THE INFLUENCE OF THE CONSTRUCTION HOLIDAYS ON HGV TRAFFIC IN BELGIUM

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Abstract

Although construction logistics activities are the source of significant environmental nuisances, they are often overlooked. Limited knowledge is available about the true vehicle-kilometres (vkm) associated with the large number of vehicles in the sector. Furthermore, current studies are insufficiently robust to determine the share of construction logistics in total freight transport and its environmental effects. Countries like Belgium and the Netherlands have organized simultaneous holiday periods for the construction sector. This period is driven by the sector itself to avoid delays (within teams and between related companies). The scheme is well-respected despite the regional aspect, as 88% of the construction sector is adhering to it. Consequently, the comparison of the freight transport activities – be it traffic counts or GPS data – could be made between the organized holiday period and a reference period. This paper proposes a macro-level analysis to determine (1) the share, (2) the fleet composition and (3) the environmental impact of construction logistics within Heavy Goods Vehicle (HGV) traffic. This is done using On-Board Unit (GPS) data, covering almost all road vehicles with a gross weight of >3,5t on the entire territory of Belgium. This analysis is conducted over reference periods of 4 years (2016-2019). This allows to quantify the influence of the HGV construction logistics fleet on Belgian traffic, for which an external costs analysis (air pollution, accidents, climate change, congestion, loss of habitat, infrastructure, noise and well-to-tank costs) is conducted. Results show that these vehicles, largely construction-related, represent approximately 17.58% of total HGV traffic, or 14.86% of total daily active HGVs. Overall, these transports generate €1.45mio daily external costs, a share which represents 15.33% of total HGV external costs in Belgium. These figures should be considered lower bounds.
Keywords: Construction Logistics; Impact Assessment; On-Board Units; External Costs; Heavy Goods Vehicles

1. Introduction

Construction logistics activities, if not handled properly, are also the source of significant environmental nuisances during the construction works, and are often overlooked (Brusselaers et al., 2020; CIVIC, 2017; van Essen et al., 2019). These nuisances, referred to as external costs, come in the case of transport in the form if i.a. air pollution, climate change and congestion costs. These costs are not included in the market price of the transport activity or its usage and are thus not carried by the polluter him- or herself (Weinreich et al., 2000; Bickel et al., 2005; ICCT, 2018). Current studies estimate that construction logistics represents 20 to 35% of all urban freight traffic in the EU (Brusselaers et al., 2020; Brussels Mobility, 2008 & 2016; TfL, 2019). However, limited available and robust effectiveness studies have been reported in terms of urban construction logistics flows. Generally, limited knowledge is available about the true vehicle-kilometres (vkm) associated with the large number of vehicles in the sector. Furthermore, existing traffic share and impact calculations are most based on the number of vehicles used, rather than tonne-kilometres and vehicle-kilometres, which are the most important transport performance metrics in external cost calculations. The current and limited studies are thus insufficiently robust to determine the share of construction logistics in urban transport and its environmental effects (Brusselaers et al., 2020).

Construction companies in countries like Belgium and the Netherlands organize simultaneous annual holiday periods across the entire sector. This period is driven by the sector itself to avoid delays within teams and between related companies, as the more companies comply with the regulation, the fewer problems there are in terms of planning and organization. Because of this, closing due to the annual construction holidays is a regulation and not legislation, and is therefore not mandatory. As a construction company, you may therefore deviate from this regulation. However, it is rare that companies do not comply with the construction leave regulation (Bouwverlof België, 2021). Despite the regional aspect, 88% of the construction sector is adhering to the scheme and is thus very well-respected (Bouwunie, 2018). Consequently, the comparison of the freight transport activities could be made between the organized holiday period and a similar reference period outside of the construction holidays.

This paper proposes a macro-level analysis to determine (1) the share, (2) The fleet composition and (3) the environmental impact of construction logistics within the Heavy Goods Vehicle (HGV) transport using On-Board Unit (GPS) data, covering most HGV with a gross weight of over 3,5t on the entire territory of Belgium. This analysis is conducted over reference periods across 4 years (2016-2019). This allows to quantify the influence of the HGV construction logistics fleet on Belgian traffic, for which an external costs analysis (air pollution, accidents, climate change, congestion, loss of habitat, infrastructure, noise and well-to-tank costs) is conducted. This study aims to partially respond to an open challenge in calculating the true share of construction logistics in total freight traffic, and in the computation of a robust sector-wide environmental impact assessment (Brusselaers, 2020).

2. Literature review

From a socio-economic point of view, the construction sector fulfills 9.7% of the EU27’s GDP, employing 12.7mio workers in over 3.1mio enterprises (FIEC, 2019). In Belgium, the construction sector accounts for 6% of the country’s GDP, equaling an annual turnover of approximately 36 billion EUR. The sector employs close to 7% of the working population (or 275,000+ FTEs) in 127,000 companies (21,1% of companies in Belgium) (NBB, 2019; StatBel, 2020; FOD Economie, 2021; Construction Confederation, 2019), as such forming one of the largest economical industries in the country. These figures also cascade down on the construction logistics sector. Indeed, the sector is heavily and intrinsically reliant on logistics activities (Lundesjö, 2015), as suppliers and subcontractors procure 60-80% of the building materials and services which are necessary for the gross work (Scholman, 1997). These numerous transport movements are further reinforced by the case-especific nature of construction projects, which are uniquely located at the site of production and rely on ephemeral multi-organization (Koskela, 1992). Consequently, the building which is always manufactured or assembled at the static final usage location, requires vast amounts and voluminous transports going to and from the site (Lindén & Josephson, 2013; CIVIC, 2017). The financial logistical costs that go hand in hand with the delivery of materials and reverse waste flows are substantial, representing 8-15% in the total construction budget (VIL, 2020). Commonly, projects encounter additional failure costs due to i.a. poor communication or coordination, quality issues and repair or reworks. These additional costs can increase the total construction budget by 10% (VIL, 2020). Furthermore, the construction sector still suffers from lower productivity performances compared to other sectors (Groves, 2017). Optimizing the planning, the consolidation and the cooperation, can render construction logistics to become more efficient and sustainable (CIVIC, 2017). Studies show that a rigorous transport and logistics planning could cut total construction costs by up to 20% (Dubois et al., 2019; Sveriges Byggindustrier, 2010; Lindén and Josephson, 2013).

Construction logistics activities are also the source of substantial environmental nuisances during the duration of the construction works, if these are not handled with correctly. In the case of transport, these externalities present themselves as air pollution, climate change, noise pollution, congestion, accidents, infrastructure costs, loss of habitat and well-to-tank costs (van Essen et al., 2019). As these environmental nuisances are not included in the market price of transport activities, the polluter is not held financially responsible (Weinreich et al., 2000; Bickel et al., 2005; ICCT, 2018). The European Commission estimates the size of external costs of transport to reach approx. 1,000 billion EUR per year in the EU-28, representing 7% of the region's GDP (EC, 2018). However, little attention has been paid to the environmental costs of construction logistics so far, as these are often overlooked (CIVIC, 2017; Brusselaers et al., 2020).

Current studies estimate that construction logistics represents 20 to 35% of all urban freight traffic in the EU (Brussels Mobility, 2008 & 2016; TfL, 2019; Quak et al., 2011; TNO, 2018; Ploos van Amstel & Quak, 2017; Otten et al., 2016; City of Oslo, 2019) or 20-30% of transported tonnages (Löfgren, 2010; Dablanc, 2009). Brusselaers et al. (2020) present the main methodologies used thus far to assess the external costs of construction logistics, including traffic counts (Brussels Mobility, 2008 & 2016; TfL & OPDC, 2018), surveys (TfL, 2017 & 2018; Mommens & Macharis, 2014) and/or data from Construction Logistics Setups (CLS) such as checkpoints (Ekeskär & Rudberg, 2016; Sundquist et al., 2018) or construction consolidation centres (CCCs) (Guerlain et al., 2019; Lundesjö, 2015; Janné, 2019; TfL, 2013). It is important to note that limited available and robust effectiveness studies have been reported in terms of urban construction logistics flows. This is mainly due to the *data availability issue* on actual vehicle- or tonne-kilometres and the diverse scopes and approaches in impact assessments (Brusselaers et al., 2020). To measure the performance of transport and external cost calculations, the two main indicators are vehicle-kilometres or tonne-kilometres. The limited reported impact assessments so far rely however on the number of vehicles used and/or the transported volume, which are inadequate in the calculation of externalities and conclusively, insufficiently robust to determine its impact (Brusselaers et al., 2020).

There is thus a challenge in calculating the true share of construction logistics in total freight traffic, as well as computing a robust sector-wide environmental impact assessment. Policies targeting zero emission cities in the upcoming years (Brussels Mobility, 2019; EC, 2020) and the urbanisation trend leading to increasing numbers of construction projects (UN, 2015; UN DESA, 2018) pushes regional and local authorities to attach more and more importance to logistics. Therefore, freight transport policy enforcement strategies are being developed, such as On-Board Units (OBU; GPS-based trackers) which are currently implemented in Belgium.

3. Materials and methodology

3.1. On-Board Unit (OBU) data

In Belgium, data on vehicle-kilometres can be retrieved from On-Board Units (OBU). These GPS-based trackers were first implemented in 2016 to introduce a kilometre charge for the use of highways and regional roads across Belgium, as well as the entire inner-city road network in the Brussels-Capital Region. It is mandatory for all road vehicles with a Maximal Authorized Mass (MAM; gross vehicle weight) of 3,5t or more driving within or through the territory of Belgium, thus applicable both for Belgian as well as foreign vehicles. Excluded from this kilometre charge are machine-vehicles (such as cranes, bulldozers, and lifts) and other types of vehicles such as test drive license plated vehicles and old-timers. The tariffs of the toll roads are fixed by the regional governments, and are differentiated based on three parameters: (1) the Gross Vehicle Weight (GVW), Gross Combination Weight Rating (GCWR) or Maximal Authorized Mass (MAM); (2) the emission standard of the vehicle (EURO norm) and; (3) the type of toll road. As all roads in Belgium are considered toll roads (although most of them are charged at 0 tariff), the OBU are switched on everywhere in Belgium and therefore measure all driven vehicle-kilometers (ViaPass, 2021).

The data was directly obtained from Viapass, the supervisory and coordinating government organization for the kilometer charge in Belgium, and contains data from Satellic, accredited as a service provider for OBU in Belgium. This provider still holds the majority of OBU in Belgium, with approximately 560,000 active units in 2016. The data collected through the OBUs is differentiated based on different variables needed to calculate the road price for a variety of road and vehicle types. It includes the vehicle's geometry (extracted via a unique identifier along with GPS points per 30" intervals), the vehicle type (the transport mode and capacity), its environmental emission standard (EURO norm) and the time of day (Viapass, 2021). Hence, the OBU data forms a very robust set for trucks with a MAM above 3,5t, which includes all off-site construction transport (including transportation of on-site machinery) using HGVs (Brusselaers et al., 2020). The data was then aggregated in time and space to include the total driven distance (km) and the number of active trucks differentiated based on their Maximal Authorized Mass (MAM) (3.5-12t; 12-32t; >32t), and their emission standard (EURO 0-6; Enhanced Environmentally-friendly Vehicles are included in EURO 5). This was done for each day in 8 periods of 2 weeks (12 days), each time a construction holidays period and a reference period for the years 2016, 2017, 2018 and 2019, as presented in Table 3.1.

Table 3.1. Construction holidays and reference periods used in the analysis.

	2016	2017	2018	2019
Construction holidays	18/07-29/07	17/07-28/07	16/07-27/07	15/07-26/07
Reference period	18/08-29/08	17/08-28/08	16/08-27/08	15/08-26/08

Despite a slight temporal variation in construction holidays from region to region and from year to year, the holiday period overlaps for all regions in the 3 last weeks of July. The construction periods in each of the 4 years was thus chosen when all regions were simultaneously in the holiday period. In addition, both the construction holiday period as the chosen reference period fall during the Summer holidays of the Belgian school system (July and August), hence eliminating the potential traffic discrepancies or patterns encountered during regular school days. Further calculations were based on averages for relevant transport days, hence omitting weekend days and bridge/national holidays (21st of July and 15th of August) where transport flows are significantly lower (on average 83,34% lower in comparison to relevant days) to eliminate the risk of data contamination.

As 88% of the construction sector is adhering to the construction holidays (Bouwunie, 2018), the comparison of the freight transport activities could be made between the organized holiday period and a similar reference period outside of the construction holidays.

3.2. Environmental Impact Assessment

Current studies estimate that construction logistics represents 20 to 35% of all urban freight traffic in the EU (Brusselaers et al., 2020; Brussels Mobility, 2008 & 2016; TfL, 2019). Besides its share in total traffic, the sector would also be responsible for a significant share in terms of external costs. But as indicated by Brusselaers et al. (2020), current studies so far often do not consider vehicle-kilometres or tonne-kilometres that are linked to the significant number of vehicles in the sector, although these are the most important transport performance metrics in external cost calculations (Brusselaers et al., 2020).

To assess the environmental impact of construction transport in this study, an external cost calculation was conducted. Externalities arise when the associated changes in wealth are not included in the market price of its usage (Weinreich et al., 2000; Bickel & Friedrich, 2005). Hence, the polluter does not bear the costs of these nuisances, although they are shown to have significant impact on the environment (Mommens et al., 2019). This study presents the calculations for the major transport externalities which are air pollution, climate change, noise pollution, congestion, accidents, infrastructure costs, loss of habitat and well-to-tank costs, and are based on the most up-to-date metrics for marginal external cost calculations available in economic literature to date (Van Lier, 2014; Weinreich et al., 2000; Bickel et al., 2005; ICCT, 2018; van Essen et al., 2019). To quantify the transport-related external costs, external cost output factors were gathered and organized. These are monetary values per vehicle- or tonne-kilometre which can i.a. be retrieved from the Handbook on the External Costs of Transport (part of the STICITE study) (van Essen et al., 2019) or STREAM Goederenvervoer 2016 (Otten et al., 2017).

This paper differentiates external costs on different variables using output values per vkm, including the vehicle type (HGV) and size class (3,5t-12t; 12-32t; >32t), the propulsion type (diesel) and the emission norm (EURO 0-6). The loading rates per vehicle size class, included in the calculation, are based on European load factors from the STICITE study. In the case of HGV, these range from 0.10996% to 0.45714%, depending on the vehicle's size class. Additional assumptions were made for variables influencing multiple external cost categories. All transport movements are assumed to occur during daytime (mainly relevant for noise costs). The environment and road types were based on vkm statistics of HGV on each type of road in the 3 regions of Belgium from the Federal Planning Bureau (2017), subdivided in (inter-urban) highways, (inter-urban) regional motorways and metropolitan urban roads (inner-urban or communal roads). Traffic situation data was gathered from monthly (August) road segment saturation indicators between 2016-2019 from the Vlaams Verkeerscentrum (2021) and weekly traffic conditions from TomTom (2021), subdivided in free flow, near capacity and over capacity. The assumptions are summarized in Table 3.2. Where relevant, figures for Belgium were applied (mainly for congestion and accidents).

Table 3.2. Geographic variable assumptions taken for the share of vehicle-kilometres.

Time of day		**Environment and road type**			**Congestion / Traffic type**		
Day	Night	Rural – motorway	Urban – motorway	Metropolitan – urban road	Over capacity (dense/peak)	Near capacity (dense/peak)	Free flow (thin/off-peak)
100%	0%	60.71%	34.00%	5.28%	20.03%	12.50%	67.47%

4. Analysis and results

Across the four studied years, there is a significant decrease in overall driven vkm during the construction holiday period, compared to the reference period, as highlighted in Table 4.1 and Figure 4.1. Given the delta between the two measured periods is considered as a good proxy to measure the share of the construction logistics HGV fleet, we focus on the composition of this fleet difference. On average, this gap accounts for 3,185,185 less vehicle-kilometres driven per day (a decrease of 17.58%), or 15,114 less trucks driving on Belgian roads (14.86% of total daily active HGV). These vehicles are assumed to be largely associated to construction logistics.

Table 4.1. Daily average measured driven distance per period and year (in absolute vkm) and their relative difference.

	2016	2017	2018	2019
Construction holidays	18,322,199.946	18,424,450.581	17,848,156.878	16,617,658.139
Reference period	21,704,686.531	21,699,015.283	20,796,714.232	19,752,788.148
Relative difference	-18.46%	-17.77%	-16.52%	-18.87%

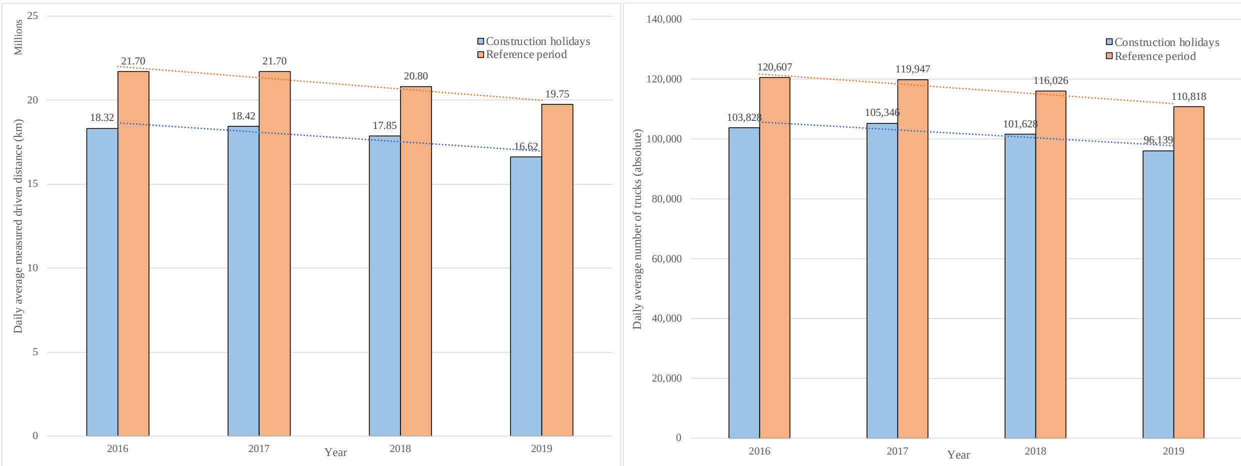

Figure 4.1. Left: daily average measured distance (million vkm). Right: daily average number of trucks (absolute).

As highlighted in Figure 4.2, the sector proportionately strongly relies on the use of >32t MAM vehicles within the HGV segment (8,219 out of 15,114 vehicles; 54.38% of all active vehicles). 58.92% of these vehicles is equipped with a EURO 5 or 6 emission standard engine. These vehicles also proportionately accumulate most total registered vehicle-kilometres (54.89% of all daily delta fleet vkm).

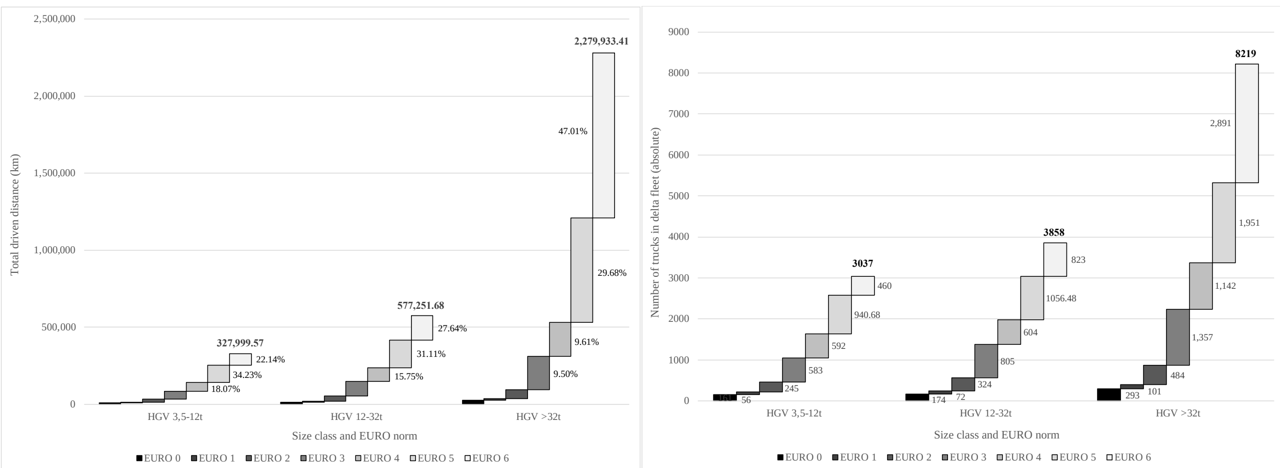

Figure 4.2. Delta logistics fleet between the construction holiday period and the reference period across the four studied years (absolute daily average). Left: Measured distance per size class and EURO. Right: Number of trucks per size class and EURO.

The Total External Costs (TEC) of Heavy Goods Road Transport (>3.5t) in Belgium (including air pollution, accidents, climate change, congestion, loss of habitat, infrastructure, noise and well-to-tank costs), were calculated for each day and differentiated based on the vehicle type (HGV), the MAM class (3,5t-12t; 12-32t; >32t), the propulsion type (diesel), the emission norm (EURO 0-6) and the time and traffic assumptions mentioned above. These results were then aggregated per period (construction holiday period and reference period for the four years). Next, the daily TEC average was calculated based on the differentiated vehicles' MAM category, propulsion type and EURO norm, for each of the 8 studied periods. Overall, the TEC of HGV transport movements during the construction holiday period account for € 7,984,316.58 per day over the entire territory of Belgium, which is 15.33% lower than the daily € 9,430,021.53 TEC generated by the sector during the reference period within its respective year. The delta fleet, which is likely largely attributable to construction logistics movements, thus generates daily € 1,445,704.95 external costs. The breakdown of the different external cost categories is shown in Figure 4.3.

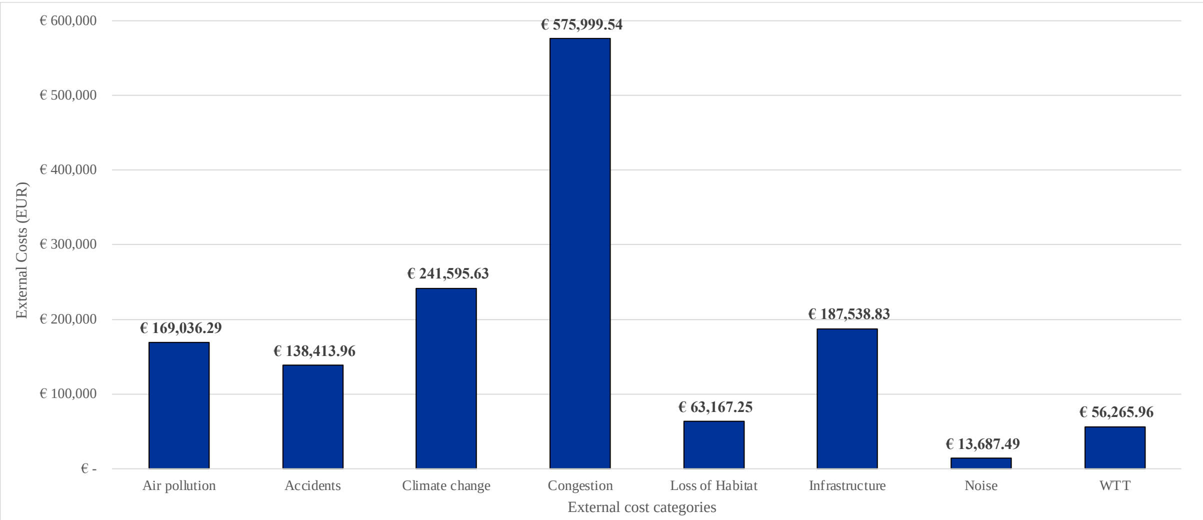

Figure 4.3. Average daily External Costs of HGV Transport between the construction holiday periods and reference periods for the years 2016, 2017, 2018 and 2019.

5. Conclusion and discussion

This paper presents a macro-level analysis to determine (1) the share, (2) the fleet composition and (3) the environmental impact of construction logistics within Heavy Goods Vehicle (HGV) traffic. This is done using On-Board Unit (GPS) data, covering almost all road vehicles with a gross weight of >3,5t on the entire territory of Belgium. Some countries, such as Belgium and The Netherlands, have adopted concurrent holiday periods for the construction sector. This period is driven by the sector itself to avoid delays and is very well-respected, with 88% of the companies adhering to the scheme. Consequently, the comparison of freight transport activities is made between the organized holiday period and a similar reference period outside of the construction holidays. The delta between the two measured periods is thus a proxy to measure the share of the construction logistics HGV fleet. This analysis is conducted over reference periods across 4 years (2016-2019), allowing to quantify the influence of the HGV construction logistics fleet on Belgian traffic. To this end, an external cost analysis is conducted (air pollution, accidents, climate change, congestion, loss of habitat, infrastructure, noise and well-to-tank costs). Results show that this fleet represents a share of approximately 17.58% in total Belgian HGV traffic in terms of vehicle-kilometres (3.19mio daily vkm), driven by 14.86% (15,114) of total daily active trucks in the territory. The sector proportionately strongly relies on the use of >32t MAM vehicles within the HGV segment (54.38% of all active vehicles), majoritarily equipped with a EURO 5 or 6 emission standard engine. Overall, construction-related transports generate €1.45mio external costs daily, a share which represents 15.33% of total HGV external costs in Belgium. Absolute figures should be considered lower bounds, as results are likely underestimated. This study aims to partially respond to an open challenge in calculating the true share of construction logistics in total freight traffic, and in the computation of a robust sector-wide environmental impact assessment.

6. Limitations and future research

The On-Board Units capture vkm of HGV with a MAM >3.5t, on which this paper focuses. Vehicles outside of this category (LCV and cargo bikes <3.5t, IWT etc.) are thus not included in this study.

The presented study takes the construction holidays as a proxy for the HGV construction logistics fleet in Belgium. Although most of the sector (88%) adheres to the schedule, the results are likely underestimated, as this adherence is not absolute. Other factors might contaminate the fleet composition, although this has been limited by taking into consideration the school and bank holidays, and by considering data across 4 years.

The OBU fail to catch the loading rate of the truck. Therefore, this study used the vehicle-kilometres which are linked to the GPS data, which were enriched by assumptions based on national statistics and local characteristics. The external cost analysis would become stronger if fewer assumptions were to be taken. Similarly, current assumptions which are based on total HGV traffic, use a 5.28% share for inner city road use. It needs to be validated whether this share is also relevant for construction-related traffic.

Although the OBU dataset used for this analysis comprises the lion’s share of active units in Belgium, it does not incorporate all OBUs (and HGVs) in the territory. This is for example the case for data from Axxès, another provider also active in Belgium. The results could therefore be slightly underestimated. The numbers of Axxès for domestic trucks are however marginal, accounting for a about 1200 trucks in 2016.

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