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The impact of courier-, express- and parcel (CEP) service providers on urban road traffic: The case of Vienna

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ABSTRACT

Current urban city logistics literature often claims that rising e-commerce and the associated courier-, express- and parcel- (CEP) deliveries are inherently responsible for the increase in urban road traffic and the related congestion, disturbances and delays within cities. However, existing research is so far limited concerning studies to what extent CEPs impact and contribute to urban road traffic, particularly in comparison with other commercial sectors and passenger cars. In response, collecting data through an extensive empirical survey, counting urban road traffic in the city of Vienna in Austria, this paper identifies the share of CEPs and other selected categories of road vehicles. Results show that the share of CEPs in urban road traffic consists of merely 0.8 per cent, while the delivery vans' share of craftsmen/technicians is almost eight times bigger with 6.0 per cent. Overall, delivery vehicles comprise 13.5 per cent of the total urban road traffic in Vienna, thus policies to reduce traffic should include not only other commercial sectors, but should also focus on passenger cars comprising the majority with 86.5 per cent of total urban road traffic. This is the first study that specifically investigates the share of CEPs and other vehicle categories in the context of city logistics.

1. Introduction

Research in city logistics is gaining importance as cities are confronted with an increase in urban road traffic, leading to congestion and environmental pollution (Anderson et al., 2005; Dobrovnik et al., 2018; Herold and Lee, 2017; Li et al., 2020; Tian et al., 2020). In most cities, the development of adequate infrastructure and transport planning cannot keep up with the fast increase in vehicle ownership. Hence, competition for available capacities on urban road network is giving rise to a set of new challenges – especially concerning urban freight delivery (i.e. delivery vans) and passenger transport (Chang et al., 2017; Rao et al., 2015; Sun et al., 2018). Existing literature in city logistics tackles these challenges usually in two research streams: the first stream is related to efficiency, which aims to reduce traffic through improved policies or productivity measures for more efficient deliveries (e.g. Akyol and De Koster, 2018; Aljohani and Thompson, 2016; Anand et al., 2015; Firdausiyah et al., 2019; Holguín-Veras, 2008; Nuzzolo and Comi, 2014; Shao et al., 2019), while the second stream addresses environmental solutions and innovations to increase the overall sustainability within urban logistics (e.g. Behnke and Kirschstein, 2017; Chen et al., 2018; Figliozzi, 2011; Jamshidi et al., 2018; Nathanail et al., 2016; Schliwa et al., 2015; Yang et al., 2016).

In both city logistics research streams, however, two flaws exist which this study tries to address. First, although the definition of city logistics (see Anand et al., 2012) comprises does not specifically highlight the role of CEPs, city logistics is often seen as an equivalent to parcel deliveries or courier-, express-, parcel-providers (CEPs) (see Behnke and Kirschstein, 2017; Chen et al., 2018; Figliozzi, 2011; Mackie, 2011; Nuzzolo et al., 2016; Savelsbergh and Van Woensel, 2016; Shao et al., 2019; Yang et al., 2016) and second, current research often claims that mainly delivery vans, thus CEPs, are increasingly responsible for the rise of urban road traffic (see Akyol and De Koster, 2013; Anand et al., 2015; Chen et al., 2018; Holguín-Veras, 2008; Marcucci et al., 2017). In both cases, the focus on CEPs is neglecting other commercial sectors, such as deliveries from craftsmen and technicians or grocery supplies, and therefore, their respective share and impact on urban road traffic.

Indeed, the claim that CEPs play a significant part in urban road traffic is regularly and repeatedly used as or in an introduction to

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justify city logistics research (often related to e-commerce, see e.g. Anand et al., 2016; Ducret, 2014; Zenezini et al., 2018). For example, Crainic et al. (2004) claim that "[freight] vehicles make a significant contribution to congestion and environmental nuisances […] that impact adversely on the quality of life in urban centers", while Macharis et al. (2014) argue that urban freight transport "contributes disproportionally to air pollution, noise pollution, congestion, traffic accidents and reduced accessibility of urban areas" or Holguín-Veras (2008) claims that urban deliveries "represent the bulk of truck traffic in urban areas". A closer look, however, reveals that the used references have other focus areas; sometimes lack specific information or the methodology section could benefit from further explanation, both in academic and practitioner literature (Aljohani and Thompson, 2016; Anand et al., 2015; Holguín-Veras, 2008; Jamshidi et al., 2018; Nathanail et al., 2016; Oliver Wyman, 2012).

As current research often base their motivation, calculations and solutions solely on these arguments (Akyol and De Koster, 2013; Anand et al., 2015; Chen et al., 2018; Holguín-Veras, 2008; Marcucci et al., 2017; Yang et al., 2016), we argue that these claims may lead to two misleading and disproportionate assumptions: First, that measures which increase efficiency in the area of CEPs may significantly help to address concerns such as congestions or delays in city logistics, thereby assuming that better management and innovation of and for CEPs represents a crucial part to solve urban road traffic problems. Second, that environmental initiatives and innovative logistics concepts for CEPs are a major driver and have a considerable and major influence on the entire sustainability in cities. There is, however, a lack of studies investigating specifically to what extent CEPs impact and contribute to urban road traffic and if their impact corresponds with the claims from above mentioned studies. In response to this uncertainty, the aim of this paper is to examine the share of CEPs and its consequences, particularly in comparison to other commercial sectors and passenger cars. Using the city of Vienna, Austria, as a case study, we collected data through an extensive and comprehensive empirical survey counting road traffic at critical traffic points to identify the share of CEPs and other specific categories of delivery vehicles.

By examining urban road traffic and the share of CEPs and other delivery vans in a city logistics context, this paper provides several important contributions to the literature. First, it provides an answer to the existing gap in the literature to what extent city logistics and CEPs impact and contribute to urban road traffic. In this regard, the study advances the growing body of city logistics, which to date has been limited in providing empirical results of the share of CEPs and its consequences in cities. Second, as far as the authors are aware, this is the first study which specifically examines the share of delivery companies and differentiates between particular categories of delivery vehicles. This study thereby addresses the inherent uncertainty associated with the impact of delivery companies and other commercial sectors and provides clarity about the impact of different delivery vehicle categories on urban road traffic. Third, the study substantiates the role of CEPs in cities and provides a foundation for further research and arguments in industry and academia. In this respect, we provide important insight into practices through which management can exert agency to influence city logistics and traffic policies.

This paper is structured as follows: the next section provides background to the case study, i.e. the urban road traffic in Vienna is described and the characteristics of city logistics characteristics are discussed. Section 3 presents the methodology and describes the research approach for counting and examining the different vehicle categories. In section 4, the results are presented, followed by a discussion that in particular addresses the role of CEPs in urban road traffic. We conclude with a summary of the results, the limitations of the study and potential future research.

2. City logistics and urban road traffic in Vienna

From an urban road traffic viewpoint, the city of Vienna represents a rather average city compared to other European cities, i.e. although we are cautious to generalize the traffic characteristics in Vienna, other European cities seem to face similar issues. Vienna has almost two million citizens and is very densely populated with > 4.000 people per square kilometer or 10.366 people per square mile (Eurostat, 2016). This density in combination with 170.000 commuters travelling every workday into Vienna (City of Vienna, 2018) leads to congestion in the city, in particular at peak times. According to the TomTom Traffic Index (2018), which calculates the additional time needed to reach the city destination, Vienna had an average congestion of 27 per cent, with 43 per cent at morning peak between 8 and 9am and 52 per cent at the evening peak between 4 and 6 pm. Compared to cities such as Munich or Berlin with an average congestion of 30 per cent and 31 per cent, respectively, the results of this study may also be relevant for these and other European cities with similar sizes.

The congestion caused by traffic affects naturally also city logistics participants including CEPs. The CEP market is dominated by the Austrian Post with a market share of approximately 70 per cent. Competition in the CEP market consists mainly of other major European and international delivery companies such as Amazon, UPS, DHL, FedEx, Hermes, DPD, GLS, etc. Similar to other European cities, e-commerce is a driver for growth in the CEP-sector in Vienna with approx. 170.000 packages delivered per day in 2016 (WKO, 2018). The vast majority of packages is delivered by CEP vans on the road (WKO, 2018), thus being part and contributing to the Viennese urban road traffic. However, apart from small environmental initiatives, the city follows a general 'smart city' concept, which includes goals for road traffic improvement (reduction) and an increase in mobility efficiency through e.g. investments to further improve and develop public transport and bicycle paths (Stadt Wien, 2014).

To measure the impact of urban road traffic, the city of Vienna has installed automatic traffic counting/census points and the data can be accessed publicly, however, there is no public data available to specifically measure the share of CEPs or differentiates between the different categories of delivery vans between 3.5t and 7.5t, e.g. between CEPs' and craftsmen or technicians' delivery vans. This paper is an attempt to close this gap and identify the share of CEPs and other delivery vehicles in the city of Vienna.

3. Methodology

For examining the share of CEPs and other traffic in Vienna, the data collection comprised primary as well as secondary data. In the next section, a detailed description of the data collection and analysis are provided.

3.1. Secondary data

To measure the share of CEPs in Vienna city's road traffic, secondary data from the city of Vienna was used to validate primary data. The Federal Ministry of Transport, Innovation and Technology (BMVIT) in Austria is using automatic traffic count/census points to measure traffic volume and publishes the results to the public on an annual basis. The data includes an overall overview about the volume of the traffic which can distinguish between cars and trucks/vans, but does not differentiate between e.g. CEPs and other commercial sectors (see BMVIT, 2018). As this study is restricted to the city of Vienna and its urban road traffic, we used publicly available data of 44 traffic count/census points in the city of Vienna to develop a ranking of most critical traffic points. Based on the ranking, primary data was collected by physical counting in the field. Primary data was then used as an additional referrer for data extrapolation as well as for validation of secondary data.

3.2. Primary data

To differentiate between CEPs and the other types of vehicles/industries, we defined the following categories and built subsequently a questionnaire for the physical counting in the field: 'passenger cars', 'CEPs', 'craftsmen/technicians', 'retail food trade vehicles', 'waste disposal vehicles', 'emergency vehicles', 'construction vehicles', 'public transport (i.e. buses)', 'other <7.5t' and 'other >7.5t' (see Table 1).

All categories except 'passenger cars' and 'other with labels <7.5t' contain vehicles between 3.5t and 7.5t. The category 'other <7.5t' comprises all delivery vans which cannot be allocated to any specific category, i.e. all delivery vans that are not CEPs, craftsmen/technicians, etc., but clearly recognizable or labeled vehicles such as flower delivery vans, confectionary vans, etc. The category 'other without labels <7.5t' is related to vans between 3.5t and 7.5t which cannot be assigned to a specific industry/sector, e.g. the popular white vans without any label, gastronomy or catering vans as well as vans for the delivery of non-food goods (such as clothing, toys or perfumeries), privately used vans, but also CEPs and craftsmen/technicians vans that cannot be recognized or identified as those.

To conduct the manual physical traffic counting, we selected the most critical traffic points on main and secondary roads based on secondary data provided by the city of Vienna. Fig. 1 shows the traffic count/census points where additional primary data was collected.

In total, 56 observations on workdays were made during four subsequent rounds of the survey at following traffic points: 'Mariahilfer Gürtel', 'Karlsplatz', 'Brunner Straße', 'Reichsbrücke', 'Atzgersdorfer Straße', 'Wienerbergstraße', 'Handelskai', 'Maria-Theresien-Straße', 'Hernalser Hauptstraße', 'Vorarlberger Allee', 'Burgring', 'Vally-Weigl Gasse', 'Alfred-Adler-Straße' and 'Sonnenallee'. Primary data was collected in these four different rounds in order to consider differences in seasonal utilization rates among the various industries:

- Round 1: calendar week 9, 2019
- Round 2: calendar week 10–11, 2019
- Round 3&4: calendar week 22–24, 2019

We conducted a pilot-phase/study during calendar week 9 to check the survey questionnaire's usefulness in the field and to check whether manual on-street counting or video recording is the best way to measure the traffic. For round 1 and round 2 we used manual physical counting as well as video recording to capture all relevant traffic vehicles and participants, while data for round three and four was only manually collected. The timeframes were used intentionally to cover intertemporal validity as well as seasonal effects. In all four rounds, data collection followed the same schedule, lasting 30 min (i.e. 30 min block), from 06:00–06:30am, 08:45–09:15am, 3:00–3:30 pm and 5:00–5:30 pm (all in one day). The chosen time stamps were in line with secondary data from the city of Vienna to capture high and low traffic volumes during workdays, thus to map the flows of a 'normal' workday.

Table 1
Vehicle categories.

Vehicle Category	Description
Passenger Cars	All cars <3,5t
CEPs	Clearly recognizable/labeled parcel delivery vehicle
Craftsmen/Technicians	Clearly regognizable/labeled vehicle
Retail Food Trade	Clearly regognizable/labeled vehicle
Waste Disposal Vehicles	Clearly regognizable/labeled vehicle
Emergency Vehicles	Clearly regognizable/labeled vehicle
Construction Vehicles	Clearly regognizable/labeled vehicle
Buses	Public Transport
Other with labels <7,5t	Clearly recognizable/labeled vehicle (e.g. Flowers, Catering)
Other without labels <7,5t	Not assignable/recognizable/labeled vehicle
Other >7,5t	All vehicles >7,5t

3.3. Substantiation of results and variability

In order to substantiate the results, category 'other without label <7.5t' will be further divided and allocated among other relevant vehicle categories. As the vehicle category 'other without label <7.5t' comprises vans without any clearly recognizable branding or logo (e.g. a white van), a subsequent allocation among other relevant vehicle categories will help to reduce the inherent uncertainty in this category and further substantiate the empirical results. However, allocation is only made to vehicles categories which actually use vans without branding/labels, which restricts it more or less to the categories 'CEPs', 'craftsmen/technicians' and 'other with label <7.5t'.

The incremental share from category 'Other without label <7.5t' regarding CEPs assumes a mix between branded and non-branded CEP vans (i.e. subcontractors of CEP companies deliver parcels, but without branding/label. The majority of CEP vans delivering vans in Vienna, however, are branded/labeled (WKO, 2018) and CEP companies are naturally interested in branding of their vehicles, providing "constant visibility" of the brand's "name and logo on each [CEP] truck" (Marquardt et al., 2011) as a differentiator (Bendixen et al., 2004; Davis et al., 2009; Juntunen et al., 2013; Mackie, 2011; Marquardt et al., 2011; Taylor, 1992) and want to avoid a high share of non-branded/non-labeled vans (Cahill, 2006; Davis et al., 2008). Against that backdrop, the maximum level (and thus the variability) of non-branded/non-labeled CEP vans in comparison to branded/labeled CEP vans is assumed to be 50 per cent, however, to depict a realistic scenario we here assume a share of non-branded/non-labeled CEP vans of one-third (Austrian Post, 2019). With regard to the category 'craftsmen/technicians' and category 'other with label <7.5t' we assume that the entire share of category 'other without labels <7.5t' may be allocated in full to either category 'craftsmen/technicians' or category 'other with label <7.5t', which also constitutes the variability of these categories. To substantiate the results and depict a realistic scenario, the allocated CEP share will be deducted from further allocation of the category 'other without labels <7.5t'. The remaining share is allocated proportional to the ratio between the categories 'craftsmen/technicians' and 'other with label <7.5t'.

4. Empirical results

4.1. Descriptive analysis

Table 2 reports the key results and the share of the respective vehicles' categories. CEPs account for only 0.8 per cent, while the share of 'craftsmen/technicians' with 6.0 per cent is between six and seven times higher. The CEP share of 0.8 per cent indicates a rather minor role in total urban road traffic in Vienna. Overall, the share of all vans and vehicles above 3.5t adds up to 13.5 per cent, while passenger cars account for the vast majority in urban road traffic with 86.5 per cent. The share of 13.5 per cent is split between the vehicle categories as follows: 'craftsmen/technicians' with 6.0 per cent, 'public transport' (buses) with 1.7 per cent, 'construction vehicles' with 1.7 per cent, CEPs with 0.8 per cent, 'emergency vehicles 'with 0.7 per cent, 'retail food trade vehicles' with 0.3 per cent, 'waste disposal vehicles' with 0.2 per cent, 'other vehicles <7.5t' with 1.2 per cent and 'other >7.5t' with 0.8 per cent.

The observation among the different times of the day reveals that the largest share in the delivery vans can be attributed with 9.2 per cent to the category 'craftsmen/technicians' between 6:00–6:30am.

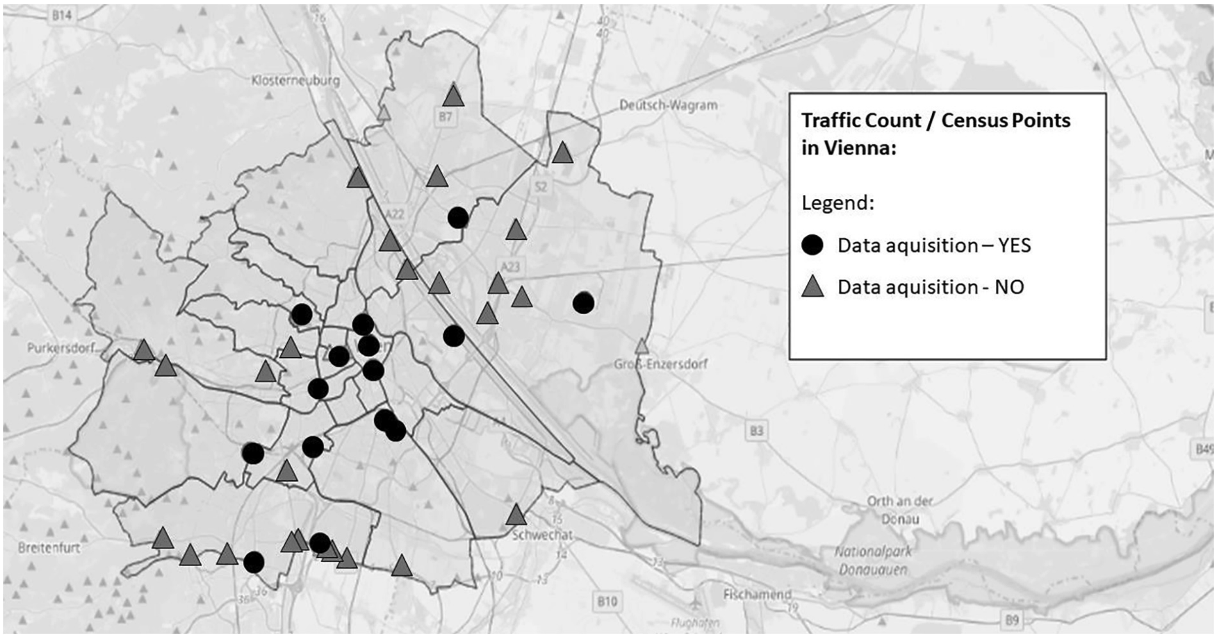

Fig. 1. Used traffic count/census points in Vienna.

Table 2
Results per vehicles category.

Vehicles Category	6:00–6:30am	08:45–09:15am	3:00–3:30 pm	5:00–5:30 pm	Ø Average	Total	
Passenger Cars	81.6%	85.2%	88.6%	88.6%	86.5%	86.5%	100%
CEPs	0.6%	0.9%	1.1%	0.5%	*0.8%		
Craftsmen/Technicians	9.2%	5.8%	4.3%	5.7%	**6.0%		
Retail Food Trade Vehicles	0.5%	0.6%	0.3%	0.1%	0.3%		
Waste Disposal Vehicles	0.5%	0.4%	0%	0%	0.2%		
Emergency Vehicles	0.4%	0.8%	1%	0.6%	0.7%		
Construction Vehicles	2.9%	1.6%	1.1%	1.6%	1.7%		
Buses (Public Transport)	1.9%	1.5%	2.2%	1.6%	1.7%		
Other <7,5t	1.7%	1.2%	0.9%	1.1%	***1.2%		
Other >7,5t	0.7%	2%	0.5%	0.2%	0.8%	13.5%	

* Variability 0.6% to 0.9%.
** Variability 4.0% to 6.6%.
*** Variability 0.8% to 3.4%.

Similarly, 'construction vehicles' have a strong presence early in the morning from 6:00–6:30am with 2.9 per cent. While 'public transport' (buses) show a relatively low variability among the different times of the day, the overall variability in the different categories among the different times of the day can be regarded as relatively high – while the absolute numbers are relatively low (compared to passenger transport).

4.2. Variability and substantiation of results

According to our methodology, Table 2 displays already a consolidated view and includes an allocation of category 'other without labels <7.5t'. The original counting showed 2.6 per cent in the category of 'other without labels <7.5t' which are further divided and allocated among 'CEPs' (with an original share of 0.6 per cent) 'craftsmen/tech nicians' (with an original share of 4,0 per cent) and 'other with label <7.5t' (with an original share of 0.8 per cent). Under the assumption of maximum level of 50 per cent and a realistic scenario of one-third of non-branded/non-labeled CEP vans (see Methodology section), the CEP share would increase by 0.3 per cent to a maximum of 0.9 per cent, i.e. the CEP share shows a variability of 0.6 to 0.9 per cent, but the realistic scenario would place the total CEP share in urban road traffic at 0.8 per cent (see Table 3).

With a share of 2.6 per cent in the category 'other without labels <7.5t', the variability for category 'craftsmen/technicians' ranges from the original share of 4.0 per cent (assuming no craftsmen/technicians vans) to 6.6 per cent (assuming that all vans are from craftsmen/technicians), while the variability of the category 'other with label <7.5t', ranges from the original share of 0.8 per cent (all vans are craftsmen/technicians) to 2.4 per cent (all vans fall into the category 'other with labels'). To substantiate the results and depict a realistic scenario, we deduct the 0.2 per cent from the CEP-share from the 2.6 per cent, i.e. the remaining share of 2.4 per cent is allocated between the categories 'craftsmen/technicians' and 'other with label <7.5t' proportionally to their ratio, increasing the share of 'craftsmen/technicians' by 2,0 per cent to an overall urban traffic share of 6.0 per cent and the category 'other with label <7.5t' by 0.4 per cent to an overall share of 1.2 per cent (see Table 4).

5. Discussion

The results of the study provide interesting insights into the van and vehicles characteristics of urban road traffic. As the first study

Table 3
Incremental CEP share.

	CEPs with label	Original Share	CEPs without label	Incremental share	Total share
Realistic scenario	100%	0,6%	33%	0,2%	0,8%
Maximum Scenario	100%	0,6%	50%	0,3%	0,9%

Table 4
Allocation of 'craftsmen/Technicians' and 'other with label <7.5t' share.

	Original Share	Other without labels	Incremental share	Total share
Craftsmen/Technicians	4,0%		2,0%	6,0%
Other with label <7,5t	0,8%		0,4%	1,2%
	4,8%	2,4%		7,2%

performing a physical counting of vans on critical traffic points at different times, the study not only extends knowledge in the urban traffic and CEP area, but provides exact details and shares of the traffic composition in Vienna. The results show that passenger cars account for 86.5 per cent of urban road traffic, while the remaining share of van and other vehicles above 3.5t comprises 13.5 per cent. A few studies exist that also measure or calculate the share of delivery vans or vehicles in other areas and cities, but these studies are mainly based on secondary data modeling. For example, a modelling approach by the Swiss government to measure the traffic composition in Zurich found that vans account for 6.0 per cent (UVEK, 2013), but the study used only official records of vehicle registrations to calculate the respective shares, thus no physical counting occurred.

Interestingly, researchers in Melbourne found that 13.4 per cent of the vehicles entering the central business district were delivery and service vehicles, which corresponds almost exactly with our finding (Casey et al., 2014). Similarly, the most popular study in the UK from the Department of Transportation places the share of vans (or light commercial vehicles) at 15 per cent (Department for Transport, 2018), which also roughly confirms our finding of 13.5 per cent.

Studies that further divide the vans categories and investigate the share of CEPs are even more limited. Braithwaite (2017) used the 15 per cent van share of the UK traffic study and calculated that "around one in ten of the vans that people encounter on the roads in their daily lives are engaged in parcel and packet delivery, whether to consumers or businesses" (p.3), which would put the share of CEPs to 1.5 per cent. However, most of the studies do not focus on the CEPs share, but rather include other delivery vehicles as well. For example, Casey et al. (2014) in their study of traffic in the Melbourne central business districted calculated the share of vehicles involved in last mile deliveries at 4.4 per cent.

Linton et al. (2018), based on van park counting in the UK, calculated the van share for goods for collection and delivery between 3 and 4 per cent, but note that 'collection and/or delivery' of goods covers a wide range of journey purposes, thus not only the delivery of parcels to homes and businesses, but also e.g. the delivery of stock to retailers. In comparison to our study, 'collection and/or delivery' would comprises not only the category CEPs, but also 'retail food trade vehicles' and 'other <7.5t' which would account for a 2.3 per cent share (without taking into account the share of craftsmen/technicians vans). Regarding the share of craftsmen/technicians vans, a study of the Department for Transport (2009) found that a 50 per cent of van mileage in cities is for carrying tools and equipment (e.g. by plumbers), which would put the share of Craftsmen/Technicians at 7.5 per cent based on 15 per cent vans in the UK, which roughly correlates with our 6.0 per cent share.

But more importantly, the impact of CEPs with a share of 0.8 per cent in total urban road traffic is rather limited, thus, our study contradicts the claim that CEPs are the main contributors for congestions and delays. For example, a widely acknowledged assertion used by PwC (2017) claims that CEPs were responsible for 80 per cent of all congestions and delays in cities. Although it seems the references and sources of these claims cannot be identified anymore (Giclycle, 2018), the 80 per cent claim has been cited numerous times by industry outlets and reputable newspapers (e.g. Fahrun, 2017; Goebel, 2015; Schlautmann, 2017; Wildemann, 2018). In contrast, our study found not only that the 80 per cent claim is at least heavily exaggerated, but also that the CEPs only a play a minor role in urban road traffic.

Indeed, the share of Craftsmen/Technicians with 6.0 per cent is six- to seven-times higher than the share of CEPs. Moreover, utilization and efficiency are the core competencies of CEPs, while the logistics capabilities of craftsmen/technicians are not very strong. According to study from BIEK (2019), further consolidation efforts within the CEP industry would only lead to a maximum saving of 10 per cent for delivery vans, i.e. with a total share of 0.8 per cent on total traffic, a reduction would not even reflect 0,1 per cent. However, for Craftsmen/Technicians with a share of 6.0 per cent, developing logistics capabilities and concepts may lead to relatively higher contribution to reduce the overall traffic in cities. As such, transport policies, which deal with an overall traffic reduction should be mode- and category-specific and directed at all relevant industries.

6. Conclusion

This aim of this study was to empirically investigate the impact of CEPs and other vehicles on urban road traffic. To achieve this aim, we performed subsequent manual physical counting of different vehicle categories on critical traffic points in Vienna and used publicly available data for validation purposes. The results show that the share of CEPs accounts for merely 0.8 per cent of total urban road traffic in Vienna, thus this study contradicts the claim that CEPs are the main contributor to urban congestion and delays. Craftsmen/technicians, in contrast, account for 6.0 per cent and is thus almost seven times higher than the CEP share. Overall, vans and vehicles above 3.5t account for 13.5 per cent of total traffic, while passenger cars comprise 86.5 per cent. As a consequence, transport policies, which deal with an overall traffic reduction should consider all vehicle categories and the respective industry specific logistics efficiency capabilities.

By investigating the share of CEPs and other city logistics vehicles in urban road traffic, this paper provided three important contributions to the literature. First, it provides an answer to the existing gap in the literature to what extent city logistics and CEPs impact and contribute to urban road traffic, thereby providing managers and academics with an empirical foundation of the traffic composition in cities. Second, this is the first study the specifically examines the share of delivery companies and differentiates between particular categories of delivery vehicles, thereby addressing the inherent uncertainty associated with the impact of delivery companies and other commercial sectors on urban road traffic. Third, the study substantiates the role of vans and CEPs in cities, thereby providing insight for future city logistics and traffic policies.

However, the results have to be viewed in the light of its limitations. The study was restricted to the city of Vienna, so we are cautious to generalize the findings as other cities' population or density may lead to other results. Future research could measure specifically the impact of CEPs and other vehicles in other cities and highlight similarities and differences to our study. In addition, our data was collected mainly through manual physical counting, thus the use of advanced technology may help future researcher to simplify the process. Moreover, we conducted our survey in the first half of the year and in very specific timeframes. Future research could expand surveys to other months and/or other times of the day to build a more comprehensive picture. It also seems that CEPs are confronted with a bad reputation, thus future research could investigate the rationale behind it. The calculation of the vans 'Other without label <7.5t' is also rather practice oriented, thus city logistics scholars could examine or validate the results with further research. Last, although the study considers environmental aspects, future research may calculate or compare the specific carbon emissions caused by the different vehicle types. As the first study that specifically investigated the share of CEPs on urban road traffic, we hope that future researcher will use this case to advance city logistics research and the results will spark further discussions how to make cities more sustainable.

7. Declarations

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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CRediT authorship contribution statement

Sebastian Kummer: Supervision, Conceptualization, Writing - review & editing. **Marko Hribernik:** Conceptualization, Writing - original draft, Writing - review & editing, Methodology. **David M. Herold:** Conceptualization, Writing - original draft, Writing - review & editing. **Jasmin Mikl:** Conceptualization, Writing - original draft, Writing - review & editing. **Mario Dobrovnik:** Conceptualization, Supervision. **Stefan Schoenfelder:** Supervision, Writing - review & editing.

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