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Which stakeholders benefit from rescheduling more freight deliveries to the off-peak hours? Results of a pilot study in the retail industry

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Abstract: Off-peak and night-time deliveries are widely considered to be able to absorb some of the traffic network congestion at peak hours. Furthermore, it is expected that they would be highly beneficial to the carrier performing these deliveries. However, because of the lack of practical experience, it is not clear how it would affect the other stakeholders within the supply chain. This paper discusses the outcome of a pilot study in the retail industry treating the advantages and disadvantages of rescheduling deliveries for suppliers as well as carriers and receivers.

Keywords: off-peak deliveries, night-time deliveries, city logistics, urban logistics

1. Introduction

A random journey along major motorways and primary roads in European metropolitan areas during peak weekday driving hours takes an average 18.6% longer than the same journey would take in uncongested conditions (INRIX, 2010). As European road traffic demand is expected to increase by 20% towards 2020 and by 33% towards 2030 (base year 2005) time losses due to congestion will continuously rise (Newton et al., 2009). An alarming observation which makes it likely that carriers could gain a considerable amount of time and therefore save money if they would make better use of the off-peak hours to carry out deliveries, especially at night, when the road infrastructure is under-utilised.

However, in practice it appears to be not that obvious to successfully reschedule freight operations to the off-peak hours, in particular when the three main stakeholders (shipper, carrier and receiver) are part of different companies and have to mutually negotiate commercial contracts. At the moment, receivers are reluctant to start taking receptions at night because they think it would cost them and they do not expect to be compensated for these additional costs. Therefore, in order for off-peak deliveries to stand a chance, a better understanding of both the benefits and disadvantages for all stakeholders involved is needed.

This paper discusses the results of a Belgian pilot study in the retail industry. Although the distribution centres of large retailers are open from 6am until 10pm or even 24 hours a day, retailers indicate that they mainly receive their goods during the morning from 6am until 2pm. The aim of this project was to temporary reschedule some of these trips to the off-peak hours in order to determine the impact on the three stakeholders, i.e. the shipper (and/or his 3PL), the carrier and the retailer. The paper is structured as follows. In a first section the concept of

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4 Ghent University, Geography Department, Krijgslaan 281/S8, 9000 Gent, Belgium. Tel.: +32 9 264 45 53
night-time deliveries and its practical application is discussed. The second section introduces the pilot study and its participants while the third section discusses the method used to measure the impact. Finally the observational data and the results are reported and some conclusions are made.

2. Night-time deliveries

Off-peak deliveries are widely considered to be able to absorb some of the traffic network congestion at peak hours (Browne et al., 2006; Holguín-Veras et al., 2005). The idea is that carriers reschedule trips in a way that they send out more freight vehicles when traffic is low in order to avoid recurring traffic congestion and thus reduce time losses to a minimum. As a consequence, during traditional passenger peak hours, roads are less occupied by freight vehicles bringing at least some relieve as freight vehicles are accountable for 19% of all distances travelled on Belgian motorways (http://statbel.fgov.be, 5th of May 2011). Recent traffic data demonstrate, however, that at the moment carriers do not systematically avoid passenger peak hours (Figure 1). Both the number of trucks with a maximum allowed mass up to 3500 kilograms and the number of vans reach their top right at the start of the morning peak at 6 am (Ben Tato and Macharis, 2010). Heavy goods vehicles (HGV) seem to, at least to some extent, reckon with both the morning and evening rush hour as their number is at its highest between 9am and 3pm. Figure 1 also clearly demonstrates that the number of vehicles on the road at night is significantly lower than during the day but not non-existing.

Figure 1: The average number of freight vehicles per counting station at the different times of day for March 2010. Legend: blue line: vans; red line: small trucks, green line: heavy goods vehicles. Source: Ben Tato and Macharis, 2010.

Already freight vehicles, especially HGV’s, are deployed at night mainly for long distance trips throughout Europe. However, these long haulage nocturnal trips are not treated within the literature on night-time and off-peak deliveries because often both the loading and unloading is done by day. In that case, when it is only the transport taking place at night, nor
the shipper nor the receiver are affected. To the carrier making use of the night is advantageous because he can deploy his rolling stock more efficiently. Therefore, nocturnal trips without nocturnal deliveries were quite easy to implement. Usually, rescheduling road freight transport operations is considered in the context of urban distribution. This is due to the fact that the urban stumbling blocks which have to be overcome in order to benefit from the potential advantages are numerous and therefore require more study. The most important argument in favour is gaining time by driving when there are less traffic jams. In urban surroundings daytime congestion is more severe than elsewhere, both on motorways to and from the city as on the urban road network itself. Analysis of congestion on Flemish motorways demonstrates that of all these roads the ring roads around Brussels and Antwerp together with the parts of the E40, E313, E17 and E19 close to Brussels, Antwerp and Gent are saturated most often (Hoornaert et al. 2011). In addition to that, urban deliveries also usually involve shorter trips with multiple delivery points relatively close to each other. Therefore, the already more severe urban congestion becomes even more significant. Furthermore, these deliveries when carried out by day can be subject to several different types of time restrictions or vehicle limitations quite often leading to a suboptimal utilisation of the vehicle fleet. Theoretically, it is expected that all of these inefficiencies could be avoided if urban road freight transportations were rescheduled to the off-peak moments thus reducing delivery costs and the burden on the environment (Holguín-Veras, 2008).

However, there are two important stumbling blocks preventing urban night-time deliveries to be put into practice easily. First of all, decisive to the success of any initiative rescheduling deliveries to the nightly hours is the attitude of the receiver (Holguín-Veras et al., 2005). Carriers, wholesalers and suppliers doing their own logistics indicate that off-peak deliveries would be cheaper to them but they tend not to switch over because the receiver, their customer, does not want them to. He prefers to receive his goods during opening hours, because he expects that night-time deliveries would put him up with extra costs for evening or night work, heating, lighting, insurance and security. Various solutions were developed to tackle these reservations e.g. focussing on receivers who are already open during the off-peak hours such as restaurateurs and bar owners (Holguín-Veras et al., 2005) or who are part of the same group as the shipper (Sel et al., 2011), tax deductions and lower shipping costs to be given to receivers willing to accept off-peak deliveries (Holguín-Veras and Polimeni, 2006) or unmanned receptions making use of different kinds of safety solutions such as lockers (Sel et al., 2011).

An additional difficulty is the lack of contractual obligations between retailer and carrier. Urban deliveries are carried out because people buy consumer goods at downtown retail stores. In response to that, retailers order new items from their suppliers to replenish their stock. At that point, supplier and retailer agree on the amount of goods to be delivered, the price (including transport) and the lead time. The supplier strives to provide the best possible service to his client. That is why he tries to fulfill their agreement to the best of his abilities by making sure the requested goods are delivered on time. Some suppliers carry out their deliveries on own-account and are therefore able to enter into direct consultation with the retailer on a mutually favourable delivery date and/or time within the agreed lead time. For the most part, however, suppliers put out the job to a professional carrier who is paid a certain price to pick up the goods and to take them to the shopkeeper’s premises. Supplier and carrier enter into an agreement of their own which, among other things, states how much time the carrier is granted to deliver the goods. As a result, receiver and carrier are only little inclined to consult with each other on the most appropriate delivery date or time which makes it even more difficult to change rusted habits (Stichting Leve De Stad, 2005).
A second important stumbling block for urban night-time deliveries is the noise nuisance caused by loading and/or unloading freight vehicles at night in densely populated areas (Dassen et al., 2008). In many cities this is the reason why night-time deliveries are currently prohibited. However, the Dutch PIEK-programme has shown that meeting acceptable noise standards is technically possible. At the end of 1998 the renewed “Decree Retail Trade Environmental Protection” came into force in the Netherlands (www.piek.org, 12th of March 2009). It stipulated that the noise emission generated when loading and unloading goods between 7 pm and 7 am must comply with strict peak noise standards. Given the products that were used at that time, industry and commerce could not comply with these strict standards. They were forced to come up with innovative measures. The Dutch government supported the implementation of these new products with a long-term subsidy scheme which was called the Piek-programme and was valid from 2004-2008. Under this programme many new ‘quiet’ products were developed. However, although the technical solutions exist, in many countries they are not governmentally supported and demand for additional investments from carriers and receivers.

Despite the fact that both the receiver’s availability and the noise nuisance can be overcome, only limited attempts have been made to put the concept into practice within the urban environment. Throughout Europe, a number of pilots have been setup with food retailers such as Sainsbury’s, Mercadona, Condis, Lidl, Albert Heijn, Boni, Jumbo etc. The three-month night-time delivery trial undertaken at Sainsbury’s supermarket in Wandsworth, in cooperation with the UK Freight Transport Association and the Noise Abatement Society, resulted in reduced journey times (60 minutes per trip), delivery costs (£16000 per annum) and CO2 emissions (68 tonnes per annum) while no noise-related complaints were reported (Freight Transport Association, 2009). In Spain, during the period between 2003 and 2007, several night-time delivery pilots were set up with Mercadona, Condis and Lidl also resulting in reduced journey times, delivery costs and emissions (www.silence-ip.org and www.osmose-os.org, 5th of May 2011). The Dutch Albert Heijn, Boni and Jumbo trial shifted all deliveries to 10 shops in 9 different cities to the evenings (7pm - 2am) and early mornings (5am - 7am) during 3 weeks (Dassen et al., 2008). It concerns more than a thousand deliveries resulting in only a single noise-related complaint by a local resident. Travel times were up to 4 times shorter and because the severe Dutch time windows and vehicle restrictions were relaxed, load rates were higher and fewer but bigger vehicles could be used. All of these examples, however, involve the supply of chain stores of larger retail chains. A rather specific setting which makes it easier to set up night-time deliveries because instead of the three traditional stakeholders (shipper, carrier and receiver) there is only one or two as the chain store is supplied from the chain’s central distribution centre either by the retail chain’s own transport company or by an external haulier.

3. **Pilot study with four shippers, three carriers and one retailer**

For the most part, shippers and receivers are not part of the same company but contracting parties agreeing on a particular amount of goods to be delivered at a certain price and within a certain lead time. In order to be able to truly assess the potential of night-time deliveries, this concept should be tested within a similar realistic and competitive setting. To set up a test case, inner-city commercial receivers appear to be less suitable as they are either part of a retail chain (and thus depending from their supplier) or too small to be willing to bear the possible expenses involved. However, within a broader urban setting, there are other professional receivers which are eligible for night-time deliveries, e.g. the central distribution centres of food retailers. Desk research and several interviews with two important Belgian retailers, a number of their suppliers and the transport companies carrying out the deliveries
for these suppliers first of all taught that at the moment, although their distribution centres are open from 6am until 10pm or sometimes even 24 hours a day, that the greater part of the receptions takes place between 6am and 2pm. Secondly, the different stakeholders within the supply chain are, each from their own point of view, motivated to partly reschedule deliveries. They hope to decrease costs, expand their capacity and/or limit their ecological footprint. Thirdly, both the distribution centres from the retailers and the suppliers are in the near vicinity of Brussels meaning that all transport between these centres has to deal with severe congestion during rush hours. Therefore, this setting is appropriate to assess the impact of night-time deliveries on the three main stakeholders and to find solutions for possible stumbling blocks along the way.

This pilot study was set up together with one retailer, four of his suppliers and three logistic service providers. Between October 2010 and January 2011 these 3PL’s rescheduled some of their deliveries destined for one of the retailer’s distributions centres to the off-peak or night-time hours. All of the deliveries within this study departed from a close by regional distribution centre of the supplier and did not directly originate from a production plant abroad. Most of the retailer’s distribution centres are open from 6pm till 10pm, except for a particular one which receptions perishable goods 24 hours a day. As part of this study, a second centre was also opened at night (between 10pm and 6am). At the other centres deliveries were rescheduled to the afternoon or evening hours. Three out of four supplier’s distribution centres are also operational between 6am and 10pm whereas the fourth one is non-stop operational during the working week.

4. Method

The first step of this study consisted of mapping the typical ordering and delivery process between supplier, retailer and logistic service provider based on extensive interviews with the participating companies. Five steps were distinguished:

1. The retailer places an order with his supplier
2. The order is dealt with at the distribution centre of the supplier
3. A 3PL collects the delivery at the supplier’s distribution centre
4. This 3PL delivers the goods at the distribution centre of the retailer
5. The retailer receptions the goods at his distribution centre

Afterwards, based on previous research, interviews with the participants and the existing literature, the aspects of this process which would be affected by more night-time deliveries were listed. In order to be able to compare the reference and pilot situation, a second list with measurable indicators was linked to the first one. These lists were submitted for approval to the participating retailer, one of the participating suppliers and one of the participating logistic service providers. Some of the effects had to be measured making use of quantitative data which were collected by the eight participating companies, both before the different pilots started (reference week(s)) and during the test weeks. Other effects are harder to express in figures and can only be assessed making use of qualitative data. Therefore, all participants were interviewed at least twice. The quantitative data were collected per trip, the qualitative for all trips of a particular participating company.

The quantitative data were analysed in three different ways. First of all, for each of the four pilots (linked to the four participating suppliers), the reference week(s) was/were compared to the pilot week(s). However, because not all reference trips were at peak hours and not all pilot trips were off-peak or at night, two alternative methods of analysis were developed. First of all, all trips were classified according to the time of day the delivery was carried out. A
distinction was made between morning deliveries (6am-2pm), afternoon and evening deliveries (2pm-10pm) and night deliveries (10pm-6am). Furthermore, the trips were reclassified according to the time the trips were made. Again, three types of trips were distinguished: peak trips (on weekdays between 6am and 10am and between 4pm and 7pm), off-peak trips (on weekdays between 10am and 4pm and by day during weekends) and night trips (between 7pm and 6am). For each expected effect, the three types of deliveries were mutually compared as well as the three types of trips. Each time, a paired T-test was performed in order to assess the chances that an observed difference is due to coincidence.

Table 1 summarizes the number of trips within each pilot and within each category. In total 108 trips were monitored. Although in advance all participating companies confirmed that they would be able to provide the data needed, some of them appeared not to be able to.

<table>
<thead>
<tr>
<th>DISTRIBUTION OF THE TRIPS</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Pilot 1</td>
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<tr>
<td>Pilot 2</td>
</tr>
<tr>
<td>Pilot 3</td>
</tr>
<tr>
<td>Pilot 4</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
</tbody>
</table>

Table 1: Summary of the different trips within the pilot study on off-peak deliveries

5. Findings

5.1. Supplier

The participating brands all have at least one distribution centre on Flemish territory from which they supply the Flemish, Belgian or Belgian-Luxemburg market. Usually they put out these centres to a 3PL. Once a supplier has received an order from the retailer it is automatically redirected to the 3PL who picks the requested goods and puts the delivery ready for transport.

5.1.1. Opening hours supplier’s distribution centre

Only one of the four participating suppliers works non-stop during the working week. The other three work from 6am till 10pm. During the pilots they did not have to expand their opening hours in order to facilitate off-peak and night-time deliveries at the retailer’s distribution centre. Furthermore, they indicated they did not have to change their working process nor make any practical adjustments.

5.1.2. Pre-loading

When it concerns shorter trips, in order to be able to deliver at night, loads also have to be ready for departure at night. Beforehand, it was assumed that more trailers would have to be pre-loaded because most distribution centres are closed at night. Pre-loading means that the logistic service provider does not only put the cargo ready for a truck driver to pick it up, but also loads it onto a trailer which enables the carrier to make a pick up at any moment even when the distribution centre is closed. In practice, however, it turned out that pre-loads were not more frequent than before. One of the suppliers always preloads the trailers of his carrier and kept doing so. The others, who usually do not preload, did not have to do it either during
the pilot study. That is due to the fact that although at night there is no orderpicking at the
distribution centres, there are always at least two workers present on the inbound side to
reception goods coming from non-stop working production plants. These workers can also
deal with the truck drivers who come to pick up deliveries which were already picked the day
before.

5.1.3. The speed at which a supplier finishes off an order
Table 2 shows per pilot and per type of deliveries how much sooner or later the logistic
service provider starts picking the order. As at the moment, deliveries are usually carried out
during the morning hours, these are used as a reference and set to 100. For 3 out of 4 pilots, it
appears as if when deliveries are carried out off-peak or at night there is less time between
receiving an order and the actual orderpicking. However, none of the observed differences are
significant which was also confirmed in the interviews afterwards. The participants also
attribute these differences to coincidence as the lead time they agreed on with their client is
the same for the different types of deliveries.

<table>
<thead>
<tr>
<th></th>
<th>5/10</th>
<th>6/10</th>
<th>7/10</th>
<th>8/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot 1</td>
<td>100</td>
<td>90</td>
<td>92</td>
<td>50%</td>
</tr>
<tr>
<td>Pilot 2</td>
<td>100</td>
<td>94</td>
<td>-</td>
<td>29%</td>
</tr>
<tr>
<td>Pilot 3</td>
<td>100</td>
<td>160</td>
<td>106</td>
<td>21%</td>
</tr>
<tr>
<td>Pilot 4</td>
<td>100</td>
<td>93</td>
<td>39</td>
<td>42%</td>
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</table>

Table 2 : Speed of transaction by the supplier

Table 3 shows that, when trailers are not pre-loaded, orders are mainly picked during the
morning hours and that the moment an order is picked does not relate to the ultimate delivery
time.

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<tr>
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<th>5/10</th>
<th>6/10</th>
<th>7/10</th>
<th>8/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot 1</td>
<td>NO DATA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilot 2</td>
<td>73%</td>
<td>27%</td>
<td>0%</td>
<td>82%</td>
</tr>
<tr>
<td>Pilot 3</td>
<td>72%</td>
<td>22%</td>
<td>6%</td>
<td>80%</td>
</tr>
<tr>
<td>Pilot 4</td>
<td></td>
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Table 3 : The time of orderpicking at the supplier’s distribution centre in relation to the final delivery
time at the retailer’s distribution centre

5.1.4. The duration of the orderpicking process
Beforehand, it was assumed that the time of orderpicking would relate to the time a load
departs for its destination and therefore, that it would be able to pick off-peak and night-time
orders more efficiently at the calmer moments. Table 3 showed, however, that this is not the
case and it is also confirmed by data on the duration of the orderpicking process (See Table
4). Although there are no data available on the duration of the orderpicking process for pilot
3, the supplier experienced a positive impact. Pilot 3 is the pilot with pre-loaded trailers and a non-stop operational distribution centre. In that case, it was possible to pick the orders when it was less busy at the centre.

<table>
<thead>
<tr>
<th>DURATION OF THE ORDERPICKING PROCESS</th>
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<tbody>
<tr>
<td>Morning</td>
</tr>
<tr>
<td>Pilot 1</td>
</tr>
<tr>
<td>Pilot 2</td>
</tr>
<tr>
<td>Pilot 3</td>
</tr>
<tr>
<td>Pilot 4</td>
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<tr>
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</tbody>
</table>

Table 4: Duration of the orderpicking process at the supplier’s distribution centre

5.1.5. Complaints on noise nuisance
There were no noise-related complaints by local residents during the test period. However, the suppliers consciously did not plan any additional nocturnal departures from distribution centres in residential area. Furthermore, already, at most of these centres a limited amount of trucks do arrive at night. Possibly, as the number of nocturnal rides within the framework of this study was limited, local residents might not have noticed them.

5.2. Carrier
All pilot deliveries were carried out by the three regular carriers of the participating suppliers. Two out of three only do pickups and deliveries, the third one also warehouses and delivers to the retailer from his own distribution centre.

5.2.1. Average speed
During rush hours the average speed was 43.92km/h whereas during the off-peak and at night the average speed increase by 25% and 34% respectively (See Table 5). These figures confirm that in urban settings much time can be saved by making better use of the off-peak hours.

<table>
<thead>
<tr>
<th>AVERAGE SPEED DURING PEAK, OFF-PEAK AND NIGHT TRIPS</th>
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<tbody>
<tr>
<td>Peak</td>
</tr>
<tr>
<td>Km/h</td>
</tr>
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<td>Peak = 100</td>
</tr>
</tbody>
</table>

Table 5: The average speed reached during peak, off-peak and night trips

However, it is difficult for a carrier to make use of these off-peak hours as during the day traffic is consecutively low for no longer than five to six hours. As a driver’s shift lasts longer, he nearly always has to drive part of his shift during rush hours. In addition, traffic rush hours do not coincide with the working peaks at the retailer’s distribution centre, e.g. the afternoon and early evenings are calm at the distribution centre, but very busy on the road. Because the interviews preparatory to this pilot study revealed that levelling off these working peaks is the retailer’s main motive to reschedule deliveries, it is interesting to study the average speed reached when performing morning, afternoon and evening, and night deliveries. Table 6 demonstrates that when performing afternoon and evening deliveries, an average speed was reached of 48.93km/h. Against all expectations, the average speed during morning deliveries was 8% higher. However, this difference does not prove to be significant. It does mean that, on average, there is no big difference between morning and
afternoon/evening deliveries as both during both periods of times there are calm and very busy moments on the road.

| AVERAGE SPEED WHEN PERFORMING MORNING, AFTERNOON AND EVENING, AND NIGHT DELIVERIES |
|---------------------------------|---------------------------------|-----------------|-----|-----|-----|
|                                 | Morning                        | Afternoon Evening | Night | T1  | T2  | T3  |
| Km/h                            | 52.83                          | 48.93            | 59.95 | 9%  | 3%  | 0%  |
| Afternoon and evening = 100     | 108                            | 100              | 123   |     |     |     |

Table 6: The average speed reached when performing morning, afternoon and evening, and night-time deliveries

During the interviews, all carriers stated that it is advantageous to carry out deliveries until about 3pm because these trips still are ahead of the evening rush hour and still can be scheduled within a driver’s morning shift. These early afternoon deliveries also enable the carrier to better stagger his trips as his working peak also falls during the morning hours. The evening hours appear to be less suited for deliveries. Mainly because at most retail distribution centres the last truck for reception has to arrive before 8pm. If it arrives later, workers are unable to unload the truck before the end of their shift which runs till 10pm. Arrivals before 8pm do coincide with the evening rush hour and therefore are not advantageous to carriers. However, all carriers equally state that non-stop operational distribution centres are suited for evening deliveries.

5.2.2. Fuel consumption
None of the different carriers taking part in this pilot study recorded the fuel consumption on trip level. Therefore, no conclusions can be made based on the trips within the scope of this study. However, one carrier mainly driving short-distance trips within the same urban setting of our pilot study indicated that at night, between 6pm and 6am, his freight vehicles consume an average 6.5% less fuel than during the day.

5.2.3. Waiting period at the retailer’s distribution centre
Truck drivers do not only lose time when standing still in traffic-jams, sometimes they also have to queue at the receiver’s distribution centre in order to get unloaded. However, the retailer involved in this pilot study does arrange a delivery time directly with the carrier and is able to keep to these time, irrespective of the moment of delivery. That is why, during this pilot study, no differences in waiting periods were registered. However, all carriers indicate that waiting periods at the distribution centres of other retailers could drastically be reduced when performing more off-peak deliveries.

5.2.4. Staff
In Belgium, truck drivers legally are entitled to a compensation for night work. It amounts to 1.0465 euro per hour when the driver is younger than 50 and to 1.3082 euro per hour when he is older. Some carriers pay a fixed compensation of 25 to 32 euro per night; others stick to the legal compensation scales. The carriers indicated that, when compared to a day driver, a driver at night costs 12.5% more.

None of the three carriers within this pilot study were faced with difficulties to find drivers willing to work at night. Quite the contrary, their drivers often ask them for more night trips. The most given grounds are the financial profit and the less stressful working conditions.
5.2.5. Efficient use of the carrier’s fleet
One of the possible advantages of night-time deliveries is the fact that a carrier can make more efficient use of his fleet. Carrying out night-time deliveries means that vehicles can be used for two shifts each twenty-four hours instead of one. When rolling stock is used more often, the fixed costs can be spread over more vehicle kilometres which would be beneficial to the carrier. However, none of the carriers recorded the average use of the freight vehicle in question (in minutes) on the day the night trips were driven meaning that within the framework of this pilot, it is impossible to pronounce upon this topic.

Whether or not a truck can be deployed during an additional shift depends from the ease with which a connecting trip can be found. Two out of three carriers recorded data on the trip right before and/or right after the pilot trip. However, only one of these trips was a true night trip and therefore, also on this topic, nothing conclusive can be said.

5.3. Retailer
All deliveries for this pilot study were carried out at several distribution centres of only one retailer. This retailer was not able to record data for each delivery separately. That is why conclusions for the retailer are on the one hand based on data which were retrieved from the supplier’s and carrier’s data and on the other hand on a report from this retailer in which he clustered his general findings after the 4 pilot projects.

5.3.1. Ordering behaviour
The lead times for deliveries at the distribution centres of the retailer in question are fixed in an agreement with each of his suppliers. It states that an order has to be delivered a specific number of days after it was placed. Only after the delivery has been confirmed by the supplier, the retailer settles a delivery time with the carrier meaning that the retailer does not know the exact delivery time and does not ask for one when he places his order. The retailer indeed indicated that he did not change his ordering behaviour for this pilot study. Furthermore, he also does not expect to do so in the future when more deliveries would be carried out during the off-peak or night.

5.3.2. Lead time
Because the retailer did not change his ordering behaviour, it is not expected that the actual lead times changed when more off-peak and night-time deliveries were carried out. Table 7 demonstrates that there is no significant difference between morning, afternoon and evening, and night deliveries.

| LEAD TIME (relative compared to morning deliveries (set to 100)) |
|-----------------|-----------------|-----------------|
| Morning | Afternoon | Evening | Night | T1 | T2 | T3 |
| Pilot 1 | 100 | 100 | 128 | 50% | 15% | 13% |
| Pilot 2 | 100 | 86 | - | 3% | - | - |
| Pilot 3 | 100 | 95 | 49 | 46% | 13% | 2% |
| Pilot 4 | 100 | 124 | 56 | 7% | ERROR | ERROR |

Table 7: Relative lead times

5.3.3. Staff
In order to be able to reception night-time deliveries, at one of the distribution centres an additional shift (between 10pm and 6am) had to be established. Two workers were deployed for this. It was easy to find volunteers to work this shift. In the case of this retailer, deploying
workers at night increases the labour costs with 30% which means that these 2 workers have to at least unload 14 to 16 trucks in order to be profitable to the retailer.

5.3.4. Distribution centre capacity and stock reductions
When the possible delivery times are extended to the nightly hours, the capacity for reception equally enlarges. It would also enable the retailer to decrease stock by one day if deliveries arriving in the night between day A and day B were virtually considered to be in stock at the end of day A and therefore ready for delivery at the start of day B instead of day C. Of course, this requires a high reliability of deliveries.

5.3.5. Handling time at the retailer’s distribution centre
Because at the moment there are now order pickers at work at night, the productivity of the night workers doing receptions is much higher. On average, they are able to handle an incoming truck 15 minutes faster which means a gain of 25%. Furthermore, when more freight is received at night, it is also less busy on the discharging bays during the working peaks in the morning. A downside of night-time deliveries is that outside ordinary business hours it is difficult to reach the supplier or carrier whenever there is a problem. This is mainly the case for excisable goods.

5.3.6. Complaints on noise nuisance
Also at the retailer’s distribution centre there were no noise-related complaints by local residents during the test period. However, the retailer made the reservation the test involved a limited amount of night-time deliveries which were carried out during the winter months. In the past they did register an increase of complaints when the weather is better and people tend to sleep with their windows open.

6. Conclusions
This paper discusses a Belgian retail sector pilot study on rescheduling deliveries to the off-peak and night-time hours within a congested setting. The idea of making better use of the off-peak hours is to avoid time losses due to traffic congestion. However, rescheduling freight trips to a different time of day means that the deliveries have to be rescheduled too. The pilot study proved that transporting and delivering at another time mainly affects the receiver and the carrier. Whether deliveries are shifted to the daytime off-peak or the night, the effect for the supplier is discountable. The impact for the retailer-receiver depends on when the goods are delivered. At the moment, most receptions are made between 6am and 2pm, although the distribution centres are open between 6am and 10pm or even non-stop. If deliveries are rescheduled within these opening hours, there is only the positive effect of levelled off working peaks. However, to most carriers, this kind of shifts is not beneficial as they oblige them to drive during the evening rush hour. Rescheduling deliveries to the night-time hours is beneficial to both parties. Carriers have to pay higher labour costs, but these are compensated by the higher average speed and the actual increase of capacity as more deliveries can be carried out making use of the same rolling stock. Regarding receivers, the labour costs they have to pay in order to be able to do receptions at night increase by 30%. However, even to them night-time deliveries are beneficial as night-workers are able to work more efficiently and it enables them to decrease their stock by up to one day. Furthermore, receiving more freight at night would enable the retailer to level off the daytime working peaks at his distribution centre.
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