English summary of the initial study on the Value added of infrastructure in the Netherlands, 1995-2015

1. Introduction

Within the Next Generation Infrastructures (NGinfra) consortium the Executive Agency of the Dutch Ministry of Infrastructure and Water Management (Rijkswaterstaat), the Rotterdam Port Authority (Havenbedrijf Rotterdam), Alliander, Schiphol Group, ProRail and Vitens have joined forces to establish a knowledge platform in support of infrastructure operations and investment planning. As part of its knowledge mission, NGinfra seeks to identify the value generated by infrastructure for society and the economy.

To this end, NGinfra commissioned Statistics Netherlands in 2017 for an initial study to map the value added of the infrastructure in the Netherlands[1]. This summary highlights the most important items taken from the initial study, which is only being published in Dutch.

2. Definition and operational approach

There is no separate industry for 'infrastructure' within the NACE classification. Statistics Netherlands therefore attempted to construct value added (VA) of infrastructure from relevant and already existing NACE classes. In order to do so, it is important to use an unambiguous definition of what infrastructure is. NGinfra and the advisory group from the first study, proposed a definition that expresses the *functionality* of capital-intensive immovable assets. A railway contributes little to society itself, unless there are also trains that can move people and goods according to a timetable and with traffic control. In the same way, a drinking water supply network is useless if it is not used to supply clean drinking water to consumers and other users. As such, infrastructure as defined by Statistics Netherlands in consultation with NGinfra and the advisory group constitutes *the total of immovable and movable assets and activities that are necessary to ensure the provision of the primary services upon which society and the economy rely*:

- Flood safety and water level management
- Energy supply: electricity, gas, fuels (for transportation and space heating) and heat

[1] https://www.cbs.nl/nl-nl/publicatie/2017/44/toegevoegde-waarde-infrastructuur-nederland-1995-2015

- Information and telecommunications (both analogue and digital, both using fixed lines as well as wireless transmission)
- Transportation of passengers and goods by road, water, rail and air
- Drinking water supply
- Waste (and wastewater) removal and processing

In substantiating the comprehensive definition of infrastructure used in this study, a pragmatic approach was adopted: for the NACE industries that are part of the production and supply chains of the aforementioned primary services, the VA was included. In doing so, the entire system, from production up to and including delivery of primary infrastructural services, is taken into account. A specific NACE industry may also contain secondary activities, which should not be allocated to infrastructure. Where possible a correction was made to exclude that part. Hence, value added of infrastructure is constructed from the value added of the following industries:

- *Mining and quarrying*
  This industry includes the extraction of minerals occurring naturally as solids (sand, gravel, coal and ores), liquids (petroleum) or gases (natural gas), as well as exploration activities. Hence, it is part of the whole production and supply chain of the primary services of energy supply and the construction of, for example, roads and dykes.

- *Manufacture of coke and refined petroleum products (only fuels)*
  This industry includes the transformation of crude petroleum and coal into usable products. The study only takes into account the conversion into fuels (for transportation), as the transportation industry cannot function without fuel supply.

- *Energy supply*
  This industry includes the provision of electric power, natural gas, steam, hot water and the like through a permanent infrastructure (network) of cables, lines, mains and pipes. Also included are the distribution of electricity, gas, steam, hot water and the like in industrial parks or residential buildings. It therefore includes the operation of electric and gas utilities, which generate, control and distribute electric power and gas.

- *Water collection, treatment and supply*
  The collection, purification and distribution of water is another as a primary service to the economy and society. Returns on investments in production and transportation facilities are obtained through exploitation activities carried out by water companies.

- *Sewerage and waste treatment*
  This industry provides primary services such as the prevention, reduction, processing and disposal of hazardous substances into and from the environment.

- *Land, water and air transport*
  These industries provide the transportation services needed to move people and goods.

- *Warehousing and support activities for transportation*
  This industry includes – among other things – the basic services of airports (transfer of goods and passengers) and ports (transshipment of goods), including warehousing activities.

- *Telecommunications*
  This activity includes the activities of providing telecommunications and related service activities, i.e. transmitting voice, data, text, sound and video. The transmission facilities that carry out these activities may be based on a single technology or a combination of technologies: mobile (e.g. satellite) or fixed (e.g. cable, fibre optic) networks. These constitute the basis of telecommunications.

- *Public administration and government services*
  In the Netherlands, the government manages and invests in public infrastructure such as roads, dykes and other water infrastructure. The services produced (flood risk management, road access etc.) are consumed collectively. These services are included in NACE industry 'Public Administration'.

The key indicator in this study is the value added of infrastructure in basic prices (for the period 1995-2016). See box A for more information.

Box A What is value added?

Value added can be determined by considering production or income formation. Both of these methods result in the same outcome in terms of value added.

According to the production method, value added is the total value of the goods and services produced, minus the value of what has been used during production (the “use” or “intermediate consumption”). The use during production not only consists

of goods such as raw materials and semi-finished products (e.g. car parts), but also services such as purchased automation work and hired personnel.

According to the income formation method, value added is the sum of employee compensation, gross operating surplus and the balance of non-product related taxes and subsidies.

The compensation of employees is the total compensation, in cash or in kind, that an employer owes to an employee for the worked hours during a reporting period. The compensation of employees is equal to the total of wages and social contributions at the expense of employers.

The balance of non-product related taxes and subsidies consists of taxes and subsidies that are not directly related to the value or quantity of produced and sold products. Examples of non-product related taxes are the property tax, cleaning rights and sewerage fees paid by producers and consumers. An example of a non-product related subsidy is wage subsidies.

The balance remaining after the value added at basic prices has been reduced by the remuneration of employees and the balance of taxes and subsidies on production and imports is the gross operating surplus. For self-employed persons (who form part of the household sector) this balance is called mixed income because it also includes the remuneration for the work they have provided.

Relationship Gross Domestic Product (GDP) and value added
GDP is the sum of the gross value added of all institutional sectors or industries and the balance of product related taxes and subsidies (which are not allocated to sectors and industries).

A breakdown of value added into compensation of employees, gross operating surplus and the balance of non-product related taxes and subsidies is provided in this report. This facilitates a useful interpretation of the results.

Value added is also broken down into exploitation activities and investment activities. Exploitation activities involve direct use of existing infrastructure assets by the operators. Consider the value added generated by an energy company from transporting energy over an already existing energy network. Investment activities concerns value added linked to investments in new infrastructure (the construction of the assets themselves). An example is the value added that occurs during the construction of power lines. This only concerns the value added that is generated by the producer of the investment, namely the construction industry.

3. Data sources and methods

The National Accounts (NA) were the main source for this study. The NA form the official overview statistics of the national economy. Within the NA, the Supply and Use Tables (SUT) are constructed. In the SUT, production, consumption and value added per industry are described and broken down by product group.

3.1. Exploitation activities

SUT data are broken down by industry and product group. Values of production are available for each combination of industry and product group. However, the value added and its components (i.e. salaries, gross operating surplus and the balance of non-product related taxes and subsidies) are only given at industry level. To split the value added to each product group within an industry, a key was created based on shares of all product groups in the total production of the industry in question.

The value added (VA) of product group i in industry j in year t, ($\mathrm{VA}_{\mathrm{t}}^{\mathrm{ij}}$), is calculated as follows:

$$VA_t^{ij} = \frac{P_t^{ij}}{P_t^j} VA_t^j, t \in \{1995, \dots, 2015\}$$

where $\mathrm{VA}_{\mathrm{t}}^{\mathrm{j}}$ is the VA of the whole industry j, P_t^{ij} the production value of product group i in industry j and $\mathrm{P}_{\mathrm{t}}^{\mathrm{j}}$ the production value of the entire industry j in year t. The three VA components per product group are calculated in the same way as the total VA ($\mathrm{VA}_{\mathrm{t}}^{\mathrm{ij}}$).

The assumption underlying this method is that the value of production of product groups is an indicator for the VA that is generated and therefore that the ratio between production and VA is the same for all product groups within an industry. It is also assumed that the distribution of the VA to salaries, gross operating surplus and the balance of taxes and subsidies within an industry is the same for all underlying product groups. However, these two assumptions do not always have to apply, especially for industries with a wide variety of product groups. The VA per sub-activity will therefore be less accurate than the VA of the total activity.

3.2. Investment activities

The VA that is created by investments in civil engineering works is included under the investment activities. To determine this VA, a few steps are taken.

First of all, the total investments in civil engineering (including major maintenance) are determined for the industries that are part of this study. These investments are valued at purchase prices and must be converted to basic prices. This is done with help of a correction factor. This correction factor is determined by taking the ratio between production at basic prices and production at purchase prices for the "Construction industry", according to the following formula:

$$CF_t = \frac{P_t^b}{P_t^a}, t \in \{1995, \dots, 2015\}$$

Where CF_t is the correction factor in year t, P_t^b is the production of the "Construction industry" in basic prices in year t and P_t^a the production of the "Construction industry" in purchase prices in year t.

The investments per industry are multiplied by this correction factor to determine the investments in civil engineering at basic prices:

$$I_t^{jb} = I_t^{ja} \times CF_t, t \in \{1995, \dots, 2015\}$$

where I_t^{jb} are the investments in basic prices of industry j in year t and I_t^{ja} are the investments in purchase prices of industry j in year t.

Next, for the "Construction industry", the VA per unit of production is determined. This ratio is multiplied by the investments by means of the following calculation:

$$VA_t^j = I_t^{jb} \times \frac{VA_t^{construction}}{P_t^{construction}}, t \in \{1995, \dots, 2015\}$$

where $VA_t^{construction}$ is the VA for the "Construction industry" in year t and $P_t^{construction}$ the production is for the "Construction industry" in year t.

The result is the direct VA caused by investments in civil engineering by infrastructure intensive industries. Indirect effects are not included.

A large part of the investments in civil engineering in the Netherlands are included through this method; over the period 1995 - 2015, on average 97 percent of the

investments in civil engineering are carried out by the industries that are part of this study.

4. Main results

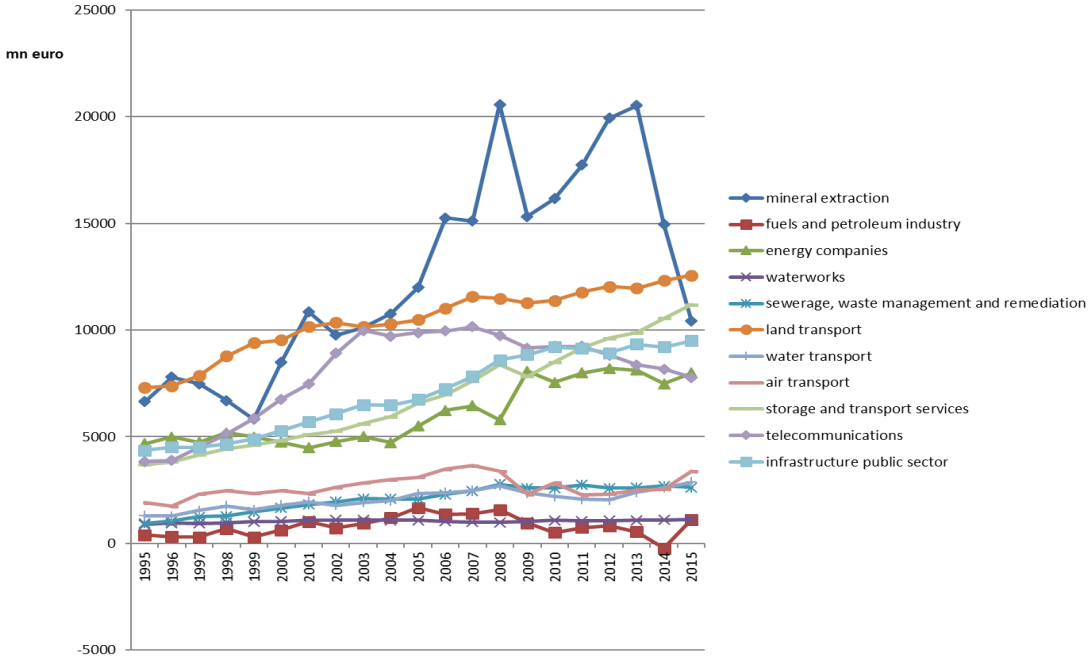
In 2015, the contribution of infrastructure to the total VA amounted to more than 70 billion euros. With this amount, the relative contribution to the total VA of the Netherlands in 2015 stood at approximately 11.5 percent. The absolute value of the VA related to infrastructure grew slightly less rapidly in the period 1995-2015 than other activities in the Dutch economy. The absolute value of the infrastructure sector is therefore growing over time, but there has been some stagnation since 2008. In relative terms, the contribution in 2015 was only slightly smaller than in 1995. This is due to the development of the industry "Mineral extraction", which is a very decisive factor in the total picture. Without "Mineral extraction", the contribution of the infrastructure sector to the Dutch economy can be described as very stable, also in recent years.

Value added of the infrastructure

	Total	Exploitation activities	Investment activities
	million euros		
1995	35 936	33 441	2 495
2015	70 570	64 946	5 624
	contribution to total value added of the Dutch economy, %		
1995	12.2	11.3	0.8
2015	11.5	10.6	0.9

Significantly more VA is generated by the exploitation activities than by investment activities. This is not illogical in itself, given the accumulation of large investments in infrastructure in the past. These investments ensure that much VA can be generated during the exploitation activities (the use of the infrastructure).

Value added for various activities, exploitation and investment activities



Infrastructure as defined in the first experimental study consists of many different activities. Some activities add a lot of VA in the direct sense, others less. The activities "Land transport", "Storage, transport services", "Mineral extraction" and "Public administration and government services" make the largest contribution to the total direct VA (jointly 62 percent). The activities "Petroleum industry (fuels)", "Water companies" and "Waste management" make a small contribution. Obviously, a smaller contribution does not mean that the activity is not important. This concerns VA as an economic concept. The fact that households receive clean drinking water is of great social value, but is not reflected in the VA.

The VA of infrastructure is characterised by a relatively skewed ratio of capital / labour remuneration. The VA generated by infrastructure is mainly used to compensate capital (including depreciation). A smaller part goes to labour and a very small part goes towards the government (the balance of non-product related taxes / subsidies). The share of the total gross operating surplus in the total VA of the Netherlands was 46 percent in 2015. Specifically for infrastructure, this share is equal to 61 percent in 2015.

5. Reflections and limitations

It is important to mention that this initial study merely concerns the economic and monetary value added of the infrastructure. Obviously, infrastructure also generates non-economic or social value, such as the safety provided by dikes or the health effects of hospitals. Although important, these issues are not quantified or integrated into this study, which is limited to the strict economic definition of value added.

This explorative study only includes the direct effects of various relevant activities. Indirect effects are not included. Indirect effects are, for example, the effect of investments in transport infrastructure on the attractiveness of certain locations for business activities. The effect of clean drinking water and sanitation on public health can also be considered as an indirect effect. Negative indirect effects associated with the infrastructure, such as air pollution or loss of nature, are not included in this study. The value chain behind the relevant activities can also be seen as an indirect effect. After all, the infrastructure-related activities lead to the consumption of goods and services. These products must be produced by other industries and this also yields value added. This includes for example the rent of industrial buildings by a natural gas producer. The value added of this rental is not included in this study, because it is only indirectly the result of production by the infrastructure sector.

This study does not include 'long-term effects' of changes in infrastructure. This effect is difficult to quantify. These types of effects may be hidden in multifactor productivity and the volume component of the capital services of all individual industries. The 'short-term effects' on the construction industry have been charted in this study via direct investments.

For the estimation of VA of investment activities in infrastructure, it has been decided to include only investments in civil engineering. It is assumed that this type of asset gives a complete and relevant picture of infrastructure developments. For example, the asset type "Machines" is not included.

This study only looks back at how much value added has been generated in the recent past (1995-2015). Nothing can be said about the future merits of the infrastructure on the basis of this study. In addition, this study says nothing about the 'profitability' of the infrastructure that has been built. If we want to say something about this, we need data about the relationship between the operating surplus and the value of the assets. The operating surplus is calculated in this study, but the value of the assets is not.

6. Recommendations for the follow-up study

This initial study provides a number of recommendations. First of all, there are a few issues relating to the scope of the operational definition in the study. For example, the sale of fuels via petrol stations was not included, because it is part of an industry that largely consists of non-infrastructure activities (retail). As a result, the treatment of fuels differs from other energy carriers such as electricity, where the chain up to and including the delivery of electricity is included. In the follow-up study, the question will be examined as to whether the relevant part of the petrol stations can be quantified (i.e. excluding the retail and catering section such as the ancillary sales f petrol stations).

Companies that are engaged in data processing, web hosting and other activities in the field of information (e.g. data centres) are also not part of the chosen industry definition of the initial study. The follow-up study will investigate whether and to what extent these activities also fall under infrastructure and may be quantified in a meaningful way.

For the government, only the depreciation of investments in civil engineering is taken into account. As a result, some activities carried out by the government are not fully included in the VA of infrastructure. This is the case, for example, for water quantity management by water authorities (part of the government). This activity includes activities aimed at flood defence (preventing flooding) and water management (ensuring the right water level) for agriculture, nature and residents. In addition, the water authorities also carry out activities for sewerage, waste management and remediation (water quality management). These kinds of activities will be included in the follow-up study.

Finally, the main recommendation from the first study is to place the data in an internationally comparative perspective. Comparing the VA of the infrastructure of the Netherlands with that of, for example, Belgium is interesting from an analytical point of view. Because there is currently no internationally harmonised definition and demarcation for the VA of the infrastructure available.

7. Accountability

The first report was written by Statistics Netherlands, commissioned by NGinfra. The authors thank the advisory group with Johan Jacobs (Ministry of Infrastructure and the Environment), Joost van der Vleuten (Ministry of Economic Affairs), Maike Boggemann (Shell Netherlands), Maarten van der Vlist (Rijkswaterstaat) and Co Verdaas (Over Morgen) for their collaboration in conducting research, providing instructions and administering corrections.