliers played a role in both impact categories (Steam and hot water supply services) and could be corrected based on the BU study (chapter 4). As regards the other outliers, a literature review was conducted or the impact of the Dutch final demand from Exiobase was adopted, without adjusting the impact coefficients (see Table 3.3).

Table 3.3 Exiobase product categories per impact category for which a correction has been applied.

Impact category	Outlier Exiobase product category	Correction
Climate footprint	Steam and hot water supply services	Correction based on BU study (chapter 4)
	Electricity by solar photovoltaic	Correction based on desktop research (impact coefficient)
Resource consumption	Chemical and fertiliser minerals, salt and other mining and quarrying products n.e.c.	Correction based on the aggregated value of Exiobase products on the NACE H0 level
Land use	no relevant outliers	-

As regards one outlier, Exiobase seems to be the cause and not the link between spend and Exiobase. Exiobase is a complex macroeconomic model, which also causes inaccuracies (as described earlier in section 3.1). Outliers cannot therefore be ruled out in the results for the impact of the final demand from Exiobase. A prominent example is the category Steam and hot water supply services. The total final demand is €0.1 million, while the total spend comes down to €54 million. The final demand (i.e. including households) appears to be a serious underestimate. If we were to assume Exiobase, the impact per euro (impact coefficient) would be two orders of magnitude greater than the vast majority of the impact coefficients.

Step 5: Uncertainty analysis and sensitivity analysis
This study is based on linking two data sets and therefore has three sources of uncertainty: 1) uncertainty in the spend data and the processing thereof, 2) uncertainty in Exiobase, 3) uncertainty due to the way of linking the two and the choices made therein. The uncertainty of the results caused by the uncertainty in the underlying spend data is quantified as part of the sensitivity analysis. In addition, a sensitivity analysis is performed for the possible variation within the associated product categories. Uncertainties arising from the use of Exiobase do not fall within the scope of this study.

Sensitivity analysis for scaling up tender data
Chapter 2 describes that an amount was available for the spend analysis for 42% of the tenders. The other 58% has been estimated on the basis of purchasing data for the years 2010 to 2019. The coverage, and thus the share on the basis of which an estimate could be made, differed per product group and per type of government organisation. In most cases, a lower coverage also means greater uncertainty in the outcomes. The effect of this method of scaling up on the impact analysis is that product groups or purchasing organisations with relatively low coverage carry a greater level of uncertainty. Two examples are explained:

- Example 1: In the group of purchasing organisations 'Academic hospitals' (relatively low coverage), the tenders with amounts add up to only 6% of the expected amount for this organisation group, resulting in an uncertainty of 40%. As regards the 'Provinces' group, the coverage is relatively high at 51%, resulting in an uncertainty of 4%.

- Example 2: In the 'Care and Welfare' product group (relatively low coverage), the tenders with amounts add up to only 12% of the expected amount for this product group, resulting in an uncertainty of 19%. As regards the Construction product group (relatively high coverage), coverage is 28% and uncertainty is valued at 8%.

In order to be transparent about the effects of the uncertainty on the results, the coverage deficit in relation to the coverage (percentage of the number of tenders with amounts) of the relevant product group or purchasing organisation is stated in the results as a sensitivity score. Table 3.4 states these values for the purchasing organisations. After aggregating the CPV-L0 product groups into twelve analysis categories (aggregated to keep the results clear, according to the table in Appendix E), the following sensitivity scores were found for the analysis of product groups (see Table 3.5). Incidentally, a higher sensitivity score does not necessarily mean a higher uncertainty of the results for environmental impact; the sensitivity depends on both the coverage and the homogeneity of the CPV-L0 category. The latter has not been taken into account in this sensitivity analysis.

Table 3.4 Sensitivity scores for the government organisations.

Purchasing organisation	Division factor	Sensitivity score in %
Academic hospitals	0.55	40%
Public services	2.54	9%
Municipalities	1.98	11%
Other	2.46	9%
Special sector companies	3.32	7%
Ministries	2.33	10%
Provinces	5.15	4%
Schools	0.84	27%
Universities	2.26	10%
Water boards	2.25	10%

Table 3.5 Sensitivity scores for the analysis categories.

Analysis category	Division factor	Sensitivity score in %
Construction	2.78	8%
Catering	1.23	18%
Commercial services	1.50	15%
Electronics	1.77	13%
Energy	1.47	15%
Machinery	2.05	11%
Education	1.26	18%
Other products	1.69	13%
Public administration	1.27	18%
Social services	1.39	16%
Transport and mobility	2.30	10%
Care and welfare	1.20	18%

The sensitivity scores found are included in the impact calculation by setting an expected value, a lower and upper limit as basis for three scenarios: medium (MID), low (LO) and high (HI). For each L0 group, the expenditure is scaled by the sensitivity: $1-u$ for the LO scenario and $1+u$ for the HI scenario, where u represents the sensitivity score.
Sensitivity analysis electricity
In addition to the uncertainty that arises from scaling up the spend data, there is also uncertainty as a result of splitting CPV codes into different Exiobase product classifications (the one-to-many correspondence, see Table 3.2). Because the CPV coding is not specific for, for example, the origin of electricity but *is* for Exiobase, it must be distributed.

Section 4.2 shows that the results of the impact calculation for the electricity mix can differ greatly based on different assumptions. In this sensitivity analysis, the deviations are quantified for the electricity mix by again drawing up three scenarios in which the expected one-to-many distribution key is adjusted for the lower and upper limits (LO scenario and HI scenario). The expected scenario (MID) is based on the current situation with 12.2% solar or wind power (CE Delft, 2018a), the LO scenario on 50% solar or wind power and the HI scenario on 0% solar or wind power. The distribution keys for the electricity mix in the three scenarios are shown in Table 3.6.

Table 3.6 Electricity mix distribution keys for the HI, MID, and LO scenarios.

CPV	Exiobase product group	Distribution key LO	Distribution key MID	Distribution key HI
Electricity	Electricity by coal	0.028	0.164	0.226
Electricity	Electricity by gas	0.060	0.346	0.478
Electricity	Electricity by hydro	0.000	0.000	0.000
Electricity	Electricity by nuclear	0.004	0.022	0.030
Electricity	Electricity by biomass and waste	0.004	0.023	0.032
Electricity	Electricity by geothermal	0.000	0.000	0.000
Electricity	Electricity by petroleum and other oil derivatives	0.004	0.023	0.032
Electricity	Electricity by solar thermal	0.000	0.000	0.000
Electricity	Electricity by tide, wave, ocean	0.000	0.000	0.000
Electricity	Electricity by wind	0.380	0.093	0.000
Electricity	Electricity by solar photovoltaic	0.120	0.029	0.000
Electricity	Transmission services of electricity	0.200	0.150	0.100
Electricity	Distribution and trade services of electricity	0.200	0.150	0.100

3.3 Results

3.3.1 Total spend and impact

Figure 3.1 shows the result of linking the spend data to Exiobase product groups. Since the expenditure per CPV code ultimately related to 83 Exiobase product groups, it was decided to aggregate these Exiobase product groups into twelve so-called analysis categories or product groups for the communication of the results. Figure 3.1 shows how the expenditure is divided over the twelve different analysis categories and by which organisation it was purchased. Appendix I contains a complete overview of all Exiobase product groups. The visualisation (Figure 3.1) shows that almost all purchasing organisations contribute to each different analysis category, with expenditure on construction and commercial being the largest expenditure items in most cases.

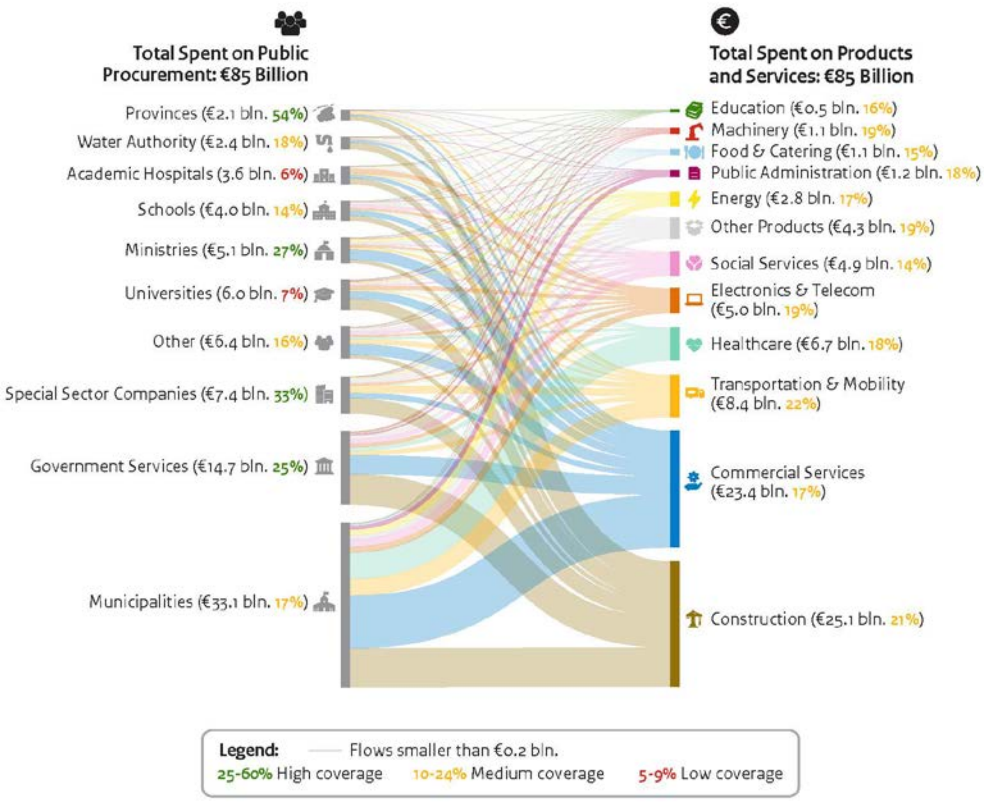

Figure 3.1 Distribution of spend data per purchasing organisation to the aggregated Exiobase product groups for Dutch public procurement in 2019.

The environmental footprints have been calculated based on the linking of the spend data with the Exiobase product groups. Table 3.7 shows the results for the impact of the total purchase sum. The total procurement expenditure for the year 2019 (€84.7 billion) has an expected climate footprint of 22.1 megatons of CO_2 equivalent, an expected agricultural land use of 9,020 km^2 and an expected consumption of mineral resources of 1.32 million tons. The range of the categories, calculated by including a lower limit and upper limit, are between +/-15% for the climate footprint,+/-12% for the footprint for agricultural land use and +/- 11% mineral resource consumption.

Table 3.7 Aggregated results of the total spend of the Dutch governments and footprint calculation for procurement, after corrections for outliers, and the calculated range, for the year 2018.

	Expenditure	Climate footprint	Agricultural land use	Mineral resource consumption
Expected value for combined spend (MID)	€84.7 billion	22.1 Megatons of CO_2 eq	9,020 km²	1.32 million tons
Sensitivity impact categories in range LO and HI		± 15.3 %	± 11.6 %	± 11.2 %

LO = lower limit, MID = expected value or mid range, HI = upper limit

In Table 3.8, in order to interpret these absolute values for the spend and associated impact, the results of this study are compared with the total final demand of the Netherlands, i.e. the total Dutch consumption. As for the government spend, the Dutch consumption values only consider the embedded impact of consumption expenditure (scope 2 and 3), and do not include the direct emissions (scope 1). When viewing the data, it is interesting to see how the spend expenditure percentage differs from the three impact categories in comparison to the total consumption. This shows that, relative to the spend, the climate footprint and the consumption of mineral resources are roughly as high and the agricultural land use is lower.

Table 3.8 Aggregated results for the total Dutch final demand in 2018 from Exiobase v3 compared to the expected value for the combined procurement.

	Expenditure	Climate footprint	Agricultural land use	Mineral resource consumption
Values of Dutch consumption in Exiobase v3 in 2018	€ 689 billion	179 Megatons of CO_2 eq	167,620 km²	9.90 million tons
Expected value for combined spend (MID)	€84.7 billion	22.1 Megatons of CO_2 eq	9,020 km²	1.32 million tons
Spend percentage compared to final demand	12,3%	12.4%	5.4%	13.3%

MID= mid-range impact of government procurement

3.3.2 *Impact per product group*

In order to explain the differences in percentages of the impact categories, the structure of the footprints can be examined. By way of illustration, Figure 3.2 shows the structure of the total spend in percentages on the left and on the right, you can see how this spend is translated into contribution to the total climate footprint. The same has been done in Figure 3.3 but here, the ratios for spend and the three impact categories are instantly clear, with the colour coding adopted from Figure 3.2. The absolute values for spend and the impact categories can be found in the table in Appendix F.

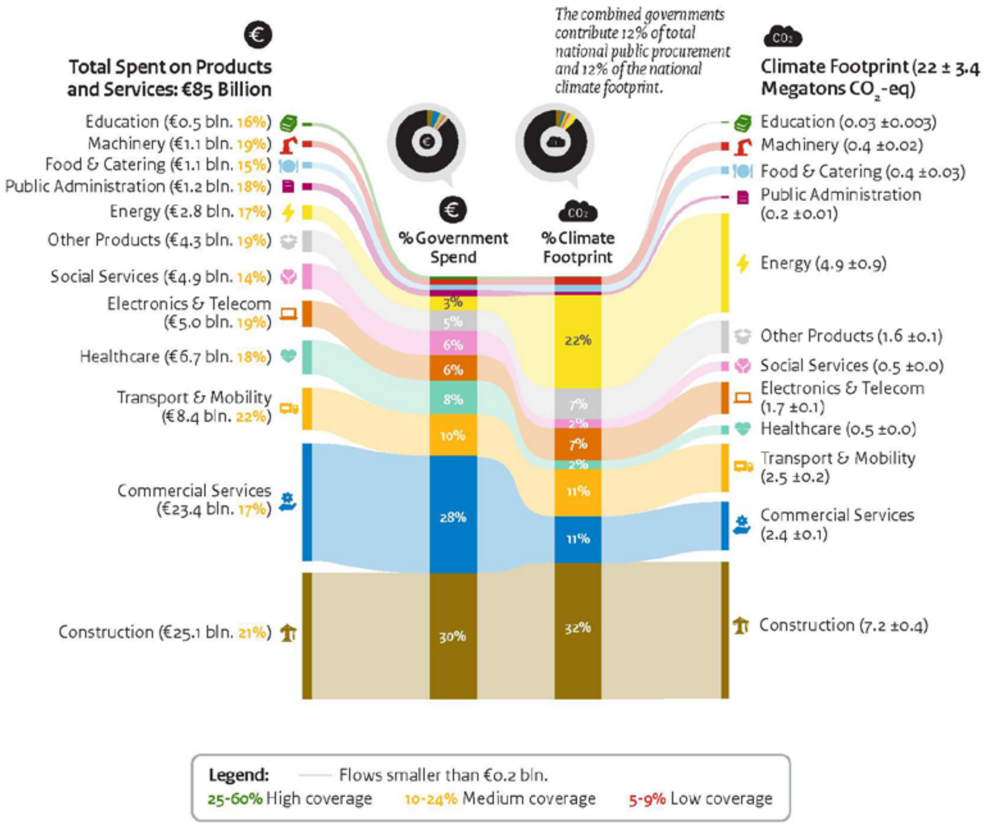

Figure 3.2 Relative share of the analysis categories (aggregated Exiobase product groups) for the total expenditure and total climate footprint for Dutch public procurement in 2019.

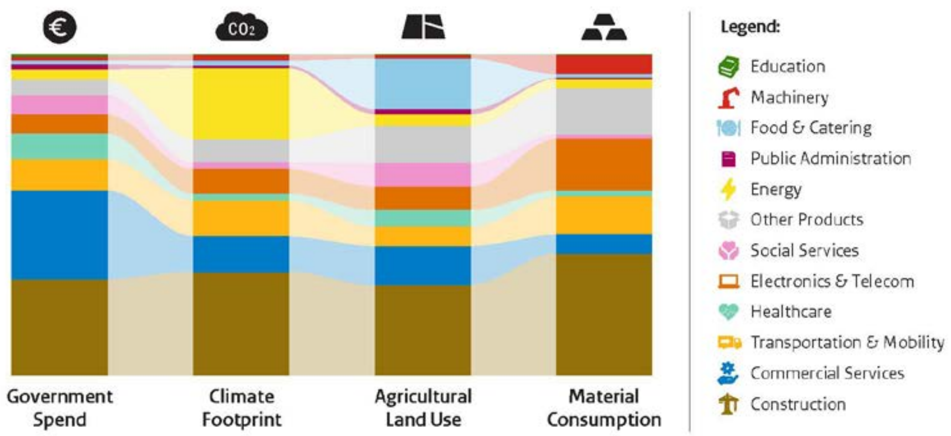

Figure 3.3 Relative share of the analysis categories (aggregated Exiobase product groups) in the total expenditure and impact categories for Dutch public procurement in 2019, with the colour coding adopted from Figure 3.2.

Lastly, the impact of the spend can be viewed as impact per euro, i.e. the impact coefficients. Table 3.9 shows the weighted average impact per euro for the twelve analysis categories

Table 3.9 Impact per euro for the twelve analysis categories for the three impact categories.

Product category	Climate footprint [CO2 eq/€]	Land use [m²/€]	Resource consumption [kg/€]
Construction	0.28 ± 11 %	1,001 ± 11 %	19.8 ± 11 %
Commercial services	0.10 ± 10 %	472 ± 8 %	3.3 ± 8 %
Transport and mobility	0.29 ± 14 %	631 ± 11 %	18.9 ± 10 %
Care and welfare	0.07 ± 15 %	708 ± 12 %	3.8 ± 12 %
Electronics	0.33 ± 15 %	1,307 ± 15 %	41.6 ± 14 %
Social services	0.10 ± 10 %	1,329 ± 11 %	4.2 ± 11 %
Other products	0.38 ± 13 %	2,579 ± 13 %	45.0 ± 7 %
Energy	1.74 ± 28 %	1,062 ± 9 %	13.9 ± 9 %
Public administration	0.12 ± 17 %	1,244 ± 13 %	4.8 ± 13 %
Catering	0.33 ± 15 %	13,144 ± 14 %	12.5 ± 14 %
Machinery	0.40 ± 13 %	1,097 ± 11 %	80.2 ± 11 %
Education	0.05 ± 19 %	297 ± 14 %	3.0 ± 14 %

The product groups that are a major expenditure item and that also account for a large part of the impact are construction related. It is the largest spend (30%) and also contributes the most to the impact for the three impact categories (32%, 28% and 38% for climate footprint, agricultural land use and mineral resource consumption, respectively). When examining the impact coefficients in Table 3.9, construction has a relatively average impact coefficients compared to the other product groups. The major impact is therefore mainly due to the large expenditure on this item. After all, the government is responsible for much of the built environment. Because of all the building materials needed for the construction of roads, structures etc., the relative impact on mineral resource consumption of the spend is greater than that of the spend in relation to total consumption (as explored in Table 3.8).

In addition, there is a product group that accounts for a large share in the spend, but which is relatively smaller as a share in the impact categories. This is the case for the second-largest expenditure item, namely the product group for commercial services. In this case, the spend is 28% of the total, but accounts for 11%, 12% and 6% for the climate footprint, agricultural land use and mineral resource consumption, respectively. Table 3.9 shows that commercial services, as well as social services, care and welfare and education, have relatively low impact coefficients for all three impact categories. In general, the costs for these services are mainly accounted for by labour and therefore have relatively little impact per euro spent.

The results further show a few product groups that make up a relatively small share of the total spend, but make a relatively large contribution to one or more impact categories. The product groups that stand out in Figure 3.3 in this regard are energy, machinery and catering. Energy includes products with a high climate footprint, such as fuel, heat and electricity. Table 3.9 shows that the energy carriers product group has by far the largest climate footprint per euro. As regards the energy carriers product group, 3% of the spend accounts for 22% of the entire climate footprint. Secondly, as regards the impact on agricultural land use, the catering product group very much stands out. The costs of catering are made up of costs for labour and costs for food products. Expenditure on catering is 1% of the total and accounts for 16% of agricultural land use. Household consumption is largely determined by expenditure on food products (Exiobase v3: 15% of spending on food products and Hotels and restaurants by households compared to 0.1% by governments), so will also account for a relatively larger share of the agricultural footprint of total consumption. This may explain why the impact of the spend on the total agricultural land use of national consumption is lower than the share of spend in total consumption expenditure. Lastly, machines make up a significantly larger share of the impact on mineral resource consumption (6%) than the spend (1%). After all, the production of such products is material-intensive and contains, among other things, metals that have a relatively high resource footprint.

3.3.3 Sensitivity analysis

In the sensitivity analysis (step 5 of the analysis steps; section 3.1.2), assumptions were made to quantify the sensitivity due to the low coverage of the spend data and the one-to-many correspondence for energy carriers. This was done by calculating the estimated upper and lower limits. The results can be found in Table 3.7 as regards the impact of the total spend and in Table 3.9 as regards the aggregated Exiobase product groups. The range between which the actual impact will be differs per product group and varies between +/-8% and +/-28%. With its relatively good coverage, construction has a lower range (+/-8 to 9%) and energy carriers, for which sensitivity to the breakdown into different Exiobase product groups is also included, has the largest range in the climate footprint (+/-28%).

3.4 Discussion

In this discussion, the results will first be reflected on by comparing them with similar figures from another study. Next, the limitations of the data, method and results are discussed and recommendations are made on how to address these for a more accurate result. Lastly, the interpretation and relevance of the results are discussed.

3.4.1 Comparison of results with similar study

The final results were compared with previous studies by means of a literature review (Nissinen & Savolainen, 2020; De Graaff et al., 2019; Zijp et al., 2020), with the results appearing to be in line with previous research (after correction of the outliers). However, the study by Nissinen & Savolainen (2020) for Finland provides the only results that are comparable to the results of this study for the Netherlands. Table 3.10 compares the results of the total footprint with Finland based on the relative ratios of the two countries. A smaller climate footprint has been calculated for Finland’s spend (8.3 million tons of CO_2 equivalent to 22.1 million tons of CO_2equivalent in the Netherlands). However, Finland has a smaller population and a smaller government. When the proportions of the number of civil servants or residents are compared, the results are closer together. The emissions per employee (FTE) are approximately the same, i.e. 17 tons of CO_2 equivalent per FTE in Finland and 24 the Netherlands. When examining the results per inhabitant, the amount of tons of CO_2 equivalent per person in the Netherlands is about 16% lower than in Finland (1.3 tons of CO_2 equivalent per Dutch resident compared to 1.5 tons of CO_2 equivalent per Finnish resident).

Table 3.10 Comparison of the results of this study with a similar study for Finland (Nissinen & Savolainen, 2020) together with a number of macroeconomic indicators to compare the ratio of the results between the Netherlands and Finland with other ratios.

Category	The Netherlands	Finland	Factor
Spending Combined Governments (CG) (billion euros)	€ 85	€ 20	4.3
Estimated climate footprint (million tons of CO_2)	22.1	8.3	2.7
Number of public administration employees**	930,000[5]	496,000[6]	1.9
CG expenditure per employee	€ 91,000	€ 40,000	2.3
CG emissions (tons of CO_2) per employee	24	17	1.4
Population (million inhabitants)	17.3	5.5	3.1
CG expenditure per resident	€ 4,900	€ 3,600	1.4
CG emissions (tons of CO_2) per resident	1.3	1.5	0.9

The results can also be compared at the level of product groups and impact per euro. Nissinen & Savolainen (2020) examine the relative impact for households. Due to the different methods of categorising product groups, the results can only be compared broadly. The product group with the largest relative impact in this study is 'Energy', which includes the purchase of energy carriers such as petrol, electricity and gas. In the Finnish household survey, these energy carriers are classified into different groups, 'Operation of personal transport equipment' (2.15 kg CO_2/euro) which mainly refers to the purchase of petrol and 'Housing and energy' (0.54 kg CO_2/euro) which includes both housing costs and energy costs. In this study, housing is classified under 'commercial services' (0.10 kg CO_2/euro). The Finnish study focuses on households, which spend a relatively larger part of their expenditure on housing than the Dutch governments. With this in mind, the results of these product groups appear comparable. Another comparison is that of the food categories, in which the product group 'Catering' (0.33 kg CO_2/euro) corresponds to the Finnish product groups 'Plant based food items' - 0.58 kg CO_2/euro', 'Animal based food items - 1.09 kg CO_2/euro', 'Beverages - 0.17 kg CO_2/euro', 'Restaurants and hotels - 0.34 kg CO_2/euro'. The weighted average of the product groups is 0.56 kg CO_2/euros. Based on this, the results of this study seem to have a relatively lower impact than

[5] Consulted at: https://kennisopenbaarbestuur.nl/media/256376/trends-en-cijfers-2019-definitief1.pdf
[6] Consulted at: http://adapt.it/adapt-indice-a-z/wp-content/uploads/2014/08/finish_govemnet211.pdf

the Finnish study, but the spend analysis shows that the vast majority of expenditure in the 'Catering' group is spent on restaurant/hotel services. The results found therefore seem to be quite comparable with the results from the Finnish study.

3.4.2 *Discussion about method and materials*

CPV codes as a basis for the final demand vector

With the necessary assumptions, we managed to link the spend analysis of the Dutch government to the product classifications of Exiobase. Uncertainties in the spend analysis therefore also affect the impact analysis. The main sources of uncertainty are the estimation method for filling in missing spend data and cases in which the CPV coding was not sufficiently aligned with the subdivision needed for an impact analysis. These are two sources of uncertainty that can be addressed.
First, providing insight into the consequences of this uncertainty. This was done in this study by examining the sensitivity to these two sources of uncertainty. The degree of coverage has been made transparent for all product groups and translated into a range of outcomes. As regards the electricity product group, an analysis has been made of the effect of a green electricity mix compared to a grey electricity mix. For follow-up research, it is recommended to investigate the latter for more product groups with a high impact: energy, construction, transport and catering.
Second, addressing the source of uncertainty. To make this method more robust, it is essential that tenders are booked against specific tender codes as much as possible. This requires two developments:

- Improving the representativeness of CPV codes, by adding impact relevant tender codes. Some groups that are important for impact analysis (e.g. electricity) have only one or two CPV groups. This makes it impossible to distinguish between the purchase of grey electricity or a renewable variant, whereas this is usually clearly indicated in the tender text.
- Administering a higher quality of tenders, as part of which purchasing organisations document tenders as completely and as specifically as possible, including at least the amount awarded, but also a CPV code that is as specific as possible.

Validating and correcting the outliers

Outliers are results that do not appear plausible upon validation. An example is the environmental impact of steam and hot water, which, after construction, is the second largest in the uncorrected results. This can be explained by the fact that the expenditure on steam and hot water in the spend analysis is a multiple of the expenditure on steam and hot water assumed by Exiobase (€54 million instead of €0.1 million). In order to make the results more plausible, it was decided in this case to use an alternative environmental impact per euro on the basis of desk research, instead of the results produced by Exiobase. A standardised approach of dealing with outliers in these types of studies is not available. In this study, outliers were identified through:

- the ratio of expenditure spend analysis and Exiobase final consumption;
- expert assessment of impact per euro and magnitude of impact; and
- critical approach towards the Exiobase results.

Based on this, it was decided to correct some of the modelled results. If adjustments were made, the following methods were used to arrive at adjusted results:

- literature study on impact per euro;
- copy impact per euro on scale of the Netherlands (primary data from Exiobase);
- aggregating product groups to align expenditure with Exiobase.

Formalising these actions is not easy, because any necessary correction steps depend on the primary data source, Exiobase. It seems likely that updating these databases will involve making changes to the database structure, for example, to represent changes in an industry or by choosing a new set of products/sectors that are more representative of today's society (e.g. given the developments in the IT sector over the past 20 years). With a new version of Exiobase, it is up to the researchers to again interpret the results and, if necessary, to correct them.

Hybrid approach is time consuming
The original plan for the spend-impact analysis was to match as much expenditure to physical products as possible through a BU analysis and integrating these results into the top-down IOA calculations. However, during the study, it was found that linking physical flows to the CPV codes was more difficult and time consuming than expected due to incompatibilities between CPV and Exiobase (explored in Table 3.2). It was therefore decided to focus the BU studies on the product groups that were expected to have a large share in one or more impact categories at the start of the project: 'Construction' and 'Electricity'. The results from the BU analysis were then used to correct these product groups, which also emerged as outliers. A description of the BU approach and the results can be found in chapter 4.

No distinction between durables and consumables
The current footprint calculation does not take into account the distinction between durables and consumables. This means that a higher footprint is not by definition a bad development, because investments would also be made in more products (and more sustainable products) that lead to a lower footprint in the following years.
It is therefore important to maintain a long-term vision when developing a plan to reduce the footprint.
In addition, there is no distinction between more sustainable alternatives within a product group. An EE-IOA assumes that at macro level, the impact is linear to expenditure. Ultimately, in order to include the impact reductions as a result of more sustainable alternatives in a many-to-one product group in the total footprint, a bottom-up study is required.

3.4.3 Use of the results
The presented results are relevant to the total (recent) annual tender of ~€85 billion by the Dutch government organisations, both nationally and locally. The results can be used to focus on where to deploy SPP with more ambition. Although numbers are presented that indicate impact per euro, which can be multiplied by the expenditure of individual organisations, the smaller the contribution of the organisation to the €85 billion total, the greater the risk that the impact figures are not

representative. If this is done, it is important to compare whether the composition of a product group is comparable to the composition of the product groups in this study. If this deviates, it is recommended to conduct a specific study, preferably bottom-up, into the impact of the expenditure and to publish these results so that it can be used to better interpret aggregated studies such as this one. An example of such an analysis at organisational level is the impact analysis of the UMCU by CE Delft (CE Delft, 2018b).

4 Environmental impact - Bottom-up analysis

4.1 Introduction

In this study, on the basis of the spend data and in addition to an input-output analysis (chapter 3), we have applied another method to map out the environmental impact of the expenditure of the Dutch governments: the Bottom-up analysis (BUA). In a BUA, the environmental impact is based on information about materials, energy carriers and products from several tenders and the spend analysis is used to extrapolate this data. This alternative method of calculating environmental impact helps to gain more detailed insight into the product groups and to validate the results of an IOA. A BUA provides additional insight into subcategories, because expenditure is examined more specifically. BUA is a more labour-intensive method. Therefore, it has been carried out for two specific product groups, rather than all.

Deeper insight into product categories
Two product groups have been selected for the BUA: a relatively simple and a relatively complex product group. The product groups that have been selected are energy carriers and construction materials respectively. These product groups have been selected from the list L0 *Divisions* as described in section 2.2.2 and thus each contain multiple levels (L1 to L6) with more specific product groups or CPV groups.

4.2 Method

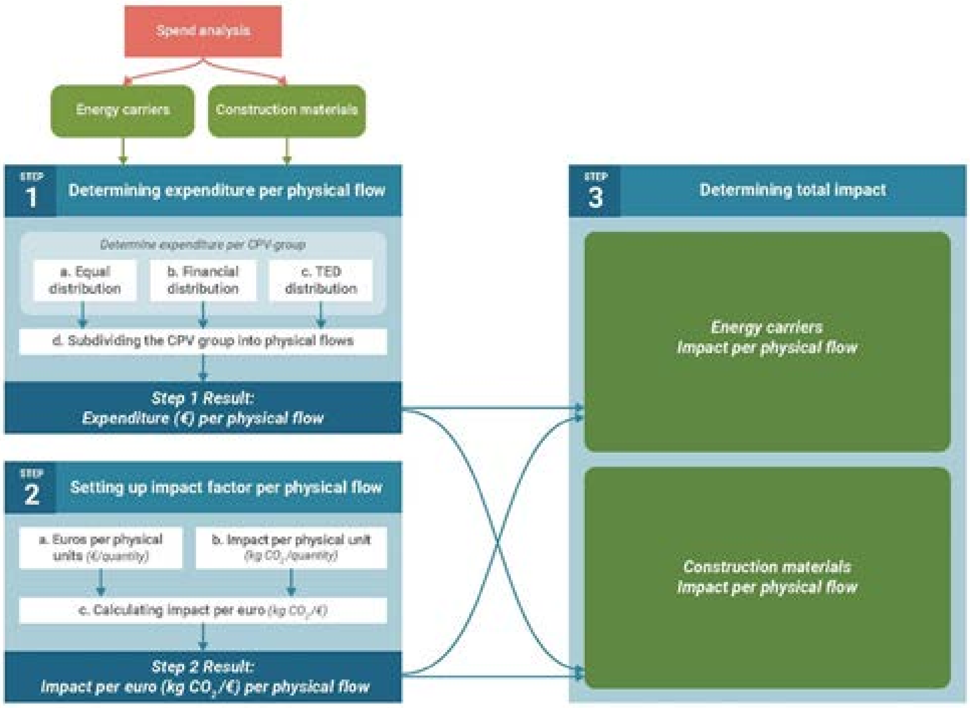

Figure 4.1 Schematic representation of the BUA methodology.

Figure 4.1 is a schematic representation of the methodology used during the bottom-up analysis. The spend analysis was performed prior to the BUA. The results of the spend analysis were used to perform the BUA for two product groups: energy carriers and construction materials. As can be seen in Figure 4.1, the BUA methodology then consisted of three steps.

Step 1: determining the expenditure per physical flow, using three different ways to determine expenditure per CPV group and translating the costs per CPV group into physical flows;

Step 2: determining the relative impact per identified physical flow, using costs and impact per physical units to calculate this, and

Step 3: calculating the total impact per physical flow, by combining the results of steps 1 and 2.

The aim is to translate each CPV group into a physical flow and use the expenditure on the physical flows to calculate a total environmental impact. A physical flow refers to the actual estimated materials (e.g. wood, concrete) in kilograms within a product group.

The steps of the study are described in detail in the following sections. The description cites examples from the two investigated product groups (energy carriers and construction materials).

Step 1. Determining expenditure per physical flow
In this step, a) the expenditure per CPV group is determined; b) CPV groups are subdivided into physical flows; c) the expenditure is redivided over the physical flows.

a. Determining expenditure per CPV group
Expenditure per CPV group is determined in the spend analysis. However, as described in chapter 2, costs are not always properly administrated. For example, currently, expenditure is not always booked under the most specific CPV group available. An example: some costs have been booked under CPV group ‘Fuels’, while this expenditure has been incurred under a specific fuel, such as petrol or kerosene. These two fuels have a different environmental impact. It is therefore important that costs booked under fuels are classified under the more specific CPV groups, petrol and kerosene. This allows a more specific environmental impact to be linked to that expenditure. To overcome this problem, we have identified different ways to redistribute expenditure booked under higher-level CPV groups to lower-level CPV groups: i) equal distribution; (ii) financial distribution; and iii) TED distribution. These are explained below.

i) Equal distribution
One way is to divide all costs booked under a higher-level CPV group (such as fuels) equally among all CPV groups directly below it (such as petrol, kerosene). The advantage of this method is that it costs little extra research, but it does create a lot of uncertainty, because an equal distribution is often not representative. In this case, for example, relatively few costs are booked under petrol, while many costs are booked under diesel, while the average distribution of these costs in the Netherlands is actually different.

ii) Financial distribution
A second way is to look at the existing distribution of costs booked under the lower levels of the CPV groups in the past year and use that same distribution of costs to divide the costs booked under the CPV group above it among the low-level CPV groups. This method is a more realistic indication of which CPV groups are often booked under, but there is still a risk of misrepresentation.

iii) TED distribution
The third method carefully examines all tender documents that have been used in a tender for a higher level CPV group (e.g. fuels). The tender documents sometimes describe exactly which type of fuels are purchased. These descriptions can be retrieved, but that takes a relatively long time. However, this method does provide most security. A problem arises when the descriptions in the tender documents are insufficient or not specific and clear enough. During the study, it was found that it is often not possible to determine from the descriptions to which lower level CPV code the costs can be redistributed, as a result of which the costs cannot be accurately redistributed.

These three methods have all been applied in this analysis in order to make a comparison and to assess the results for practicality and their validity.

b. Subdividing the CPV group into physical flows
Subsequently, all low-level CPV groups were classified into physical flows. This is because the environmental impact for raw materials and materials is determined in step 2. For some CPV groups, this step is easy, for example for CPV group petrol; a physical flow (petrol) can be directly linked to this. This is somewhat more difficult for other CPV groups, such as for pipelines. Pipelines can be made of different types of materials (e.g. polyethylene, copper). If several physical flows can be assigned to a CPV group, as with pipelines, it also means that physical flows may be missed. For example, innovative new materials could be used for pipelines, but this is not generally known. Therefore, in order to allocate physical flows, an accurate CPV code is required (e.g. pipelines made of bioplastic), a detailed tender description, or specialist knowledge to make a reliable estimate. This research is based on desk research, descriptions found in the TED files and other specialist knowledge within the research team.

In addition, in some cases it was impossible to link the CPV group to a physical flow. This may be because the title of the CPV group is not a clear indication of which materials have been used (e.g. stairlifts). All

CPV groups and corresponding expenditure where this was the case are classified as 'Non-specific'.

c. Redistributing expenditure across identified physical flows
Lastly, steps 1a and 1b were combined to determine expenditure per physical flow. The results for the two product groups are presented and described below.

Results step 1

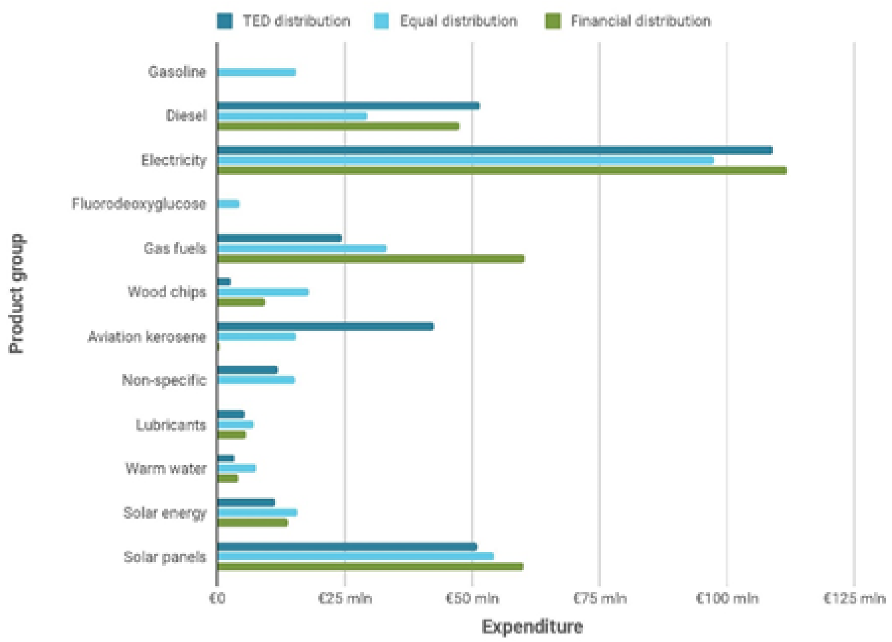

Figure 4.2 Annual expenditure per physical flow for the energy carriers product group, for three different methods of expenditure distribution.

Figure 4.2 shows that, within the energy carriers product group, the subgroup of electricity has the largest annual spend, independent of the way of redistributing expenditure.

Aviation kerosene stands out. This physical flow shows there is a big difference between the results of the different ways of redistributing expenditure. For example, the allocated expenditure on aviation kerosene in the TED distribution is considerably higher than in the other two distribution methods. This means that initially, not much expenditure was booked under aviation kerosene and if the tender descriptions of the tenders had not been examined further, this expenditure on aviation kerosene would have been missed.

This problem becomes even clearer in the petrol example, under which relatively little expenditure has been booked in the data. Hence spending on this physical flow in the graph is very small, nor does it show up in the financial distribution. This result seems unrealistic, as a significant part of fleets at government organisations consists of petrol cars. Apparently, bookings are not always made under the correct CPV code or amounts are missing from the documents.

Linking expenditure to physical flows on the basis of the CPV groups is therefore highly varied for energy carriers. This caused uncertainty in the further analysis of the environmental impact of the various physical flows within these product groups. In step 2, we show how we determined the environmental impact and we discuss the uncertainty analyses.

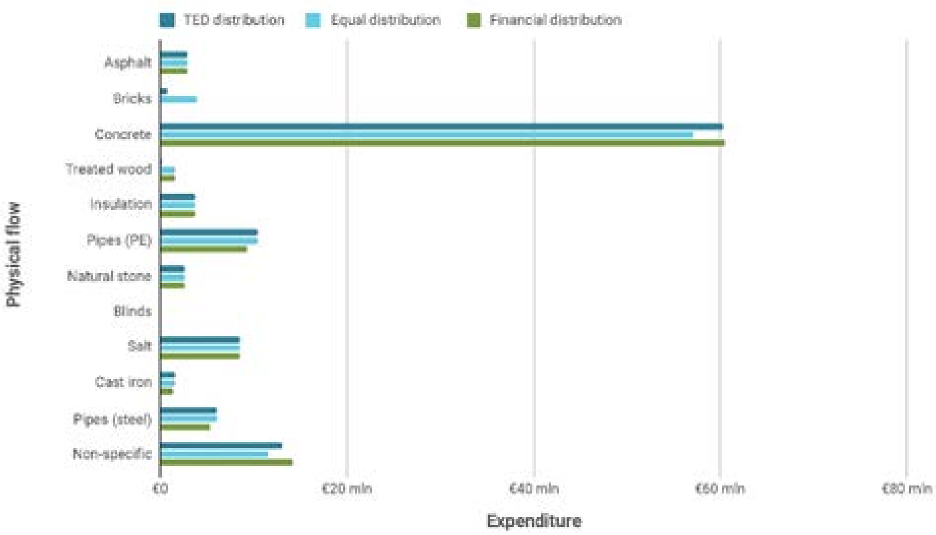

Figure 4.3 Annual expenditure per physical flow for the construction materials product group, for three different methods of expenditure distribution.

We applied the same analysis and spend breakdown to 'Construction Materials'. Figure 4.3 shows that expenditure on concrete is relatively high. This also includes concrete structures, pipes (such as culverts for water boards) and other concrete products.

There does not seem to be much difference in results between the use of the different methods of redistributing expenditure in the construction materials product group. This can be explained by the fact that relatively little expenditure could be redistributed in that product group. Relatively little expenditure was booked under higher level CPV groups. This means we know with a greater degree of certainty where the expenditure has gone. This helps us determine the physical flows across the different materials within the product group.

Methodical insights step 1
Carrying out this step yielded the following methodological insights:

- Tender documents often have an inadequate description, as a result of which it is not possible to determine (in retrospect) exactly which physical flow has been purchased. Example: the tender document for the purchase of electricity does not contain information about the energy source.
- Costs are often booked at a higher level of CPV code, as a result of which it is not possible to find out which physical flows have been purchased. Example: diesel is booked as fuels;

- the type of physical flow involved cannot be deduced from the CPV code descriptions. Example: partition walls can consist of different types of materials.
- The products purchased under a CPV code consist of various physical flows and/or services. Example: pipelines, or the purchasing and construction of (pipeline) infrastructure.
- Some physical flows may be missed. Example: innovative materials for pipelines.

Step 2. Setting up impact factor per physical flow
In step 2 of the methodology, the goal was to determine an impact factor for each physical flow identified in step 1. The impact factor contains an amount of embedded environmental impact per euro spent on the physical flow (in kg CO_2 eq/€). The embedded impact includes all emissions to the environment that are involved in the life cycle of the physical flow in the Netherlands and abroad (extraction, production and transport, up to the point of purchase).

a. Euros per physical units (€/quantity)
First, it was determined how much it costs to purchase a quantity of the physical power. A functional unit is used for this in which a physical flow is generally purchased; for example, litres for petrol or kg for concrete. These costs were largely determined by using Statistics Netherlands energy prices[7] (for the energy carriers product group) and the COMEXT[8] database (for the construction materials product group). The key indicators used and associated sources can be found in Appendix G.

b. Impact per physical unit (kg CO_2/quantity)
Subsequently, it was determined how much embedded impact a physical flow contains per functional unit. The EcoInvent[9] database was used for this, which is a Life Cycle Inventory (LCI) database. An LCI database contains key indicators of embedded impact for different products and physical flows. These key indicators are determined in so-called Life Cycle Assessment studies, in which the life cycle of a product or material is examined (Hollander et al., 2018). These key indicators are linked to the identified physical flows from step 1. The key indicators used and associated sources can be found in Appendix G.

c. Calculating impact per euro (kg CO_2/€)
The two factors determined in steps 2a and 2b were then combined to determine the impact per euro spent.

[7] Data set consulted at: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/80346ned/table?ts=1603724481789
[8] Data set consulted at:https://ec.europa.eu/eurostat/web/international-trade-in-goods/data/focus-on-comext
[9] Data set consulted at: https://www.ecoinvent.org/database/access-the-database/access-the-database.html

Results step 2

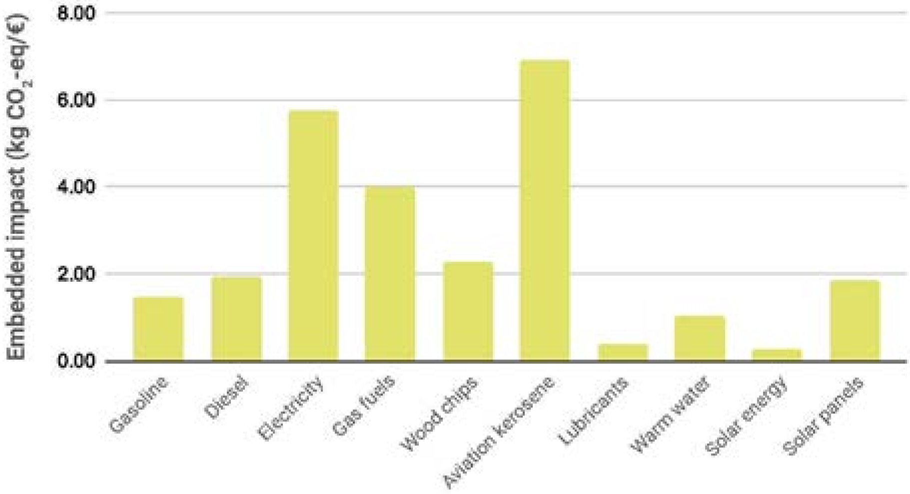

Figure 4.4 Embedded impact per physical flow for the energy carriers product group.

In Figure 4.4, aviation kerosene, electricity and gaseous fuels stand out in particular. The high impact factor for aviation kerosene can be explained by the fact that kerosene is a relatively cheap fuel. Since the impact factor is a ratio between the price of a physical flow and the embedded impact of a physical flow, a low price will lead to a high impact factor. Electricity and gaseous fuels too can be purchased by the government at very low prices and therefore have a high impact factor. Since no information was available about the origin of the electricity, the use of grey electricity is assumed here. This choice contributes to the high impact factor for electricity. The use of grey electricity is often the standard in government organisations when no sustainability measures have been implemented yet. In addition, it was decided to apply grey electricity to show the effect of this choice in the uncertainty analysis.

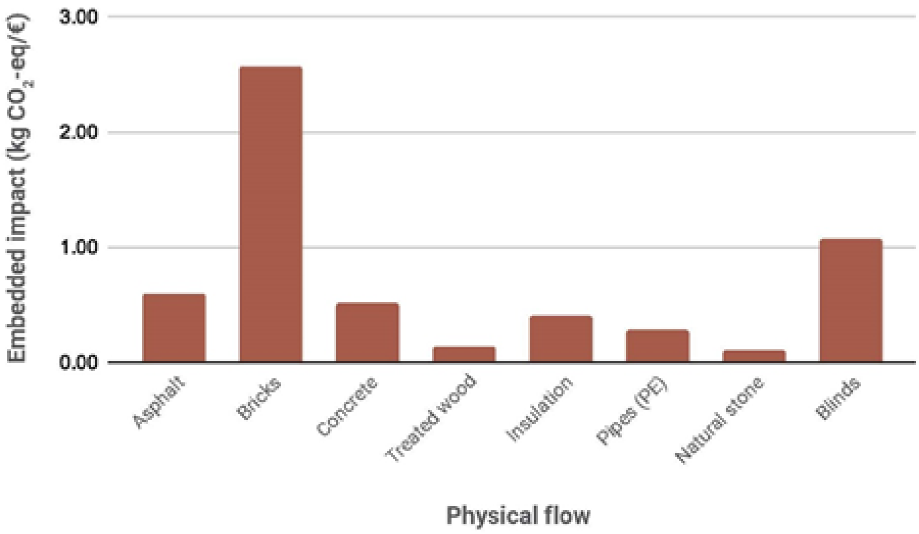

Figure 4.5 Embedded impact per physical flow for the construction materials product group.

The same phenomenon can be seen in Figure 4.5 for the construction materials product group. This shows that the impact factor of bricks is relatively high. This is because bricks are relatively cheap, but do require a lot of energy to produce. In addition, roller shutters have a high impact factor. This can be explained by the high material use of the product.

Methodical insights step 2
For some physical flows, an impact factor is difficult to determine, because that embedded impact depends on several factors that can vary greatly. As regards roller shutters, for example, the material of the roller shutter determines the embedded impact. As regards hot water, for example, the impact depends on how the water is heated (using gas, geothermal energy, electricity) or to what temperature the water is heated. Extra attention is paid to this in the uncertainty analysis of this study.

Step 3. Combining Expenditure and Impact Factors; determining total impact
In the last step of this analysis, steps 1 and 2 are combined to determine the total impact per identified physical flow.

Results step 3

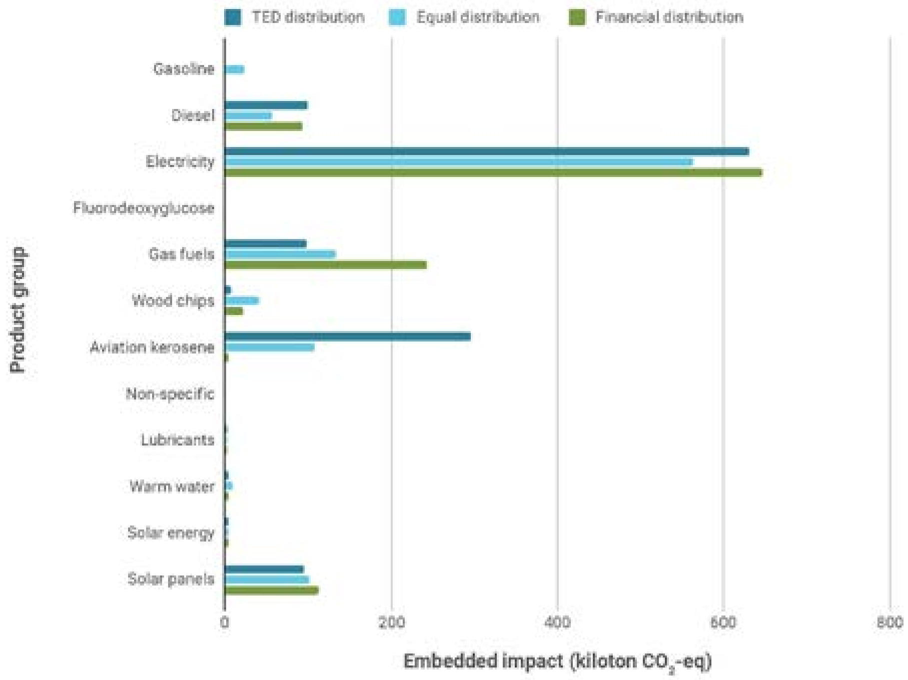

Figure 4.6 Total absolute impact per physical flow for the energy carriers product group, for three different methods of expenditure distribution.

The results of Figure 4.6 show that the use of electricity has by far the greatest absolute impact. This can be explained by the large expenditure on this physical flow, as well as the relatively high impact factor that this physical flow creates. In addition, the absolute impact of gaseous fuels emerges from the results as a prominent item. This too can be explained by the relatively high expenditure and high impact factor. What is also striking is that the item aviation kerosene, in terms of absolute impact, only emerges when using the TED distribution. This indicates that it pays to study the texts of the tenders and to look carefully at what types of fuels are purchased, otherwise this item would have been missed.

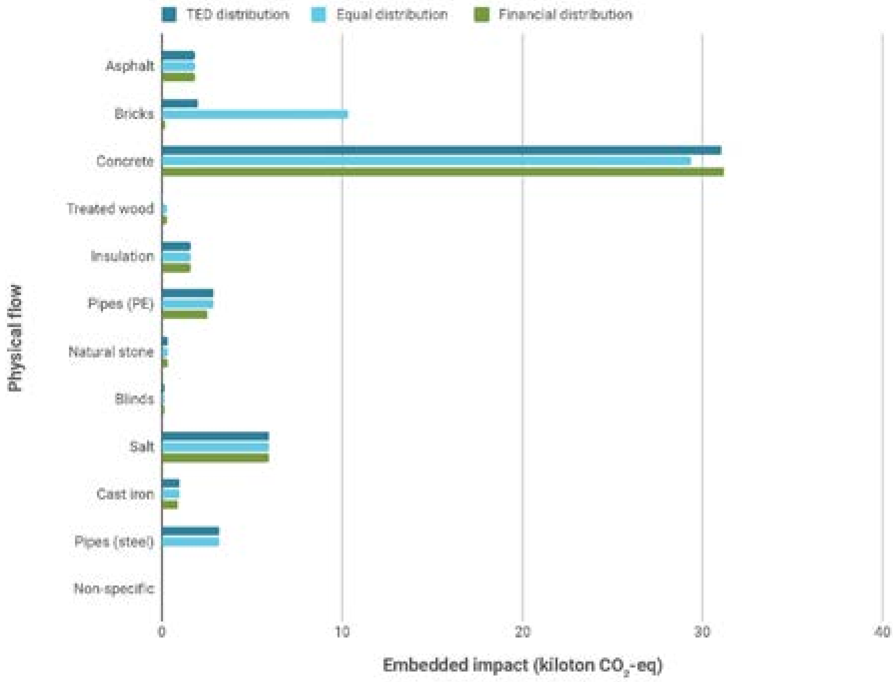

Figure 4.7 Total absolute impact per physical flow for the construction materials product group, for three different methods of expenditure distribution.

In the construction materials product category too there are a number of physical flows that stand out (see Figure 4.7). Concrete, for example, has by far the largest absolute impact, which is due to the relatively high expenditure on this physical flow and the relatively high impact factor of concrete. In addition, when applying equal distribution on bricks (with each lower CPV group being allocated the same percentage of the spend), the absolute impact increases sharply. This increase is due to the relatively high expenditure allocated to bricks when using equal distribution and the relatively high impact factor of bricks.

4.3 Discussion

4.3.1 Insights BUA general

The BUA has identified a number of key challenges in using CPV codes to understand material use and energy use as a basis for impact determination:

It seems that using the TED data is the most reliable basis for specifying higher CPV codes to physical flows. In some cases, however, it is not possible to determine which physical flow is involved on the basis of this data. Example: the tender document for the purchase of electricity does not contain information about the energy source (Insights step 1).

Costs are regularly booked at a higher level of CPV code. As a result, it is not possible to find out which physical flows have been purchased. Example: diesel is booked as fuels (Insights step 1).
The type of physical flow involved cannot always be deduced from the CPV code descriptions. Example: partition walls can consist of different types of materials (Insights step 1).

CPV codes sometimes consist of a combination of products and services. For example, ‘Pipelines, or purchasing and construction of (pipeline) infrastructure’ and the relationship between the price share of the services and the products is not always transparent (Insights step 1).

In some cases, impact factors are difficult or impossible to determine because they depend on too many unknown variables. One such example is the unknown energy source for ‘Hot water’ (Insights step 2). This implies that, if we want to gain a better insight into the impacts, better administrative records must be kept.

The above challenges make the BUA time-consuming and, due to a lack of information, require many assumptions creating uncertainty. This makes carrying out a BUA for all government expenditure infeasible.

As described in the introduction of this chapter, the BUA was carried out to supplement the IOA with the results. As described in section 3.3, this hybrid approach turned out to be too time-consuming to implement for a larger number of product groups. The CPV classification does not provide enough guidance to be able to easily link this to physical flows on a large scale and thus to environmental impacts. Therefore, the results for the two product groups worked out in this chapter have been used to validate and correct the results based on the IOA, while the hybrid approach itself has not been implemented further.

4.3.2 Sensitivity analysis impact figures

In addition to the sensitivity of the results to the choice in dividing the expenditure among CPV groups in step 1 of the BUA approach (Figure 4.6 and 4.7), the results are also sensitive to the choice in composition of the physical flow. This has been made transparent for energy carriers by using alternative compositions for a number of the physical flows (see Figure 4.8).

Grey power versus green power

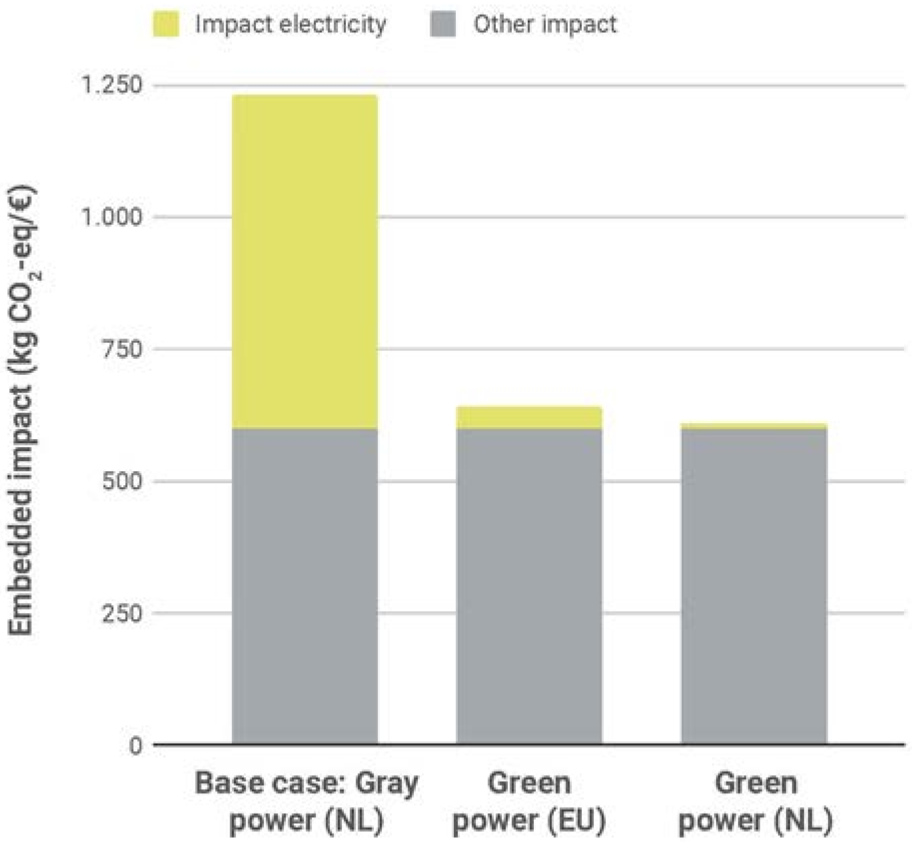

Figure 4.8 Total absolute impact for the energy carriers product group, when exploring three scenarios for different sources of electricity.

No consistent information about the origin of electricity purchased by the Dutch government is available, although the SPP effect monitor (de Valk et al., 2019) shows that in 2015-2016, more than half of the tenders requested electricity in the form of green power from the Netherlands. Figure 4.8 shows the consequences of the choice of type of electricity for the greenhouse gas intensity per euro spent on the energy carriers product group. The impact factor (CO_2 eq/€) is highly dependent on the assumption for electricity source. When choosing grey electricity, 51% of the impact per euro within the energy carriers group is caused by electricity. This drops to 1% when choosing green electricity from the Netherlands.

Fossil fuels versus biofuels

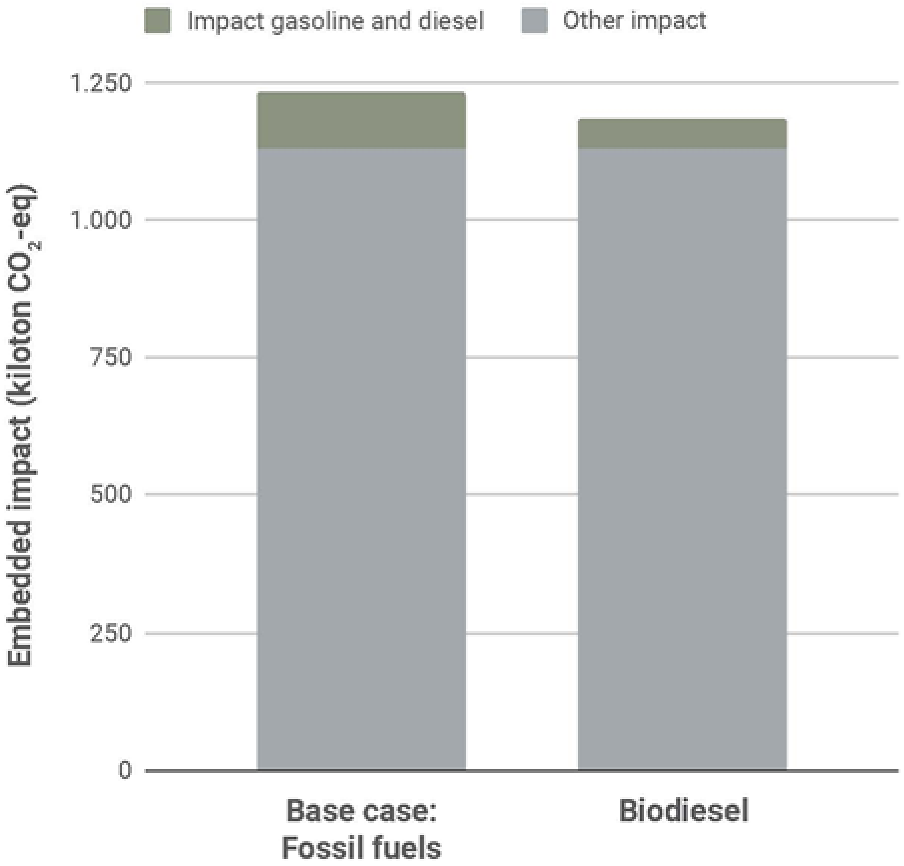

Figure 4.9 Total absolute impact for the energy carriers product group, when exploring three scenarios for different sources of electricity.

The same exercise was carried out for the use of green fuels (in this case biodiesel) compared to fossil fuels. For this expenditure group too, no consistent information about the origin of the physical flow is available. If assuming that within the energy carriers product group all diesel is of fossil origin, diesel determines 6% of the total impact of the energy carriers product group. When replacing fossil diesel with biodiesel, approximately 50% less impact is created, as a result of which the total impact by fuels decreases to 3% of the total impact of the energy carrier product group.

These sensitivity analyses show that the lack of a small piece of data (in this case, the origin of electricity that is purchased) can lead to a large difference (in this case up to 50%) in the total impact of a procurement category. The importance of correct descriptions of tenders and the correct classification of expenditure are again underlined, when aiming to understand the impact of expenditure by means of a BUA.

To be able to perform a BUA to calculate environmental impacts based on spend data, a number of important changes are needed. In the future, in order to be able to perform a BUA analysis based on CPV codes with less effort, it helps if:

- CPV codes are adapted so that a distinction can be made between, for example, different types of electricity or other ways of distinguishing sustainability ambitions;
- CPV codes are booked more consistently and at the most relevant level in tenders. This is particularly important for product groups that involve a lot of materials and energy.

5 Conclusions and recommendations on the method

5.1 The impact of procurement by the Dutch governments

The aim of this study was to develop and apply a method that provides insight into the impact of procurement by Dutch governments for a number of important impact categories. This was achieved by answering the following questions:

- What is the total expenditure of the Dutch governments?
- Which product groups are these expenditures spent on?
- What is the impact per euro for these product groups?
- What is the total impact of this on climate, resource consumption and land use?

To answer these questions, three known methods were combined: spend analysis, input-output analysis and life cycle analysis. The results of the calculations are summarised in a single image (link to the visualisation). This enables people involved in SPP in practice to gain insight into what they spend their money on and what environmental effects this creates. This insight can lead to (re)prioritisation of efforts on SPP themes per product (group). It helps to use time and resources more effectively in realising a reduced environmental impact as a result of procurement.

The quality of the data and choices that had to be made to combine the methods lead to uncertainties in the results. A sensitivity analysis was performed on some of these uncertainties, which made it possible to announce the results with an indication of the possible range. In addition, the size of the results appeared to be in line with a similar study for Finland, carried out by Nissinen & Savolainen (2020). This instils confidence in the results.

5.2 Use of the results

The results of this study can be used for raising awareness, for tightening policy and for choosing focus in the SPP practice. The results show that procurement by the Dutch governments contributes for 5% (land), 12% (climate) and 13% (raw materials) to the footprint of consumption expenditure in the Netherlands. SPP in government organisations can therefore have a significant impact on the reduction of the total Dutch footprint. Combined with insight into action perspectives for choosing sustainable alternatives, this analysis can be used to set concrete policy targets. For example, the policy target to save 1 megaton of greenhouse gas emissions per year. By applying circular procurement, these results can be further optimised: through which choices can this intended gain be achieved most effectively? The results show that almost every euro with which a purchase is made has an impact, but this impact is not distributed in direct proportion to the product groups. A euro spent on energy creates a different (and higher) climate footprint than a euro spent on a service or work in care. In other words: Not every euro spent involves the same impact. Based on the results of this study, it will thus be possible to prioritise the deployment of SPP.

The results further show that it is good to consider different impact themes when choosing focus. For example, if only climate is considered, catering is a small product group compared to other product groups, but if the starting point is land use, then catering is one of the main product groups.

Use of the results of the applied method also comes with limitations. In its current state, the method and underlying data sources are not suitable for calculating sustainable alternatives. This requires a level of detail that cannot yet be achieved for most product groups with the granularity of databases such as Exiobase. Calculating action perspectives requires a bottom-up method or a hybrid approach. This method is therefore not suitable for monitoring the effect of SPP. As such, it is not a substitute for SPP effect monitoring which, on the basis of bottom-up information, answers the question about the effect of SPP compared to regular procurement, as in Dekker et al. (2021). However, the effects that are investigated with this monitor *can* be related to the absolute impact figures that have been made available with this study.

The suitability for making a time series of the impact of government procurement is also limited. The spend data can be updated annually. For the translation into impact, however, the method depends on the availability of new versions of the underlying input-output tables and the associated emission registrations in EE-IOA. Currently, no annual updates are available on this. In addition, it is not easy to interpret changes over time in these tables. To overcome these limitations of the IOA, the answer is again: combining with bottom-up data, for which data collection is time-consuming.

At the same time, the demand for this type of studies and data is growing, parallel to the various transitions (energy, circular economy, biodiversity) and the growing support for SPP. To consistently meet this demand with sufficient detail to justify alternative actions, there are several routes to further specify the data used and make it more accurate, see section 5.3.

5.3 Improving accuracy by keeping consistent administrative records

More accurate spend data result

This study shows that purchasing organisations are inconsistent in the administration of tenders. This mainly manifests itself in the following two ways: 1) tenders are often not provided with amounts, and 2) the coding (CPV codes, see glossary) used in tenders is often not specific enough in practice.

The consequence of the lack of amounts is that a large part of the tender amounts must be estimated. This is realised by scaling up the known amounts. This raises uncertainties. The coverage of tender amounts varies between product groups and purchasing organisations. The sensitivity of the results to this coverage was investigated by adding a range based on the coverage. For purchasing organisations or products with a relatively low coverage (~5%), the range is large (~40%) and with a relatively high coverage (~50%), the range is smaller (5%).

With the current quality of data, a lot of time is spent modelling and interpreting the data and results. In order to make this method less time-consuming and to be able to better interpret the results, it is desirable to address the uncertainties from at least two sides:

- Improved tendering by providing many more tenders with correct tender amounts, so that at least 25% and preferably 50% of the tenders are provided with amounts per type of government organisation and per type of product group.
- Refining the method of scaling up coverage by comparing tender data with primary data from purchasing organisations, such as the Iv3 data (more on this in section 2.4.2).

In addition to the uncertainty due to missing tender amounts, the majority of tenders are booked on non-specific CPV codes, while more specific CPV codes are available. The more specific the coding, the better the link can be made with methods to determine the impact. In this study, non-specific expenditure in the spend analysis has been 'passed on' to more specific expenditure groups on the basis of the distribution in that group. Although this means that more expenses can be linked to specific impacts, our sensitivity analysis shows that this method is not equally accurate for every product group. Better use of specific CPV coding is therefore an important way of performing this type of impact analysis with a higher level of accuracy.

A more fundamental recommendation is to investigate whether CPV coding can be better aligned with SPP. For example, by distinguishing between different technologies that are possible (e.g. type of energy mix) or the level of sustainable ambition. This can help with the SPP implementation itself, as well as with the evaluation of the implementation and its effects.

More accurate impact calculation result
For two product groups, the impact calculation could be supplemented with bottom-up (BU) results. Particularly for product groups where IOA databases are not specific, the analysis can be improved by processing more BU results. This is a time-consuming process and particularly worthwhile if the wish is to calculate action perspectives or to calculate the footprints for, for example, individual contracting authorities (see, for example, CE Delft, 2018b).

The impact calculation could also be more accurate by evaluating if the government spend has a similar distribution of import countries and domestic consumption as the average final consumption in the Netherlands. With Exiobase, the impact coefficient of a product is calculated for all 49 regions each, and these can vary greatly. For example, grains from Brazil have a different footprint profile than grains from Germany. Therefore, the distribution of import countries and domestic consumption can greatly impact the average impact coefficient. In this study, we used averages for the mix of product origins based on the total final demand for the Netherlands. However, this might differ from the actual mix of the government spend.

5.4 Using rich source of data more effectively

Section 5.3 describes how the current method with underlying data sources can provide more accurate results. In addition, it is possible to expand and deepen the current method to create more insight into each type of government organisation.

5.4.1 Action perspective

The product groups with the highest impact are not always the product groups that offer most prospects in terms of action perspective for sustainable alternatives via SPP. The combination of insight into current impact and possible actions provides a strong basis for strategically prioritising product groups and SPP themes. An improved insight into action perspective could be compared with the impact calculated in this study. To do this quantitatively, the bottom-up approach needs to be deployed more, as was carried out for circular procurement for the Integrated CE Report (Zijp et al., 2020).

5.4.2 Other SPP Themes

Social themes. Since the relationships between trade, environment and socio-economic factors are in a single consistent framework, the current method makes it relatively easy to add socio-economic factors to the analysis, such as employment and added value. Social return is expected to combine well with this analysis as well, because information about the current implementation and its effects is available (Dekker et al., 2021). Other social themes, such as diversity and inclusion, are less easy to add, but are worth the effort to provide further insight in line with the SPP 2021-2025 action plan (Government of the Netherlands, 2021).

Environmental themes. A major advantage of using Exiobase v3 is that it includes a large number of environmental extensions. As a result, more environmental themes can be explored and a broader impact profile can be investigated, such as air quality, toxicity and water use.

5.4.3 Details per type of government organisation

This study has been set up to generate an overall picture of the expenditure of the Dutch governments and the additional environmental effects. However, it also provides a basis for creating more insight per type of government organisation. The spend analysis provided sufficient level of detail for this. This study provides a generic idea for the link to impacts, but for an analysis per type of government organisation it must first be checked whether the composition per product group is comparable to the total. In addition, a different categorisation may be desirable. For example, it would probably be useful for municipalities to break down construction into buildings and different civil and hydraulic engineering categories. It is also useful to explicitly include public transport and waste processing, because other types of action perspective arise. Follow-up studies of this kind are recommended and that is why the methods and data are described in detail in this report. If this requires refinement of the spend analysis with a better distinction between services and materials, it can be achieved by integrating Iv3 data into the analysis (more on this in section 2.4.2).

5.4.4 *Availability at a level that suits the buyer*

For the purpose of this study, the impact has been made available based on the product group classification of Exiobase (83 product groups, see Appendix E). Just as for this study, the CPV codes have been translated to these 83 product groups, they could also be translated into the commonly used classifications of the PIANOo purchasing packages and the product group classification as applied to SPP and which is visible at, for example, www.mvicriteria.nl. Such a link requires assumptions that are best made by a group of experts, as in this study, and not by a single individual.

5.4.5 *EU: €2 trillion per year*

Internationally, too, much attention is paid to sustainability through SPP, or Green Public Procurement (GPP) within a European context. The combined government organisations within the European Union purchase approximately 14% of the total combined GDP (gross domestic product). This involves €2 trillion (EC, 2021). Conducting this study at the level of the European Union could provide valuable insight into where the major gains would lie on an EU scale, whether this differs per country and why, and therefore also where close collaboration could prove effective.

5.4.6 *Spend impact analysis dashboard*

The results of the spend impact analysis can be communicated via a dashboard. This could, for example, become part of the SPP Self Evaluation Tool (mvizet.nl) or the Raw Materials Information System (RMIS) that is being developed in the context of the transition to a circular economy (Hanemaaijer et al., 2021). The estimated amounts and associated impact factors contain inaccuracies and are most representative at the national level, but also provide relevant insights at a more detailed level that can be visualised. Plotting the spend volumes on the y-axis and the SPP impact possibilities on the x-axis results in a kind of Kraljic matrix for the SPP impact. When comparing spend and impact, the quick wins become instantly visible, which makes prioritisation easier. In an example for a municipality, this could look like Figure 5.1.

In this example, roads and transport services both have the highest spend and also a high SPP impact. Green areas and sewerage are also major cost items, but with significantly less impact. We can see the highest impact in printed matter and catering, but their purchasing volumes are much lower. This way, a specific approach can be drawn up for each quadrant to start working with SPP efficiently and effectively.

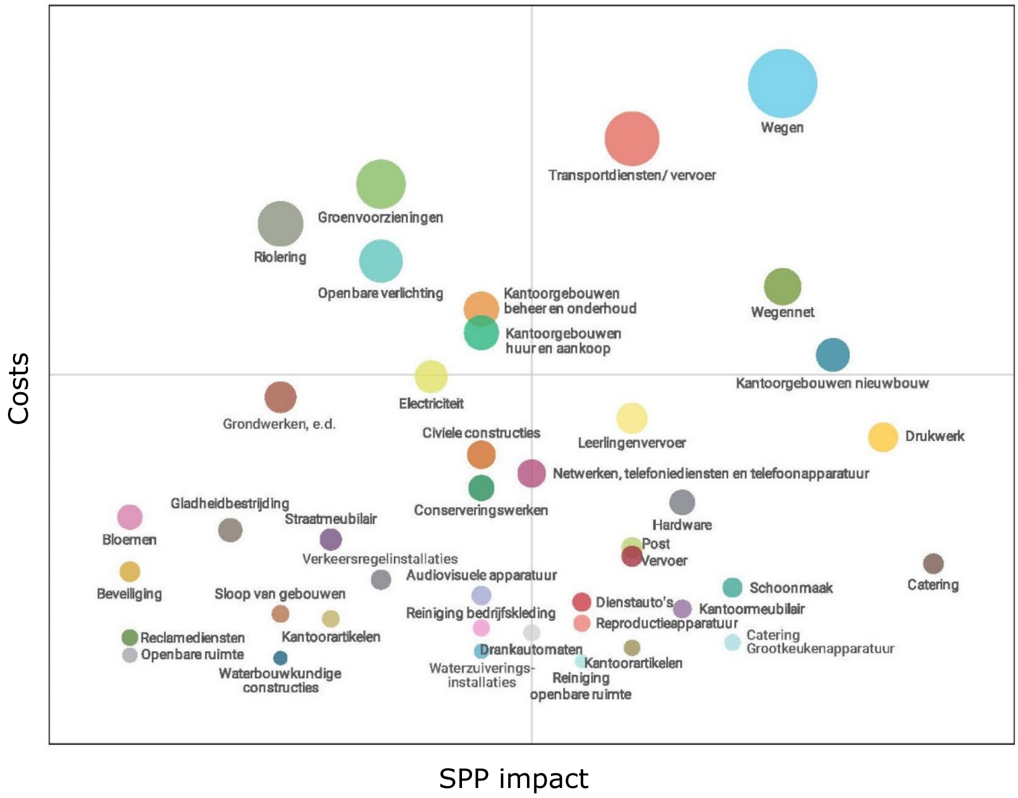

Figure 5.1 Matrix in which costs and impact are compared. This is an example for a municipality. The impact for this is not a quantitative score, but a qualitative one, based on numbers of available SPP criteria on www.mvicriteria.nl.

Based on the results of this study, a first version of such a dashboard could be drawn up, which would allow focusing on the results of this study based on interest in the type of government organisation and product groups.

5.5 Collaborating and sharing data

The study brought together expertise in spend analysis and in calculating environmental impact. Finding, properly linking and verifying and interpreting the results found not only require technical knowledge, but also insight into the context of the data. It is precisely the bringing together of expertise from the various fields (in this case spend, finance, public tenders and environmental impact calculations) that provides in-depth insights.

For the continuation of this type of analysis, it is important that the experts who work on this know where to find each other and that a joint platform or network is created, in which:

- new experiences with data links and new bottom-up data can be shared;
- second opinions on important assumptions can be requested;
- essential databases can be maintained or followed centrally for footprint calculations and the links between different databases, such as between CPV codes and Exiobase in this study.

Such a system is being developed for the data required for monitoring the transition to a circular economy: the Raw Materials Information System (under the Dutch acronym: GRIS).

List of terms and abbreviations

BUA – bottom-up analyse
A BUA provides additional insight into subcategories, because these are examined more specifically.

COMEXT
Eurostat database with international trade data

CPA – Classification of Products by Activity
European product coding widely used for static data on goods and services.

CPC – Customs Procedure Code
United Nations international product coding, commonly used for static data on goods and services.

CPV – Common Procurement Vocabulary
The CPV classification is the standard within the EU for (public) tenders.

Durable goods (accounting)
Goods the economic life of which is at least one year.

EE-IOA – Environmentally Extended IOA
An IOA extended with environmental extensions to calculate environmental impacts.

Environmental impact
Effects of economic activity on the environment, during which substances are extracted from the environment (e.g. raw material extraction) or are emitted to the environment (e.g. greenhouse gas emissions).

Exiobase
A harmonised multi-regional EE-IOT.

Final demand vector
A vector consisting of the total expenditure on the types of product groups.

Functional unit
The basis (quantity and unit) on which two alternatives can be compared

IOA – Input-output analyse
Macroeconomic calculation method to analyse relationships between industries. An IOA is used to calculate how much production value is needed from different industries in a value chain to generate a particular output.

IOT – Input-output table
This is a matrix in which the intermediate transactions (between industries) and final transactions (between industries and consuming parties), i.e. all flows of goods, are consolidated.

Impact coefficient
The calculated impact per euro.
Imputation
Filling in missing data points through estimates.

LCA – Life Cycle Assessment
A study in which the life cycle of a product or material is examined.

LCI – Life Cycle Inventory
An LCI database contains key indicators of embedded impact for different products and physical flows.

Many-to-one link
A link in which multiple codes come under a single corresponding code.

MID/LO/HI scenario
The expected value, a lower and upper limit as the basis for three scenarios: mid (MID), low (LO) and high (HI).

NACE – Nomenclature statistique des Activités économiques dans la Communauté Européenne
European coding for (business) activities.

One-to-many link
A link in which one code must be divided over several corresponding codes (with, for example, a distribution key)

Spend
The expenditure of organisations in the field of purchasing products, services and works.

TDA – Top-Down Analysis
In a top-down analysis, a macroeconomic perspective is used to roughly outline an overall picture of a situation.

TED - Tenders Electronic Daily
The TED is a supplement to the Official Journal of the EU.

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Appendix A. Description product group classifications

Description of different types of classifications of product groups that are used in the Netherlands for government procurement.

Government Procurement Categories (for generic goods and services)
In 2014, the government decided to conduct government-wide category management for 31 generic categories and to implement strategic supplier management for three categories. The categories are embedded in so-called Procurement Implementation Centres (PICs) at ministries under the direction of a coordinating purchasing director. A category manager and a contract manager have been appointed for each category. At central government, category management is directed by the Chief Procurement Officer (at the Ministry of the Interior and Kingdom Relations). He is responsible for three portfolio managers who in turn are responsible for the Facility Management, IT, Communication and Organisation and Personnel portfolios.

Table A.1 The 31 categories for which government-wide category management is conducted.

Government Segment	Government Category
Communication	Communication
	Professional literature and subscriptions
Facilities	Corporate clothing
	Security
	Catering
	Civil Service Vehicles
	Energy
	Resource management and waste management
	Hotel and meeting accommodations
	Office and computer supplies
	Office furnishings
	Laboratory supplies
	Paper, Disposal of printed matter information carriers
	Post
	Moving services
IT	Data centre
	Data connections
	Enterprise Business Applications
	IT work environment government
	Standard (package) software
	Total solutions

Government Segment	Government Category
Organisation and Personnel	Bailiffs
	Hiring financial advice and audit capacity
	Hiring IT expertise
	Hiring purchasing, tendering and legal advice, including State Advocate
	Hiring interim management
	Hiring interpreters and translators
Organisation and Personnel	Learning and developing
	Personnel mobility
	Temporary workers
	Transport (commuting, business trips)

In addition to a compact overview, another advantage of this classification (see Table A.1) is that category managers have already been appointed for each category. This allows for the results of the spend analysis to be picked up immediately by the managers responsible and converted into action plans.

The disadvantages of this classification are that a large part of the total procurement is missing (for example, construction projects, road construction and defence procurement) *and* that management is only focused on government procurement and not on procurement by local authorities.

SPP criteria tool
The SPP criteria tool contains 46 product groups and is more complete compared to the Government Procurement categories, but not exhaustive. For example, it also includes the clusters of civil and hydraulic engineering and office buildings. An advantage of this classification is that 600 SPP criteria have been drawn up for these product groups, which indicates there is a perspective for action to increase sustainability. In addition, this tool (Figure A.1) has been developed for the entire civil service, including local authorities. A disadvantage of this classification is that it is not detailed enough for purchasing departments to perform spend analyses. The more detailed PIANOo purchasing packages and CPV codes are therefore used for spend analyses.

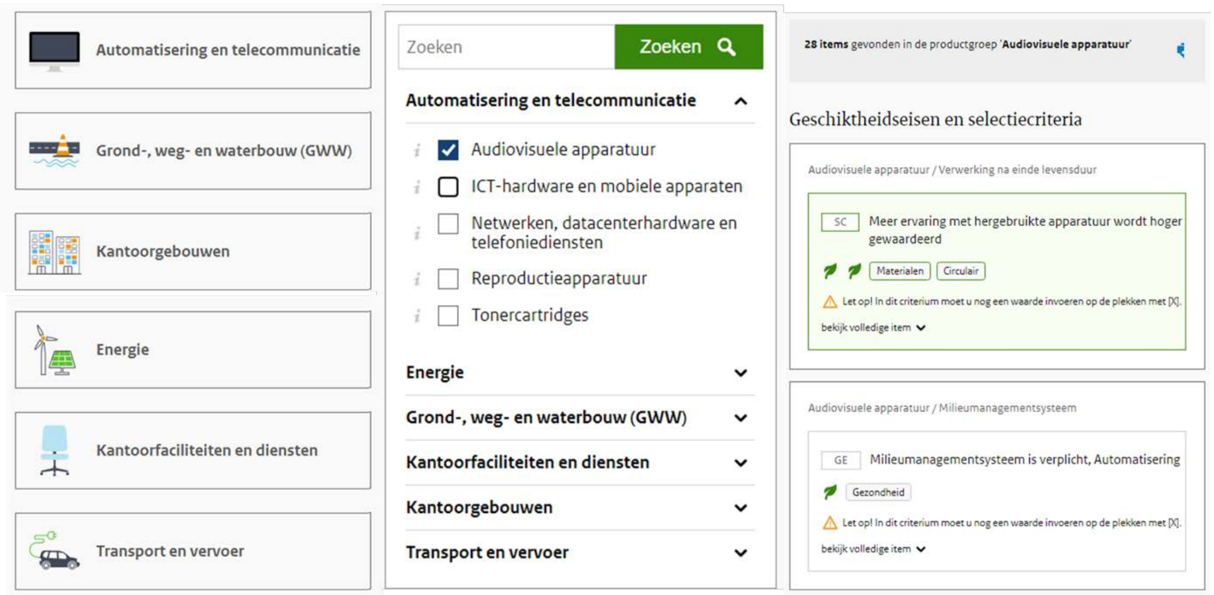


Figure A.1 Overview of the SPP criteria tool.

Central government open purchasing data
Purchasing expenditure is the expenditure incurred by the central government on goods and services at suppliers. Once a year, the Minister of the Interior and Kingdom Relations receives information about the purchasing expenditure of the previous year from all ministries and units operating below these. The ministry uses this information to provide government category managers who purchase and tender for the generic procurement categories with government-wide purchasing information. Since 2012, this purchasing information has also been used to inform the House of Representatives about government procurement and the share of small and medium-sized enterprises in it. This is done in the annual report on central government operations.

The classification consists of 66 categories, which are derived from the cost categories used in the accounting of the various ministries. In addition to open data being available with (tiered) amounts per supplier and product per ministry, another major advantage is that all purchases are available at the Ministry of the Interior and Kingdom Relations, so that spend analyses with impact can also be made at that level.
The disadvantage of this classification is that the cost categories do not always properly cover the load, such as 'Other products and services' and that bookings are not always logical.

PIANOo purchasing packages
The PIANOo purchasing packages classification is a widely used standard classification for various works, services and supplies, which helps a contracting authority in structuring its expenditure. Related supplies, services and products are grouped herein and are often used when making a spend analysis. The classification also helps to determine the CPV codes (see below) for a purchasing package, indicates which works, services and supplies are homogeneous and which sustainability criteria are available. This standard format simplifies collaboration between contracting authorities.

Table A.2 Overview of the PIANOo classification.

1-	Personnel related matters
101	Study, education and training
102	External meeting and accommodation facilities
103	Recruitment and selection
104	Corporate clothing
105	Cleaning of corporate clothing
106	Health and safety
107	Representation costs
108	Health insurance
109	Staff relocation costs
110	Company outings

2-	Office furnishings and supplies, operational resources and information
201	Office supplies
202	Paper
203	Office furnishings
204	Laboratory furniture
205	Art
206	Printed matter
207	Lettering and information boards
208	Professional literature and subscriptions
209	Archive equipment and digitisation of archive
210	Bank charges
211	Business insurance
212	Events
213	Muskrat traps, pest control agents
214	Emergency buildings
215	Advertising costs
216	Gym equipment, fitness equipment, sporting goods and gear
217	Corporate memberships

3- Automation and telecommunications	
301	Hardware: purchase, hire, installation, management and maintenance
302	Printers and reproduction equipment: purchase, hire, installation, management and maintenance

4- Advice and research (not on secondment basis)	
501	IT advice
502	Special legal services
503	Marketing, PR and communication advice
504	Graphic design and layout
505	Accounting services
506	Financial economic advice
507	Estate agency services and land purchase
508	Organisational advice, management advice and formation advice and HRM advice
509	Policy-supporting research
510	Facility management advice
511	Ecological research
512	Hydrological research
513	Environmental research and aquatic sediment survey, land surveying services
514	Archaeological research
515	Explosives research
516	Laboratory research
517	Asbestos research and removal
518	Engineering services
519	Notary services
520	Architectural and urban planning services
521	Traffic and transport research and advice
522	Purchasing advice and activities
523	Interpreters and translators
524	Customer satisfaction survey
525	Customised energy scans
526	Veterinary services
527	Tourist information
528	Specialist research into environmental effects (noise, vibrations, external safety)
529	Public space monitoring
530	Regular legal advisory services

7- Buildings and building-related systems	
701	Purchase and rent of buildings and land
702	Disposal and demolition of buildings
703	Purchase of measurement and control systems
704	Maintenance of measurement and control systems
705	Purchase of electrical building systems
706	Maintenance of electrical building systems
707	Purchase and installation of mechanical building systems
708	Maintenance of mechanical building systems
709	New construction and renovation
710	Purchase of permanent establishment
711	Structural maintenance
712	Painting of buildings
713	Joinery, carpentry
714	Technical durables and consumables, tools and small equipment
715	Cleaning of offices and kitchens
716	Glass cleaning
717	Sanitary products
718	Security and reception
719	Catering services
720	Vending machines (food and drinks)
721	Industrial kitchen appliances
722	Nutrition and ingredients
723	Crockery
724	Gas including charges of power company
725	Water including charges of water company
726	Electricity including costs of electricity grid manager
727	Greenery facilities (buildings)
728	Household waste
729	Sand processing
730	Other industrial waste
731	Sewer cleaning and inspection, industrial cleaning

With 212 purchasing packages divided over ten groups, the PIANOo classification offers an excellent balance between sufficient depth/detail and is (just) manageable enough to fit on a single A4 sheet. The 'pia code' is therefore used for making spend analysis within the public sector more than any other classification. It is an interesting classification for this study too, not only because there is potentially a lot of purchasing data available as input, but also vice versa to help a contracting authority to gain insight into their potential SPP impact based on their own spend analyses. However, this coding is not uniformly included in tender databases such as TED.

CPV (common procurement vocabulary)
All government procurement above a certain threshold value must be put out to European or multiple private tender according to fixed procedures, so that the purchasing process is fair and transparent. The CPV classification is the standard within the EU for (public) tenders. The official definition of CPV is: '*The common procurement vocabulary (CPV) establishes a single classification system for public procurement aimed at standardising the references used by contracting authorities and entities to describe procurement contracts.'*. The CPV codes associated with this classification are made public with the announcement of a contract, so interested suppliers can register to compete for the contract.
The biggest disadvantage of the CPV coding is that there are no fewer than 9,454 different codes, divided into 45 groups, which is also referred to as level 0. This makes it difficult for both the contracting authority and the suppliers to select the right codes when tendering or registering.

Appendix B. Known spend per product group

Table B.1 Known + estimated spend in the period 2010 to 2019 per product group at L0 level.

L0	L0_name	Total	%Cumm	%Quantity
45	Construction work	54,085,304,172	33%	2%
79	Business services: legal, marketing, consulting, printing & security	14,278,334,585	42%	4%
85	Healthcare and social work	12,516,814,647	50%	7%
34	Transport equipment and corresponding products	9,083,518,124	56%	9%
66	Financial and insurance services	8,897,722,285	61%	11%
60	Transport services (except waste transport)	8,040,210,804	66%	13%
50	Repair and maintenance services	6,425,537,441	70%	16%
72	IT services: advice, software development, internet and support	4,723,749,464	73%	18%
90	Waste water, waste, cleaning and environmental services	4,704,552,281	76%	20%
09	Petroleum products, fuel, electricity and other energy sources	4,363,025,029	78%	22%
48	Software and information systems	3,720,956,464	81%	24%
77	Agriculture, forestry and horticulture, aquaculture and apiculture services	3,265,385,990	83%	27%
30	Office machines and data processing equipment, office equipment and supplies, excluding furniture and software packages	2,900,588,355	85%	29%
71	Services in the field of architecture, construction, civil engineering and inspection	2,729,137,014	86%	31%
32	Radio, television, communications, telecommunications and related equipment	1,892,591,928	87%	33%
33	Medical equipment, pharmaceuticals and personal care products	1,783,464,218	89%	36%
98	Other community, social and personal services	1,589,479,050	90%	38%
39	Furniture and furnishings (including office furniture), household appliances (except lighting) and cleaning products	1,499,496,696	90%	40%
44	Construction structures and materials; construction ancillary products (excluding electrical equipment)	1,254,623,781	91%	42%
22	Printed matter and related products	1,248,270,691	92%	44%
42	Company machines	1,220,898,005	93%	47%
75	Public administration, defence and social insurance services	1,066,015,527	93%	49%
64	Postal and telecommunications services	1,063,252,970	94%	51%
31	Electrical machines, appliances, equipment and consumables; lighting	1,012,610,411	95%	53%
38	Laboratory instruments, optical and precision instruments (excluding spectacles)	989,634,438	95%	56%
63	Ancillary and additional transportation services; travel agency services	964,599,753	96%	58%

L0	L0_name	Total	%Cumm	%Quantity
80	Education and training services	832,512,647	96%	60%
55	Hotel, restaurant and retail services	820,217,449	97%	62%
15	Food, beverage, tobacco and related products	743,203,002	97%	64%
92	Cultural, sports and leisure services	647,117,938	98%	67%
18	Clothing, footwear, luggage items and accessories	615,266,566	98%	69%
65	Public facilities	521,639,370	98%	71%
51	Installation services (excluding software)	472,651,674	99%	73%
35	Equipment for security, fire brigade, police and military	435,660,161	99%	76%
73	Research and development, and related advice	338,749,748	99%	78%
24	Chemical products	305,567,473	99%	80%
70	Estate agency services	262,347,470	100%	82%
03	Agricultural and livestock, nursery, fishing and forestry products and related products	139,853,405	100%	84%
37	Musical instruments, sports products, games, toys, crafts, arts and accessories	134,849,257	100%	87%
43	Machinery for mining, quarrying and construction	86,307,060	100%	89%
14	Mining, base metals and related products	72,026,819	100%	91%
16	Agricultural machinery	67,667,523	100%	93%
41	Collected and treated water	50,395,138	100%	96%
76	Services related to the oil and gas industry	43,334,633	100%	98%
19	Leather, textile fabrics, plastic and rubber materials	43,298,661	100%	100%
Total		**161,952,440,119**	**100%**	**100%**

Appendix C. Calculated total spend in 2019

Table C.1 Calculated total spend in 2019 per CPV main code and type of government organisation.

L0	L0_name	Academic hospitals	National government other	Municipalities	JA Joint arrangements	Local government other	Ministries	Not classified	Provinces	Public services	Schools	Social security funds	Special sector companies	Universities	Water boards	Grand total
03	Agricultural and livestock, nursery, fishing and forestry products and related products	7	-	35	2	1	8	4	0	2	3	2	2	10	7	85
09	Petroleum products, fuel, electricity and other energy sources	33	41	734	53	163	564	53	5	49	44	9	143	256	118	2.265
14	Mining, base metals and related products	3	2	14	1	2	3	1	2	-	-	-	4	0	4	37
15	Food, beverage, tobacco and related products	75	40	37	19	17	74	16	4	70	37	-	7	45	4	445
16	Agricultural machinery	-	-	13	-	4	-	-	3	-	-	-	-	14	7	41
18	Clothing, footwear, luggage items and accessories	27	51	48	3	9	87	12	4	35	6	8	19	8	4	322

L0	L0_name	Academic hospitals	National government other	Municipalities	JA Joint arrangements	Local government other	Ministries	Not classified	Provinces	Public services	Schools	Social security funds	Special sector companies	Universities	Water boards	Grand total
19	Leather, textile fabrics, plastic and rubber materials	-	1	2	5	2	4	0	1	2	-	-	2	-	-	19
22	Printed matter and related products	14	103	48	14	50	23	196	10	45	241	8	29	36	13	830
24	Chemical products	37	5	12	4	46	6	5	-	9	3	8	27	43	8	212
30	Office machines and data processing equipment, office equipment and supplies, excluding furniture and software packages	61	137	181	32	52	223	154	7	219	408	24	12	317	19	1.846
31	Electrical machines, appliances, equipment and consumables; lighting	12	6	146	7	58	13	10	6	6	2	-	146	77	7	496
32	Radio, television, communications, telecommunications and related equipment	48	69	129	169	58	120	47	7	114	84	26	27	320	14	1.232
33	Medical equipment, pharmaceuticals and personal care products	648	148	441	29	21	42	39	0	41	8	173	11	57	3	1.659

L0	L0_name	Academic hospitals	National government other	Municipalities	JA Joint arrangements	Local government other	Ministries	Not classified	Provinces	Public services	Schools	Social security funds	Special sector companies	Universities	Water boards	Grand total
34	Transport equipment and corresponding products	9	363	591	234	98	102	75	41	169	5	-	1.828	30	37	3.584
35	Equipment for security, fire brigade, police and military	-	121	10	33	15	49	9	2	18	1	-	13	3	0	275
37	Musical instruments, sports products, games, toys, crafts, arts and accessories	-	-	38	5	2	9	2	-	8	4	-	-	3	-	71
38	Laboratory instruments, optical and precision instruments (excluding spectacles)	190	26	45	4	34	22	21	1	15	7	-	122	237	9	734
39	Furniture and furnishings (including office furniture), household appliances (except lighting) and cleaning products	59	42	82	19	51	55	35	80	23	224	8	23	129	7	837
41	Collected and treated water	-	-	1	-	-	1	1	-	0	-	-	12	-	1	17
42	Company machines	49	17	71	20	27	39	20	7	41	20	25	160	32	58	586

L0	L0_name	Academic hospitals	National government other	Municipalities	JA Joint arrangements	Local government other	Ministries	Not classified	Provinces	Public services	Schools	Social security funds	Special sector companies	Universities	Water boards	Grand total
43	Machinery for mining, quarrying and construction	-	-	13	1	3	5	0	0	2	1	-	7	-	7	39
44	Construction structures and materials; construction ancillary products (excluding electrical equipment)	3	21	258	16	54	54	12	12	28	6	-	103	17	10	592
45	Construction work	1.163	282	7.040	136	838	667	572	966	5.911	1.054	8	2.960	2.224	1.459	25.277
48	Software and information systems	336	468	333	142	104	228	60	14	171	110	62	156	178	80	2.443
50	Repair and maintenance services	50	94	1.401	46	56	127	50	24	374	55	16	518	426	18	3.257
51	Installation services (excluding software)	18	7	21	2	8	27	8	2	20	5	-	72	7	3	201
55	Hotel, restaurant and retail services	12	74	27	22	19	21	31	10	62	87	16	15	181	12	588
60	Transport services (except waste transport)	198	22	1.179	453	1.580	65	55	459	6	7	8	23	14	1	4.069

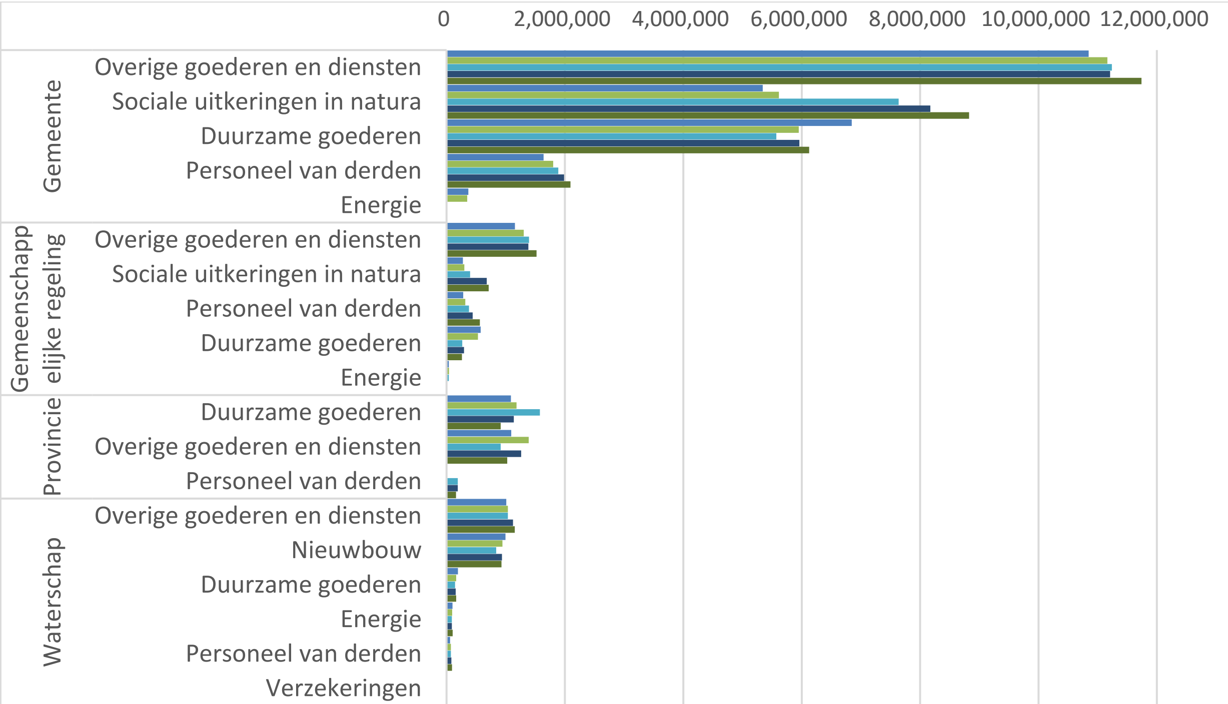
L0	L0_name	Academic hospitals	National government other	Municipalities	JA Joint arrangements	Local government other	Ministries	Not classified	Provinces	Public services	Schools	Social security funds	Special sector companies	Universities	Water boards	Grand total
63	Ancillary and additional transportation services; travel agency services	-	33	15	1	8	202	4	2	51	8	-	43	66	-	432
64	Postal and telecommunications services	38	232	74	16	21	88	41	11	60	34	8	28	25	7	683
65	Public facilities	-	-	88	-	4	-	6	1	1	2	-	102	3	0	207
66	Financial and insurance services	28	131	3.483	597	30	27	62	11	30	434	24	150	138	15	5.161
70	Estate agency services	-	2	111	0	3	1	2	4	7	4	-	-	5	3	142
71	Services in the field of architecture, construction, civil engineering and inspection	50	38	362	49	17	70	63	74	149	55	-	143	143	103	1.317
72	IT services: advice, software development, internet and support	59	474	779	180	55	279	122	45	329	127	88	59	99	19	2.713
73	Research and development, and related advice	15	22	7	6	0	63	11	4	8	2	8	13	10	3	172
75	Public administration, defence and social insurance services	-	141	253	6	44	129	12	4	9	11	1	4	-	4	617

L0	L0_name	Academic hospitals	National government other	Municipalities	JA Joint arrangements	Local government other	Ministries	Not classified	Provinces	Public services	Schools	Social security funds	Special sector companies	Universities	Water boards	Grand total
76	Services related to the oil and gas industry	-	-	0	-	0	6	1	0	-	-	-	8	-	0	15
77	Agriculture, forestry and horticulture, aquaculture and apiculture services	8	3	1.572	25	43	23	6	15	4	6	-	10	25	85	1.824
79	Business services: legal, marketing, consulting, printing & security	173	1.365	2.188	357	363	1.362	179	83	784	191	181	264	466	70	8.027
80	Education and training services	8	57	138	14	3	65	16	6	31	62	74	16	13	5	509
85	Healthcare and social work	20	37	5.246	113	51	26	18	146	685	16	182	19	13	2	6.574
90	Waste water, waste, cleaning and environmental services	77	127	705	207	265	111	224	17	100	613	16	84	267	161	2.976
92	Cultural, sports and leisure services	7	143	159	1	21	9	20	7	39	1	-	8	-	2	418
98	Other community, social and personal services	65	26	675	54	12	21	13	4	15	8	16	11	25	12	955
Grand total		3.600	4.972	28.800	3.100	4.312	5.122	2.289	2.100	9.744	3.996	1.000	7.404	5.961	2.400	84.800

Appendix D. Overview of the Iv3 data 2015 to 2019

Type	Group	2015X005	2016X005	2017X005	2018X005	2019X005
Municipality	Other goods and services	10,846,610	11,164,497	11,239,934	11,209,000	11,739,719
Municipality	Social benefits in kind	5,342,701	5,613,456	7,638,591	8,172,550	8,827,195
Municipality	Durable goods	6,845,906	5,949,511	5,570,907	5,960,040	6,126,888
Municipality	Third-party personnel	1,640,482	1,800,652	1,888,029	1,984,687	2,093,663
Municipality	Energy	369.218	349.376			
Total Municipality		**25,044,917**	**24,877,492**	**26,337,461**	**27,326,277**	**28,787,465**
Joint arrangement	Other goods and services	1,155,707	1,304,125	1,393,138	1,382,816	1,520,822
Joint arrangement	Social benefits in kind	276.278	301.506	399.173	678.509	712.251
Joint arrangement	Third-party personnel	281.242	316.916	377.910	440.954	562.862
Joint arrangement	Durable goods	575.581	530.838	265.525	294.273	258.697
Joint arrangement	Energy	37.986	39.771	37.448		
Joint arrangement total		**2,326,793**	**2,493,156**	**2,473,194**	**2,796,552**	**3,054,632**
Province	Durable goods	1,087,148	1,183,153	1,576,692	1,135,241	914.799
Province	Other goods and services	1,092,341	1,386,936	913.243	1,259,645	1,025,644
Province	Third-party personnel			189.162	190.361	159.510
Total Province		**2,179,489**	**2,570,089**	**2,679,097**	**2,585,247**	**2,099,953**
Water board	Other goods and services	1,009,049	1,036,448	1,034,901	1,123,533	1,153,239
Water board	New construction	994.855	945.038	838.952	936.327	927.844
Water board	Durable goods	191.335	162.495	144.613	154.642	161.301
Water board	Energy	100.692	95.178	90.536	90.784	103.073

Type	Group	2015X005	2016X005	2017X005	2018X005	2019X005
Water board	**Third-party personnel**	59.611	73.226	74.108	82.753	91.638
Water board	**Insurance**	6.711	7.234	6.802	7.050	7.596
Total Water Board		**2,362,252**	**2,319,619**	**2,189,912**	**2,395,089**	**2,444,691**
Grand total		**31,913,451**	**32,260,356**	**33,679,664**	**35,103,165**	**36,386,741**



Appendix E. Aggregation of Exiobase Product Groups

Exiobase product group	Analysis category
Crops nec	Catering
Fish and other fishing products; services incidental of fishing (05)	Catering
Crude petroleum and services related to crude oil extraction, excluding surveying	Energy
Natural gas and services related to natural gas extraction, excluding surveying	Energy
Sand and clay	Other products
Chemical and fertiliser minerals, salt and other mining and quarrying products n.e.c.	Other products
Food products nec	Catering
Tobacco products (16)	Catering
Textiles (17)	Other products
Wearing apparel; furs (18)	Other products
Leather and leather products (19)	Other products
Wood and products of wood and cork (except furniture); articles of straw and plaiting materials (20)	Other products
Paper and paper products	Other products
Printed matter and recorded media (22)	Other products
Motor Gasoline	Energy
Kerosene	Energy
Gas/Diesel Oil	Energy
Liquefied Petroleum Gases (LPG)	Energy
Bitumen	Energy
Plastics, basic	Other products
Chemicals nec	Other products
Rubber and plastic products (25)	Other products
Glass and glass products	Construction
Bricks, tiles and construction products, in baked clay	Construction
Cement, lime and plaster	Construction
Other non-metallic mineral products	Construction
Basic iron and steel and of ferro-alloys and first products thereof	Other products
Precious metals	Other products
Copper products	Other products
Fabricated metal products, except machinery and equipment (28)	Other products
Machinery and equipment n.e.c. (29)	Machinery
Office machinery and computers (30)	Electronics

Exiobase product group	Analysis category
Electrical machinery and apparatus n.e.c. (31)	Electronics
Radio, television and communication equipment and apparatus (32)	Electronics
Medical, precision and optical instruments, watches and clocks (33)	Electronics
Motor vehicles, trailers and semi-trailers (34)	Transport and mobility
Other transport equipment (35)	Transport and mobility
Furniture; other manufactured goods n.e.c. (36)	Other products
Secondary raw materials	Other products
Electricity by coal	Energy
Electricity by gas	Energy
Electricity by nuclear	Energy
Electricity by wind	Energy
Electricity by petroleum and other oil derivatives	Energy
Electricity by biomass and waste	Energy
Electricity by solar photovoltaic	Energy
Transmission services of electricity	Energy
Distribution and trade services of electricity	Energy
Distribution services of gaseous fuels through mains	Energy
Steam and hot water supply services	Energy
Collected and purified water, distribution services of water (41)	Energy
Construction work (45)	Construction
Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessories	Other products
Hotel and restaurant services (55)	Catering
Railway transportation services	Transport and mobility
Other land transportation services	Transport and mobility
Sea and coastal water transportation services	Transport and mobility
Inland water transportation services	Transport and mobility
Air transport services (62)	Transport and mobility
Supporting and auxiliary transport services; travel agency services (63)	Transport and mobility
Post and telecommunication services (64)	Transport and mobility
Financial intermediation services, except insurance and pension funding services (65)	Commercial services

Exiobase product group	Analysis category
Insurance and pension funding services, except compulsory social security services (66)	Commercial services
Services auxiliary to financial intermediation (67)	Commercial services
Real estate services (70)	Commercial services
Renting services of machinery and equipment without operator and of personal and household goods (71)	Commercial services
Computer and related services (72)	Commercial services
Research and development services (73)	Commercial services
Other business services (74)	Commercial services
Public administration and defence services; compulsory social security services (75)	Public administration
Education services (80)	Education
Health and social work services (85)	Care and welfare
Food waste for treatment: incineration	Social services
Inert/metal waste for treatment: incineration	Social services
Oil/hazardous waste for treatment: incineration	Social services
Food waste for treatment: composting and land application	Social services
Paper and wood waste for treatment: composting and land application	Social services
Other waste for treatment: waste water treatment	Energy
Inert/metal/hazardous waste for treatment: landfill	Social services
Membership organisation services n.e.c. (91)	Social services
Recreational, cultural and sporting services (92)	Social services
Other services (93)	Social services

Appendix F. Results expenditure and impact in absolute values

Analysis Category	Final consumption [€ million]	Climate footprint [kiloton CO_2 eq]	Agricultural land use [ha]	Resource consumption [ton]
Construction	€ 25,282	7,153	253,066	500,617
Commercial services	€ 23,571	2,436	111,195	77,082
Transport and mobility	€ 8,422	2,477	53,141	158,805
Care and welfare	€ 6,736	464	47,694	25,369
Electronics	€ 5,047	1,660	65,978	209,884
Social services	€ 4,894	475	65,042	20,676
Other products	€ 4,148	1,595	106,985	186,830
Energy	€ 2,827	4,928	30,036	39,183
Public administration	€ 1,261	151	15,693	6,038
Catering	€ 1,076	358	141,047	13,476
Machinery	€ 998	399	10,950	80,062
Education	€ 532	28	1,581	1,582

Appendix G. Key indicators bottom-up analysis

Key indicators of energy carriers						
Physical flow	**Costs per physical unit (€/unit)**	**Unit**	**Source**	**Impact per physical unit (kg CO_2/unit)**	**Unit**	**Source**
Petrol	€ 1.62	l	Statistics Netherlands	3.14	kg	RVO
Diesel fuel	€ 1.34	l	Statistics Netherlands	3.13	kg	RVO
Electricity	€ 0.11	kWh	Statistics Netherlands	0.64	kWh	EcoInvent
Gaseous fuels	€ 14.05	GJ	Statistics Netherlands	1.79	m^3	RVO
Wood chips	€ 1.65	kg	Statistics Netherlands	3.76	kg	RVO
Aviation kerosene	€ 0.45	l	IndexMundi	3.11	l	RVO
Lubricating oil and lubricants	€ 3.04	kg	COMEXT	1.20	kg	EcoInvent
Hot water	€ 1.71	m^3	Waternet	0.00	kg	EcoInvent
Solar energy	€ 0.11	kWh	Statistics Netherlands	0.09	kWh	EcoInvent
Solar panels	€ 1,720.00	kWp	Milieucentraal	6,403.52	unit	EcoInvent

Key indicators construction materials						
Physical flow	**Costs per physical unit (€/unit)**	**Unit**	**Source**	**Impact per physical unit (kg CO_2/unit)**	**Unit**	**Source**
Asphalt	€ 0.45	kg	COMEXT	0.3	kg	EcoInvent
Brick	€ 230.25	m^3	COMEXT	0.3	kg	EcoInvent
Concrete	€ 0.23	kg	COMEXT	282.1	m^3	EcoInvent
Treated timber	€ 18.98	m^2	COMEXT	134.2	m^3	EcoInvent
Insulators	€ 5.10	kg	COMEXT	2.1	kg	EcoInvent
Pipes (PE)	€ 3.11	kg	COMEXT	9.3	m	EcoInvent
Natural stone	€ 0.15	kg	COMEXT	0.0	kg	EcoInvent
Roller shutters	€ 1.98	kg	COMEXT	184.1	m^2	EcoInvent
Salt	€ 0.06	kg	COMEXT	0.0	kg	EcoInvent

Key indicators construction materials						
Physical flow	**Costs per physical unit (€/unit)**	**Unit**	**Source**	**Impact per physical unit (kg CO_2/unit)**	**Unit**	**Source**
Cast iron	€ 2.75	kg	COMEXT	1.7	kg	EcoInvent
Pipes (Steel)	€ 9.20	kg	COMEXT	4.7	kg	EcoInvent

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