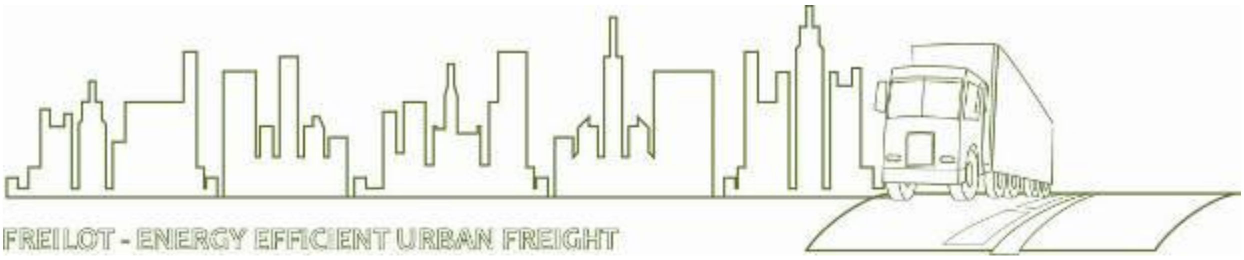
# FREILOT

***Urban Freight Energy Efficiency Pilot***

## D.FL.4.2 Final Evaluation Report

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## Legal Disclaimer

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## Abbreviations and Definitions

| Abbreviation | Definition |
|---|---|
| AC_SF | Adaptative Control, optimised for Specific identified Fleets. |
| AC_HGV | Adaptative Control, optimised for Heavy Goods Vehicles. |
| AL | Acceleration Limiter |
| ARTEMIS | A Semantic Web Service-Based P2P Infrastructure for the Interoperability of Medical Information System |
| CMEM | Comprehensive Modal Emissions Model |
| $CO$ | Carbon monoxide |
| $CO_2$ | Carbon dioxide |
| CVIS | Cooperative Vehicle-Infrastructure Systems |
| D.FL. | Deliverable Freilot |
| DAS | Data Recording System |
| DSB | Delivery Space Booking |
| EDS | Eco Driving Support |
| EEIC | Energy Efficient Intersection Control |
| FTP | File Transfer Protocol |
| GIS | Geographic Information System |
| GPRS | General Packet Radio Service |
| GPS | Global Positioning System |
| GW | Green Wave |
| GW_SF | Green Wave, optimised for Specific identified Fleets. |
| GW_HGV | Green Wave, optimised for Heavy Goods Vehicles. |
| HC | Hydrocarbon |
| HGV | Heavy Goods Vehicles |
| HMI | Human Machine Interface |
| IC_SF | Isolated Control, priority for Specific identified Fleets. |
| IC_HGV | Isolated Control, priority for Heavy Goods Vehicles. |
| LTL | Less Than Truckload |
| $NO_x$ | Nitrogen Oxides |
| Q | Quartile |
| RFID | Radio Frequency IDentification |
| RSU | Road Side Unit |
| T/F | True/False |
| TLC | Traffic Light Controller |
| UMDM | Urban Merchandising Distribution Management |

## Executive Summary

This document presents the main results obtained for the different services tested in the FREILOT project (EEIC, DSB, AL, ASL and EDS) and in the different locations (Bilbao, Helmond, Krakow and Lyon).

During more than twelve months the trucks using FREILOT services were doing the data collection in the different pilot sites. In parallel all partners involved in evaluation were working intensively in the preparation of the final data analysis, including the adaptation and calibration of data processing tools and the testing of the different tools with the data collected. The interaction with WP2 during this period was crucial, as the partners involved in this WP should assure the quality of the data and follow up the pilot evolution in order to inform WP4. All potential divergences from the initial plan (e.g. technical problems and service not operative, trucks leaving the project, new trucks in the project, etc…) were informed from operation in order to take into account during the data analysis.

As soon as the different pilots were finished, the data analysis processes started. In this case, depending on the service and the data loggers used (see detailed description in D.FL.4.1), different processes were applied. For example, in the case of DSB, the data was collected from four different sources: the truck (using a GPS data logger), the reservations system, the drivers and fleet operators (questionnaires) and observations in the street. In this case, the data from the GPS had to be cleaned and treated in advance to provide the indicators needed. Added to this, this real data was the input for the models used in the calculation of fuel consumption and emissions, and though, additional treatment of this data was needed.

In the case of EEIC, the different sources of information being treated and processed were the data from the trucks (using a GPS logger different from the DSB one), the data collected in the intersections and the information provided by the drivers and fleet operators. The work to be done with the GPS data was similar to the one performed with DSB data but the data format was different so an additional treatment was needed. In addition, for this service, the data provided by the intersections had to be synchronised with the data from the trucks before the indicators are generated.

Finally, for the in-vehicle services, the data processing was totally different. In this case, the own data logger provided information about consumption, therefore themodel was not needed and only data provided by the data logger and by the drivers and fleet operators were analysed.

For all services, the questionnaires were presented to the drivers and fleet operators. Once the information was collected, the results were codified and analysed.

Regarding the data analysis it is relevant to remark that, due to the difference nature of the services, the data analysis performed for each one is different. For example, the analysis for DSB is done for the area of the stops, the analysis for EEIC is done per intersection area and per route crossing a number of intersections with the service and for the in-vehicle services, in some cases the analysis is performed per affected zone and activation (AL and ASL) and in others for the complete route (EDS) and activations. All the information related to the data treatment and analysis is included for each service in a first subchapter called ‘Analysis Methodology’.

After all the data processing work, briefly described above, the indicators were available and it was possible to perform the statistical analyses. Related with the principal objective of the project the fuel consumption saving is significant in systems and pilot sites such as EEIC Helmond where the rate of change between baseline and pilot periods is -13% or EEIC Lyon with a rate of -8%. Krakow obtained local improvements of the efficiency in the driving in the intersections 2EW, with a rate of -62%, or in the 3NE with -22%.

Since the fuel consumption is strongly linked to gas emissions, EEIC Helmond reduces the $CO_2$ and $NO_x$ emissions by 13% and EEIC Lyon experience a benefit to the environment in a similar way. Intersection 2EW in Krakow reduces the emissions by 65%. These scores were achieved by the system mainly due to the drastic reduction in the number of stops.

Though the evaluation of DSB does not show a significant result in terms of fuel consumption/emissions reduction, it highlights its considerable impact on overall traffic, especially in illegal parking. In this case the system led to a remarkable increase in the number of deliveries. In addition, for this service the good welcome of DSB in Bilbao is remarkable. Many drivers thought that this service improved the freight image in urban areas, they liked the service and they found it is easy

to use. Moreover, drivers believed DSB increases the efficacy of their work, it facilitates their delivery operations and it increases the delivery efficiency. Regarding fleet operators, they considered that when their companies unload the goods using DSB, the delivery load is safer. Also, they believed the freight transport image in urban area is improved with the use of DSB. Furthermore, this service facilitated their tasks because they did not need to look for free spaces, therefore DSB service does not disturb their driving task.

In the case of AL system the results found under the experiment conditions, in terms of fuel consumption are not so significant, being between -2% and 2% fuel consumption increase. In the case of ASL there is reduction, but not so big. The scope of this limiter is more safety-related than economic related. Added to this, the driver has a fundamental role in the success of this system since he can accept or reject the limitation. The data analysed shows that most of the times the drivers were rejecting the limitation.

The EDS impacts on fuel consumption are also closely dependent on the drivers. In this case, the data analysed shows a maximum fuel reduction of 6,6% in the 0-100 km/h speed range and 15,3% in the 0-50 km/h speed range (in urban/suburban utilization). In long haul utilization, the maximum fuel reduction achieved was 6,3% in the 0-100 km/h speed range and 11,6% in the 0-50 km/h speed range (but this result may be not significant as previously explained).

Finally, above the main results were summarized but, it is recommended take a look at the complete report in which the extensive analyses performed on all the data collected are included, being the main results per service summarised per chapter. In the annexes of the document it is possible to find all the results of the data analyses performed.

# 1. Introduction

FREILOT was one of the first pilots in Europe and, from the beginning, it was a challenge to analyse how to deal with the evaluation of a pilot in which real users (city council, truck fleet operators and drivers) were involved during their real operation. This supposes that the evaluation carried out in FREILOT should not interfere with the normal operation of the drivers, the city and the fleet operators and it should, at the same time, collect all the data needed in the best way in order to perform a complete evaluation. The naturalistic connotations of the pilot itself obliged from the beginning to make compromises between the evaluation needs and the test of the systems in the real environment and real conditions, accepting in some cases the restrictions and doing adaptations in the evaluation methodology, assuring the objectives of FREILOT. All these aspects were taken into account from the beginning, being considered at every moment during the preparation of D.FL.4.1 Evaluation Methodology and Plan until its last version.

During the preparation phase of D.FL.4.1, WP4 established a good cooperation with WP2, WP3 and with WP6 in order to define a common methodology to obtain the general benefits of the services, taking into account all the different parts involved in the project. After the operation started, the cooperation with WP3 was intensified; as WP3 was in charge of the operation and had a first hand view on what it was happening in the different sites. This view was really important during the data analysis process.

The relation with WP6 was closer during the last phase of the project, when the results obtained in WP4 were transferred to this WP and different discussions were organized in order to understand the information obtained.

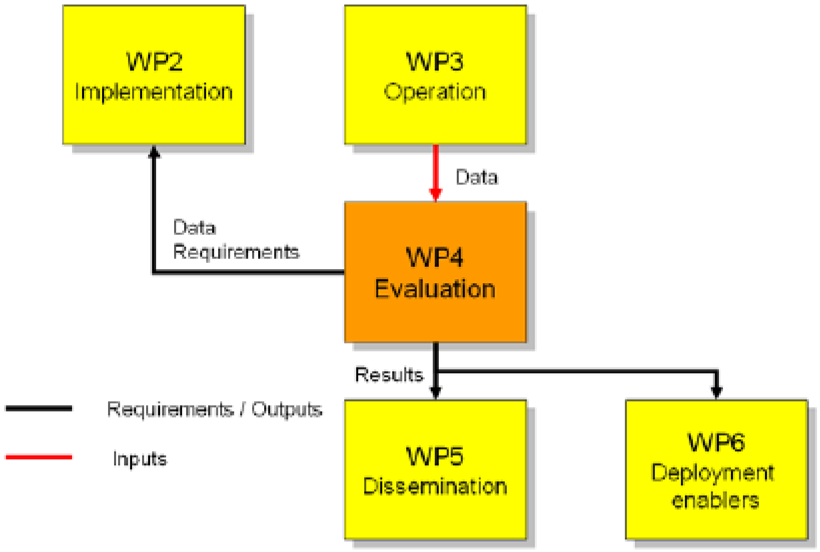



**Figure 1 Relationship between Evaluation and other WPs.**

This document collects all the results obtained from the data analyses performed on the data measured during the pilot. The results were presented per service and pilot site focusing one chapter per service in Section 3. Previously to the presentation of results, the general framework of the pilots was reminded for each site in Section 2 in terms of the final number of trucks and the implementation of services per truck.

The last chapter of the document (Chapter 4) summarises the main conclusions obtained. As a pioneer project, it was considered that all the experiences achieved during the three years of FREILOT should be considered also as a kind of results, useful for future pilots. For this reason, in this chapter a section dedicated to the lessons learned during the project is also included, especially from the evaluation point of view.

Finally, different annexes were included at the end of the document with the detailed graphics and information generated during the analyses of the different services and pilot sites.

## 2. General Framework Update

The evaluation framework was already described in the document D.FL.4.1, used as a reference during the last part of the project, but, during the operational phase some changes were made in the plan. As one of the main objectives of the FREILOT pilot is to include additional fleet operators and/or trucks (Objective 3) the number of vehicles used in the pilot was increased. Added to this, some slightly modifications were included in the evaluation plan and in the trucks themselves taking into account the evolution of the pilot and aiming to guarantee the twelve months of data collection for evaluation purposes.

This chapter aims to present the final set up of the FREILOT project from the evaluation point of view. The objective is not to repeat all the information already included in the D.FL.4.1. The idea is to present briefly the situation at the end of the project in terms of trucks per service and site and services tested in each truck. So, below, different tables were included summarising this final situation.

In the table below, the services to be evaluated per pilot site are included without any change from the plan (see D.FL.4.1):

| | | PILOT SITES | | | |
|---|---|---|---|---|---|
| | | BILBAO | LYON | KRAKOW | HELMOND |
| SYSTEMS | AL | X | X | | X |
| | DSB | X | X | | |
| | EDS | X | X | X | X |
| | EEIC | | X | X | X |
| | ASL | X | X | | X |

**Table 1 Services to evaluate per pilot sites**

At the end of the pilot, the total number of trucks participating and testing different services is 177. The tables included below describe the number of trucks per service and fleet operators in the four different locations:

| Site | EEIC | ASL | AL | EDS | DSB | Total vehicles per site* |
|---|---|---|---|---|---|---|
| Bilbao | -- | 2 | 3 | 2 | 124 | 127 |
| Helmond | 11 | 2 | 2 | 4 | -- | 14 |
| Krakow | 5** | 0 | 0 | 5 | -- | 10 |
| Lyon | 2 | 4 | 7 | 8 | 7 | 26 |
| Total vehicles per system | 18 | 8 | 12 | 19 | 131 | **177** |

**Table 2 Number of trucks per service and pilot site**

**** Several vehicles are testing a combination of systems, see annex in Implementation plan.***

***** In Krakow 10 units were produced, but only 5 have been used in real vehicles: 2 units were used in trucks and 3 in buses.***

The final table included in this chapter (see below) summarises which services were tested in each truck and location:

| | |
|---|---|
| **HELMOND** | |
| FREILOT Services Combination | Truck ID |
| AL | H14 |
| EDS | H18,H19 |
| EEIC | H01, H03, H06, H10<br>Fire brigade & Ambulances: H30, H31, H32, H33 |
| EEIC +ASL | H15 |
| EEIC + EDS | H17 |
| AL + ASL + EEIC + EDS | H16 |
| **LYON** | |
| FREILOT Services Combination | Truck ID |
| AL | L22, L23, L24, L25, L27, L31 |
| ASL | L30 |
| AL+ASL | L31 |
| ASL+EEIC | L28 |
| AL+ EEIC | L29 |
| AL+ASL+EEIC | L29 |
| DSB | L38, L39, L40, L41, L42, L43, L44 |
| EDS | L16, L18, L19, L32, L33, L34, L35, L36 |
| EEIC | L45,L46 |
| **BILBAO** | |
| FREILOT Services Combination | Truck ID |
| DSB | **124 trucks** |
| ASL | B06 |
| EDS | B04 |
| AL+ASL+EDS | B05, B04 |
| **KRAKOW** | |
| FREILOT Services Combination | Truck ID |
| EDS<br>EEIC | K01, K02, K03, K04, K05<br>K06, K07 |

**Table 3 Services tested per truck**

With this general framework, during the operation phase data was collected to be used for the evaluation and the data analyses were carried out. The next chapter summarises the main results for the different services and locations.

# 3. Results

This section summarises the main results obtained per service and location. The section is divided in different sub-chapters, each one dedicated to one service:

- Sub-chapter 3.1: EEIC
- Sub-chapter 3.2: DSB
- Sub-chapter 3.3: In-Vehicle services

At the same time, for each service, the following information is included in each sub-chapter:

- Analysis Methodology
- Results in *Location XX*
- ……
- Results in *Location YY*
- Validation of Hypothesis and Conclusions

The information included in this chapter for the different services is complemented with the contents of the annexes:

- Annex I: EEIC Service
- Annex II: DSB Service
- Annex III: In-vehicle systems

Before starting the presentation of the results, it is considered relevant to remind the reader of the different nature of the services and the different kind of data collected and analysed for each service.

| | | DATA COLLECTED | | | | |
|---|---|---|---|---|---|---|
| | | In-vehicle data | Intersection Data (only EEIC) | Reservations Data (only DSB) | Observations (only DSB) | Questionnaires |
| BILBAO | DSB | Analysed | N.A. | Analysed | Analysed | Analysed (statistical analyses) |
| | ASL | Analysed | N.A. | N.A. | N.A. | Not enough data collected |
| | AL | Analysed | N.A. | N.A. | N.A. | Not enough data collected |
| | EDS | Analysed | N.A. | N.A. | N.A. | Not enough data collected |
| HELMOND | EEIC | Analysed | Analysed | N.A. | N.A. | Analysed (descriptive analyses) |
| | ASL | Analysed | N.A. | N.A. | N.A. | Analysed (descriptive analyses) |
| | AL | Analysed | N.A. | N.A. | N.A. | Analysed (descriptive analyses) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | EDS | Analysed | N.A. | N.A. | N.A. | Analysed (descriptive analyses) |
| KRAKOW | EEIC | Analysed | Analysed | N.A. | N.A. | Not enough data collected |
| | EDS | Analysed | N.A. | N.A. | N.A. | Not enough data collected |
| LYON | EEIC | Analysed | Analysed | N.A. | N.A. | Not enough data collected |
| | DSB | Not enough data collected | Analysed | Not enough data collected | Analysed | Not enough data collected |
| | ASL | Analysed | N.A. | N.A. | N.A. | Analysed (descriptive analyses) |
| | AL | Analysed | N.A. | N.A. | N.A. | Analysed (descriptive analyses) |
| | EDS | Analysed | N.A. | N.A. | N.A. | Analysed (descriptive analyses) |

**Table 4 Data analysed per Service**

Important clarifications regarding this table are the following ones:

- In some case, e.g. DSB Lyon, due to difficulties during the installation and operation (see D.FL.3.1 Operation) it was not possible to collect enough useful data for doing an evaluation (at the end only 20 routes in Croix Rousse and less than 15 in Charité were collected). That quantity of data is not enough to ensure a valid statistical analysis, so the efforts for Lyon's DSB were concentrated on infraction counting, since the protocol has been respected carefully and is the same in both baseline and pilot.
- Regarding the questionnaires, the statistical analyses were only performed in DSB Bilbao, because the amount of questionnaires was enough for performing this kind of analyses. In the other places, the amount of answers collected was lower and only descriptive analyses of the answers were performed. In some particular cases, e.g. EEIC Lyon, EEIC Krakow, it was really difficult to obtain the feedback from the drivers and fleet operators on the services and, though the procedure was applied, no answers were received. This has not happened in Helmond, Bilbao or in general for the in-vehicle services (see Table 4).

## 3.1. EEIC

Before starting the presentation of results and aiming to help the reader to have a good understanding, below the different EEIC use cases testing within the project are briefly described.

| Use case | Pilot site | Description |
|---|---|---|
| IC_SF | Krakow | Isolated control, priority for specific identified fleets (SF = Specific Fleet). Isolated control is on an intersection by intersection basis (no coordination). Control strategies are determined by local (loop) detectors. The priority in this use case is for specific actively detected vehicles. |
| GW_SF | Lyon | Green wave, optimised for specific identified fleets. Green wave systems use coordination on a corridor. The coordination is fixed for a measured (by a limited number of (loop) detectors) traffic situation. |
| GW_HGV | Lyon | Green wave, optimised for all vehicles over a specified length |
| AC_SF | Helmond | Adaptive control, optimised for specific identified fleets. Adaptive control is a form of flexible network control, where coordination depends on the actual traffic demand. With higher volumes on the main corridor, coordination will occur as an emergent phenomenon. |
| AC_HGV | Helmond Simulation***** | Adaptive control, optimised for a large number of vehicles from identified fleets. |

***The results of simulations are not included in this report.***

#### 3.1.1. Analysis Methodology

Helmond, Lyon and Krakow have developed a method to optimise the traffic in the intersections. In each case, the EEIC is adapted to the control of the local systems.

In both cases, the first step to process the data was to unzip the GPS files from the RSUs and import them into the R software[1]. It is important, in a previous analysis, to identify traffic directions, validate speeds, calculate distances between two points, calculate the distance before/after the traffic lights, identify stops at traffic lights (when 60 m before the traffic light the vehicle speed is below 4 km/h) and finally delete the rounds on which there are less than 4 crossings at traffic lights.

#### 3.1.2. Results in Helmond

The pilot site of Helmond (Figure 2) consists of a two-way road with a length of 6 km and a perpendicular secondary road. There are 13 intersections with tricolour traffic lights resulting in 38 stop lines. The average distance between two traffic lights is 500 m.

[1] The R software (http://www.r-project.org/) is a free environment for statistical computing, graphics, analysis and modelling. It has been used for GPS and infraction counting data processing and simulation, in order to automatize the data treatment processes. More information about how the software has been used can be found in Pluvinet et al. (2012).


**Figure 2 Characteristics of the pilot area of Helmond for EEIC.**

Vehciles from Van den Broek were used and also fire brigade vehicles and ambulances. The reasons for using the intersection control for the freight transport carriers are related to economic and environmental reasons whereas for the fire brigade and ambulances they are related to safety reasons. So, data from emergency vehicles are not processed for two reasons. The first is that their benefits are safety and not fuel consumption, and the second is that they are always crossing an intersection, even if it is red, when using the system, so they could disturb the results since they measure data mainly when attending emergency situations. Moreover, the quantity of the data from fire brigade in baseline is under the statistical threshold to produce significant results.

| Period | Dates |
|---|---|
| Baseline 1 | From 15/01/2011 to 09/03/2011 |
| Pilot 1 | From 10/03/2011 to 09/08/2011 |
| Baseline 2 | From 01/10/2011 to 22/11/2011 |
| Pilot 2 | From 23/11/2011 to 18/03/2012 |

**Table 5 Baseline and pilot dates for EEIC Helmond**

During the pilot period, a regular check of the evaluation results has led to identify several dysfunctions and exceptional events. For instance, a thunderstorm disturbed the system in three intersections between April and June 2011. For this reason, a part of the results have been invalidated and a second baseline has been made. In this report the results of the two baselines and the last pilot period are shown (Table 5). The two baselines have been grouped under the same flag in Table 6.

| Period | Number of trips | Number of distinct vehicles |
|---|---|---|
| **Baseline** | **66** | **13** |
| **Pilot** | **52** | **10** |

**Table 6 Characteristics of the Van den Broek vehicles.**

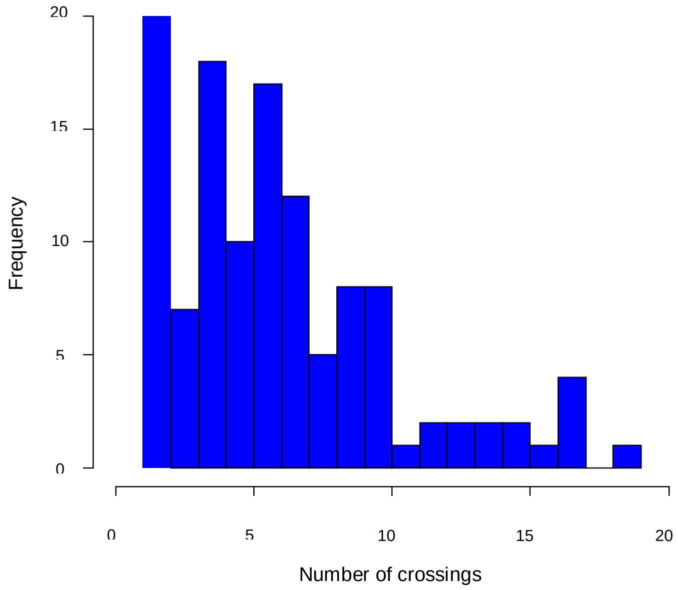



**Figure 3 Distributions of the number of crossings per route.**

Figure 3 shows the number of intersections crossed by a truck. It can be seen that, in most cases, the trucks do not complete the full route.

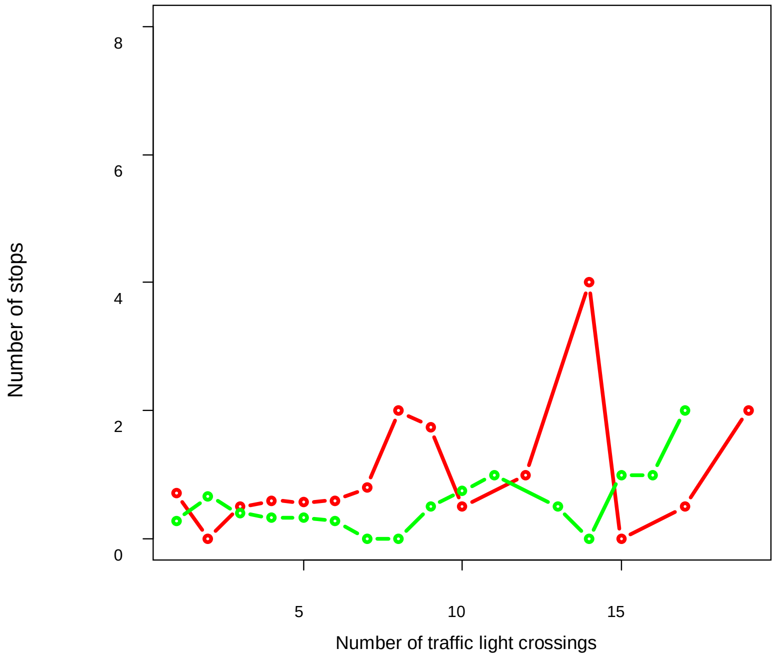



**Figure 4 Number of stops per number of traffic light crossings (baseline in red and pilot in green).**

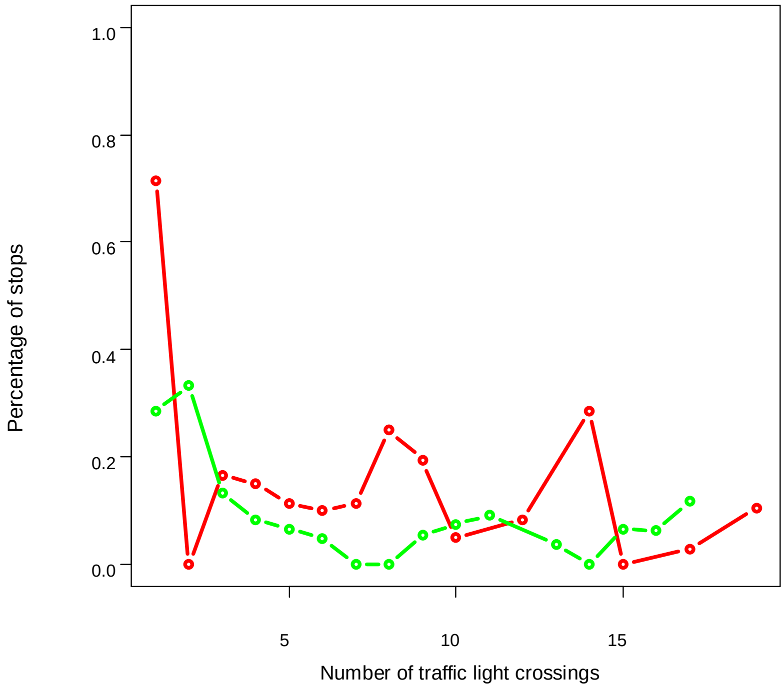



**Figure 5 Percentage of stops per number of traffic light crossings (baseline in red and pilot in green).**

Figure 4 and Figure 5 show the number of stops with respect to the number of crossings. The introduction of EEIC has had a positive effect since the mean number of stops decreases. The difference is appreciable between 7 and 9 crossings. For instance, Figure 4 shows that when the vehicle goes through 8 traffic lights stops in two of them in the baseline period (Figure 5 shows that the probability to stop is near 25%) but does not stop in any of them in the period pilot. Over 10 crossings, the data sample is very small, so it can not be concluded about the potential of EEIC in these cases.

| Period | Number of crossings | Number of stops | Percentage of stops |
|---|---|---|---|
| **Baseline** | **408** | **52** | **13%** |
| **Pilot** | **343** | **20** | **6%** |

**Table 7 Number of crossings and stops in both periods**

Table 7 reports the mean number of stops. In the pilot period a gain of 62% with respect to the baseline is observed. Nevertheless, the probability to stop at a traffic light is already low during the baseline (about 1 stop in each 8 crossings) which illustrates the good synchronisation between the traffic lights in the city of Helmond, especially in the urban area of the FREILOT site. As shown by Figure 3, each route crosses a different number of intersections, which means that some trips do not need to stop and others stop several times.

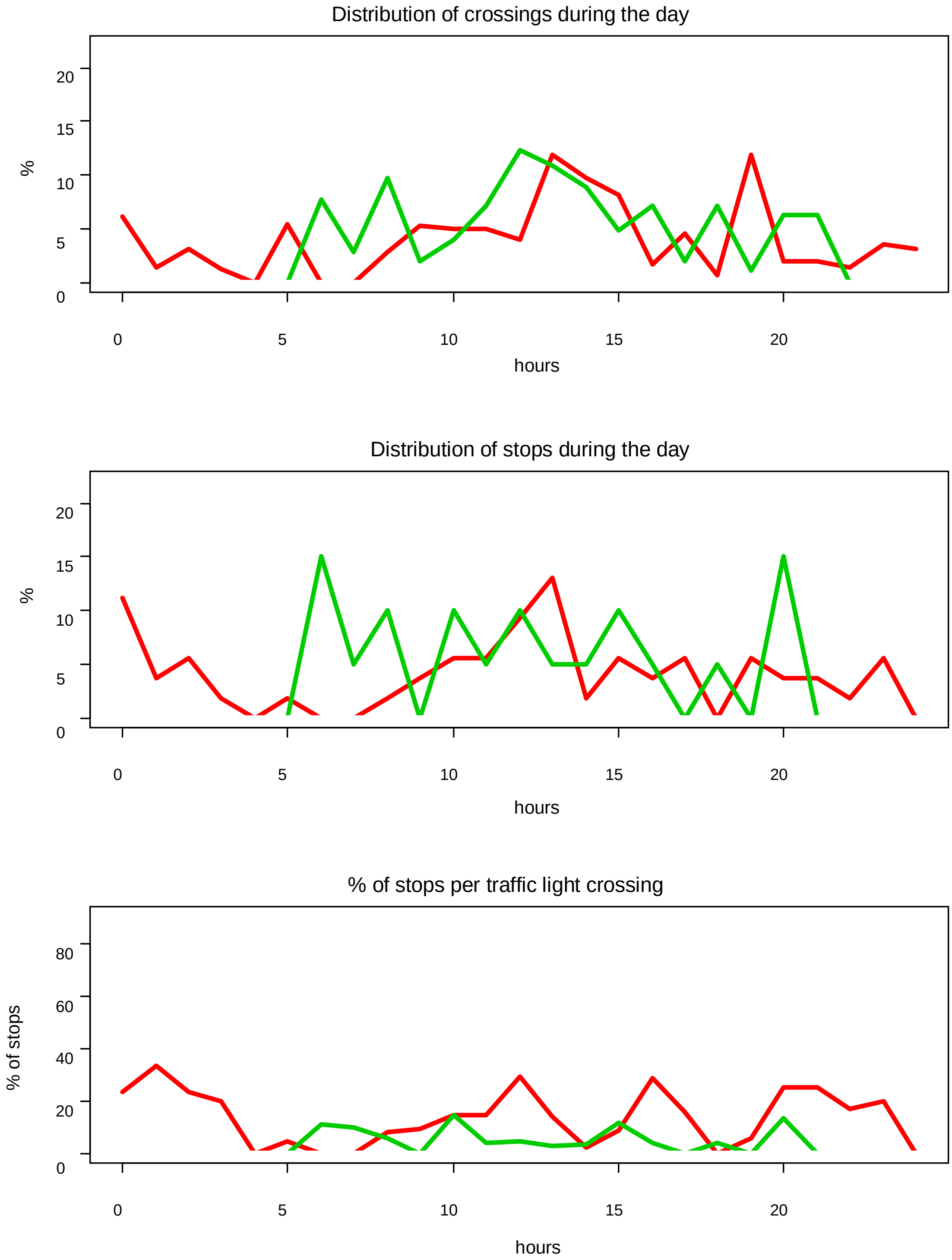



**Figure 6 Temporal distributions of crossings, stops and percentage of stops during the day (baseline in red and pilot in green).**

The temporal distribution during the day (Figure 6) presents a few changes (except between 5:00 and 9:00). Most of the observations are between 11:00 and 17:00. The same trend is applicable to the number of stops (which depend on both the temporal distribution and the traffic status, which is external). Indeed, in car traffic peak hours (5:00 – 9:00) the number of stops increases considerably. Concerning the percentage of stops per traffic light, it is observed that it decreases during the pilot. Moreover, the variability is lower during the pilot.

| | Baseline | | Pilot | | Fuel consumption | | | $NO_x$ emissions | | | $CO_2$ emissions | | | *Speed* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intersection | Nb vehicles | Nb stops | Nb vehicles | Nb stops | Baseline | Pilot | Variation | Baseline | Pilot | Variation | Baseline | Pilot | Variation | Baseline | Pilot | *Variation* |
| 5700101_W_1 | 21 | 5 | 21 | 5 | 27,6 | 22,1 | -19,9% | 4,35 | 3,515 | -19% | 746 | 602 | -19,3% | 30 | 35 | *16,7%* |
| 5700102_W_3 | 19 | 2 | 19 | 2 | 21,3 | 19,1 | -10,3% | 3,712 | 3,446 | -7% | 581 | 542 | -6,7% | 27 | 29 | *7,4%* |
| 5700103_E_6 | 15 | 1 | 15 | 1 | 27,4 | 19,5 | -28,8% | 3,98 | 2,928 | -26% | 730 | 530 | -27,4% | 41 | 44 | *7,3%* |
| 5700103_W_5 | 19 | 0 | 19 | 0 | 23,8 | 11,6 | -51,3% | 3,721 | 2,491 | -33% | 653 | 330 | -49,5% | 37 | 34 | *-8,1%* |
| 5700104_E_8 | 15 | 0 | 15 | 0 | 23,5 | 21,2 | -9,8% | 3,507 | 3,583 | 2% | 637 | 579 | -9,1% | 40 | 29 | *-27,5%* |
| 5700104_W_7 | 20 | 2 | 20 | 2 | 28,1 | 27,5 | -2,1% | 6,126 | 5,485 | -10% | 778 | 765 | -1,7% | 13 | 15 | *15,4%* |
| 5700106_W_9 | 16 | 1 | 16 | 1 | 32,1 | 30,5 | -5,0% | 4,649 | 4,154 | -11% | 858 | 811 | -5,5% | 37 | 39 | *5,4%* |
| 5700701_W_14 | 2 | 0 | 2 | 0 | 28,4 | 28 | -1,4% | 4,183 | 3,769 | -10% | 733 | 744 | 1,5% | 40 | 49 | *22,5%* |
| 5700702_E_17 | 11 | 2 | 11 | 2 | 17,4 | 15,9 | -8,6% | 3,181 | 2,707 | -15% | 476 | 433 | -9,0% | 31 | 39 | *25,8%* |
| 5700702_W_16 | 15 | 2 | 15 | 2 | 15,6 | 24 | 53,8% | 2,956 | 3,658 | 24% | 419 | 651 | 55,4% | 39 | 34 | *-12,8%* |
| 5700704_E_18 | 17 | 2 | 17 | 2 | 24,5 | 21,9 | -10,6% | 3,654 | 3,334 | -9% | 661 | 589 | -10,9% | 38 | 38 | *0,0%* |
| 5700704_E_20 | 11 | 1 | 11 | 1 | 20,7 | 20,8 | 0,5% | 3,242 | 3,372 | 4% | 563 | 562 | -0,2% | 38 | 34 | *-10,5%* |
| 5700704_W_19 | 15 | 1 | 15 | 1 | 22,2 | 18,5 | -16,7% | 3,862 | 2,945 | -24% | 604 | 498 | -17,5% | 31 | 39 | *25,8%* |
| 5700704_W_21 | 15 | 1 | 15 | 1 | 21,9 | 16 | -26,9% | 3,746 | 2,793 | -25% | 584 | 435 | -25,5% | 41 | 37 | *-9,8%* |
| 5700901_E_23 | 11 | 0 | 11 | 0 | 20,7 | 29,3 | 41,5% | 3,235 | 4,118 | 27% | 567 | 783 | 38,1% | 37 | 42 | *13,5%* |
| 5700901_W_22 | 9 | 1 | 9 | 1 | 23,3 | 25,1 | 7,7% | 3,637 | 3,446 | -5% | 626 | 669 | 6,9% | 38 | 49 | *28,9%* |
| 5700902_E_25 | 14 | 2 | 14 | 2 | 16,4 | 14,5 | -11,6% | 2,88 | 2,442 | -15% | 441 | 392 | -11,1% | 37 | 46 | *24,3%* |
| 5700902_W_24 | 9 | 0 | 9 | 0 | 19,9 | 24,7 | 24,1% | 2,968 | 3,435 | 16% | 531 | 664 | 25,0% | 49 | 47 | *-4,1%* |
| 5700903_E_27 | 12 | 2 | 12 | 2 | 36,8 | 26,8 | -27,2% | 4,962 | 3,851 | -22% | 993 | 728 | -26,7% | 34 | 39 | *14,7%* |
| 5700903_W_26 | 9 | 1 | 9 | 1 | 23,5 | 17,3 | -26,4% | 3,56 | 2,938 | -17% | 629 | 456 | -27,5% | 44 | 35 | *-20,5%* |
| 5700904_E_29 | 9 | 2 | 9 | 2 | 25,9 | 14,1 | -45,6% | 3,676 | 2,275 | -38% | 690 | 389 | -43,6% | 41 | 51 | *24,4%* |
| 5700904_W_28 | 7 | 1 | 7 | 1 | 29,3 | 30,5 | 4,1% | 4,767 | 4,524 | -5% | 774 | 810 | 4,7% | 40 | 51 | *27,5%* |
| 5700905_E_31 | 5 | 0 | 5 | 0 | 10,1 | 1,6 | -84,2% | 2,284 | 0,851 | -63% | 273 | 45 | -83,5% | 59 | 68 | 15,3% |

**Table 8 Emissions, consumption and speed by intersection.**

| | Baseline | Pilot | Rate of change |
|---|---|---|---|
| **$CO_2$ emissions (g/km)** | **644** | **562** | **-13%** |
| **$NO_x$ emissions (g/km)** | **3,7** | **3.33** | **-14%** |
| **Fuel consumption (l/100km)** | **24** | **21** | **-13%** |
| **Speed (km/h)** | **35** | **36** | **+2,6%** |

**Table 9 Geometric averages of emissions, consumption and speed for all intersections.**

Using the CMEM model on the GPS data (collected at each second) the average instantaneous speed was estimated as well as the average fuel consumption and emissions within the influence area of each intersection (100 m before and 60 m after the intersection). The calculation method is similar to that of the DSB evaluation and is detailed in the D.FL. 4.1 Evaluation methodology and plan and in Pluvinet et al. (2012). First the results are presented in a disaggregated way per intersection (Table 8) where it can be seen that differences are important from one intersection to the other (see Annex 1). In Table 9 the geometric average results are shown for all intersections. An average gain of approximately 13% is observed for fuel consumption and emissions, with an average increase in speed of only 2.6 km/h.

#### 3.1.2.1. Questionnaires

Four drivers gave their opinion about the system; therefore, no more than a description of their answer is presented. Moreover, graphics bars with their answer are showed in the Annex 1. The results cannot be generalised. The items with the highest values are the following:

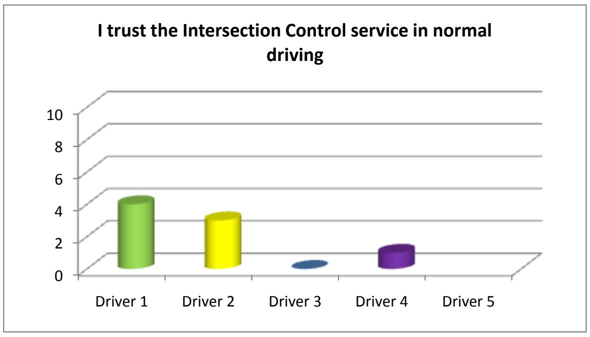
- "I consider the length of traffic queues in road intersections are smaller with the usage of Intersection Control service"
- "I think I have achieved a higher driving comfort using Intersection Control service"
- "After using Intersection Control I like the service"
- "I think that using the Intersection Control service increases the efficacy of my work"

The item with the lowest value is

- "I believe the Intersection Control service works properly".

In the case of ambulance/fire brigade drivers, 5 drivers gave their opinion about the Intersection Control service. The opinions are so variable although it seems that driver 2 and driver 3 had the best evaluation of this service.

Some questions compared the service during normal driving with emergency driving (Figure 7 - Figure 12). Both graphics are shown:



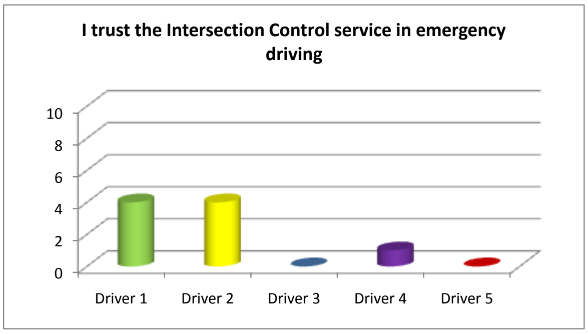
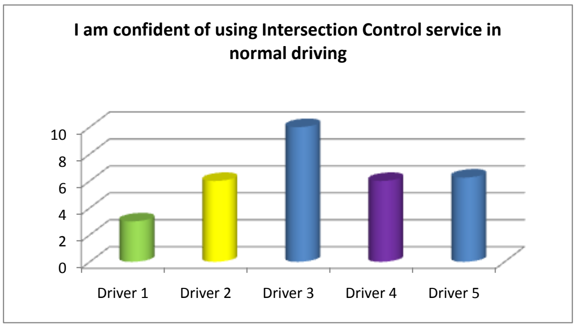




**Figure 7 Comparison between normal driving and emergency driving for the question: "I trust the Intersection Control".**

It seems that trust is similar for normal driving and emergency driving, in fact, scores are very analogous.



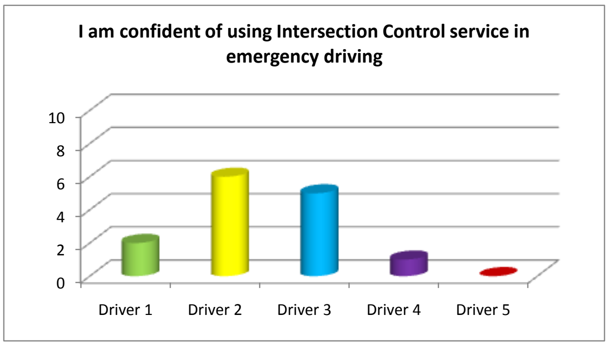
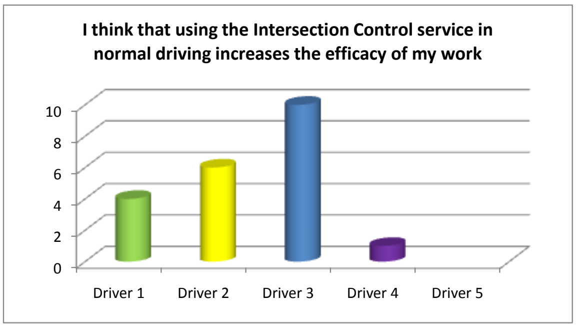




**Figure 8 The same as Figure 7 that but for "I am confident of using Intersection Control".**

However, drivers are more confident to use the service in normal driving that in an emergency driving.



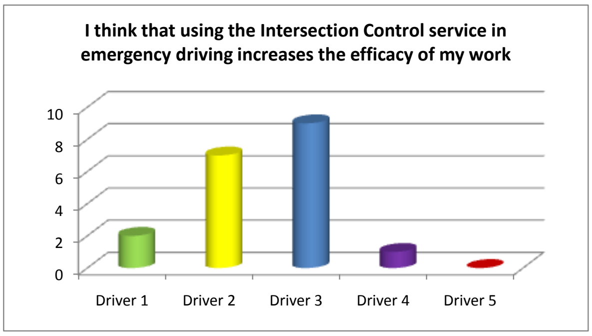
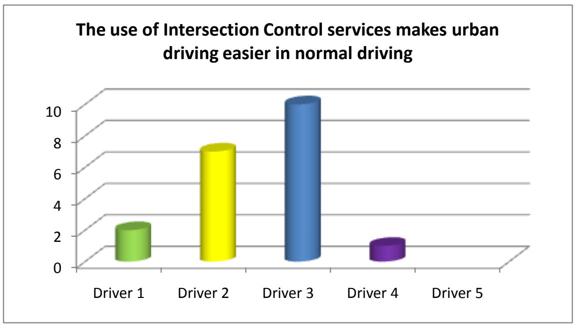




**Figure 9 The same as Figure 7 that but for "I think that using the Intersection Control service increases the efficacy of my work".**

The use of Intersection Control service doesn't seems to have an influence in both conditions of driving (scores are so similar for each driver).



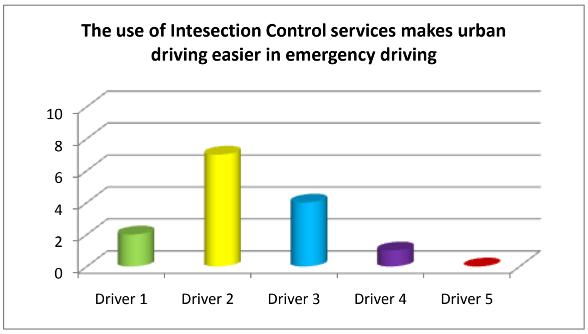
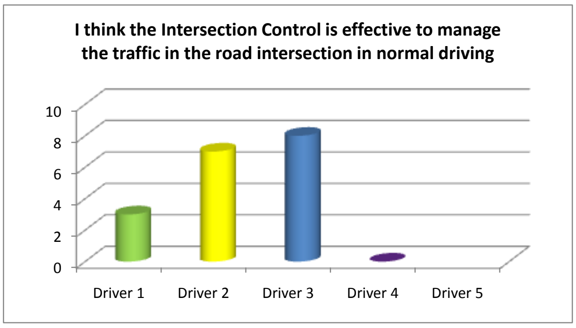




**Figure 10 The same as Figure 7 that but for "The use of Intersection Control services makes urban driver easier".**

It appears to the situation of normal driving had better scores for these five drivers regarding the fact that the use of EEIC services makes urban driving easier.



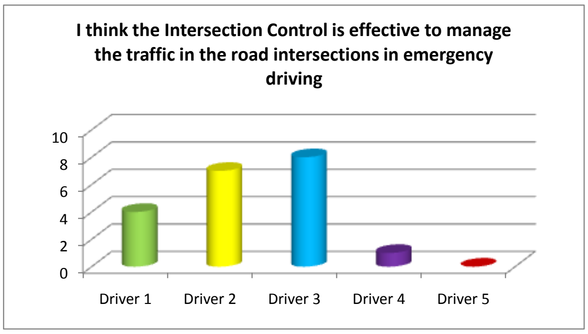
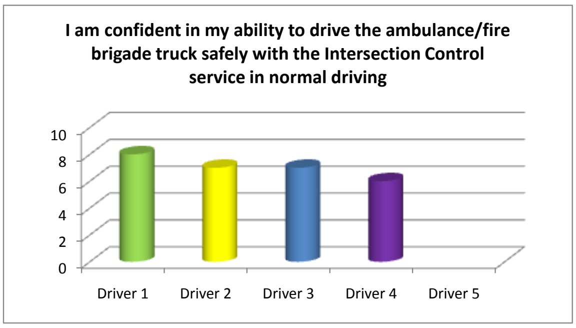




**Figure 11 The same as Figure 7 that but for "I think the Intersection Control is effective to manage the traffic in the road".**

There was not too much difference between normal driving and emergency driving when considering how  the traffic is managed by the road intersection.



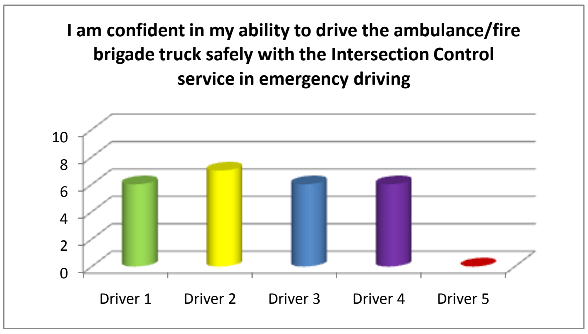




**Figure 12 The same as Figure 7 that but for “I am confident in my ability to drive safely with the Intersection Control service”.**

Finally, a similar trend is found between normal driving and emergency driving in reference to their ability to drive the ambulance/fire brigade truck safely with the Intersection Control service running.

Regarding to the fleet operator who’s answers to the questionnaires had high values (around 8 points) for all items. The item:

- “The use of Intersection Control services makes urban driving easier”

had the highest score (10 points).

Additional information about the results of questionnaires for EEIC in Helmond is included in Annex **I**.

### 3.1.3. Results in Lyon

Route de Lyon and Jean Jaurès Avenue were the chosen road to pilot the EEIC in Lyon. The first one tested the Dynamic Priority and the second one the Green Wave.

**- Route de Lyon**

Route de Lyon had two separate roads, with two lanes on each, and also a double lane bus road in the middle (Figure 13). The bus lanes benefits from specific priority at the signals. It has 3600m length with 9 tricolour traffic lights. In summer 2011 one more traffic light was added (Figure 14) by Grand Lyon’s planning issues and the FREILOT project was adapted to this new situation. The distance between two lights is about 400m.


**Figure 13 Characteristics of the pilot area of Route de Lyon for EEIC (initial configuration).**


**Figure 14 Characteristics of the pilot area of Route de Lyon for EEIC with an addittional traffic light, after Summer 2010.**

Two vehicles were concerned with this evaluation. The first one is a garbage vehicle that presents the particularity that it makes very regular routes: one daily in the morning making the same path. Moreover, this vehicle was present during all the data collection periods. The second one is a classic LTL transport vehicle which has been added during the Pilot 3 period. Unfortunately, the data from this last vehicle is not enough to obtain valid results.

Table 10 shows the distribution of the traffic lights per period and Table 11 the number of collected routes per vehicle. It is observed that almost all routes cross over all traffic lights. For this reason, only routes crossing over all traffic lights are kept for the analysis to make the results homogeneous and easier to compare and understand.

| Period | Date | Number of traffic lights | Number of traffic lights connected to trucks |
|---|---|---|---|
| **Baseline 1** | **From 10/12/2010 to 20/04/2011** | **9** | **0** |
| **Pilot 1** | **From 21/04/2011 to 30/06/2011** | **9** | **9** |
| **Pilot 2** | **From 01/07/2011 to 02/10/2011** | **10** | **9** |
| **Pilot 3** | **From 03/10/2011 to 13/03/2012** | **10** | **10** |
| **Baseline 2** | **From 14/03/2012 to 14/04/2012** | **10** | **0** |

**Table 10 Number of traffic lights during each test period**

| Period | Garbage vehicle | LTL transport vehicle |
|---|---|---|
| Baseline 1 | 39/39 | |
| Pilot 1 | 61/61 | |
| Pilot 2 | 78/78 | |
| Pilot3 | 43/48 | 5/6 |
| Baseline 2 | 39/47 | 0/0 |

**Table 11 Number of routes crossing over all traffic lights with respect to the total number of collected routes**

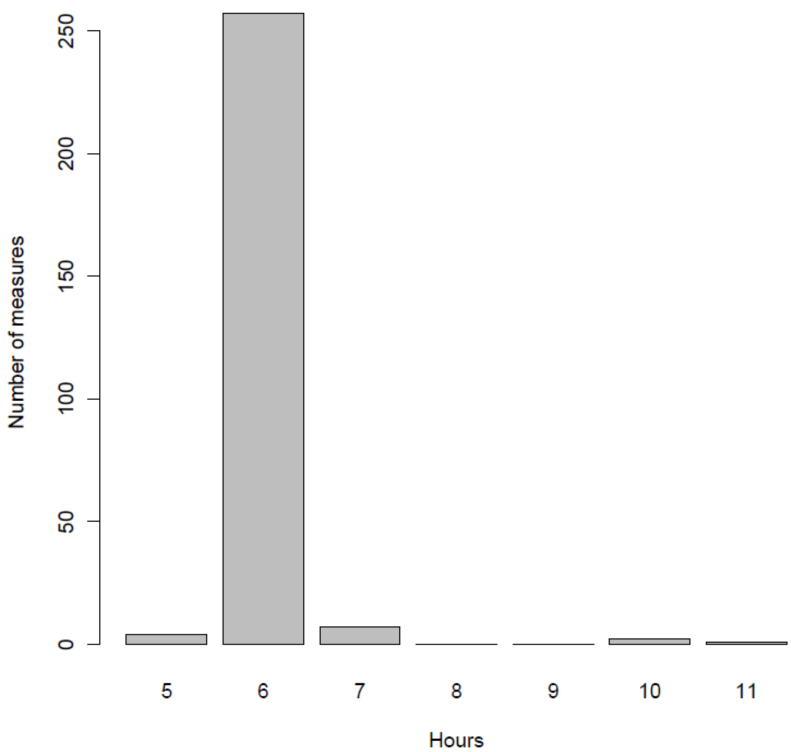



**Figure 15 Distribution of rounds during the day.**

Most routes, about 95%, happen between 5:30 and 6.30 (Figure 15), which confirms the regularity of the garbage truck. In addition, the same driver drove the truck during almost all the time during data collection. At this time period of the day, no congestion and a fluid traffic is observed in the section, which positions the pilot in a “best case” situation.

It can be identified, for each crossing, if the truck stopped or not at the traffic light. Table 12 reports the average number of stops per route during each test period. It is observed that the introduction of the cooperative EEIC system leads to a reduction of 1 stop (pilot 1 with respect to baseline 1 and pilot 3 with respect to baseline 2). Moreover, the addition of the new light had a small impact at the beginning (Figure 16 - Figure 17) because it took place in summer, during the school holidays. Note that on this section of the route there is a regular traffic of school buses at similar hours which had priority.

| Period | Number of stops per route | Percentage of stops |
|---|---|---|
| Baseline 1 | 4,15 | 46,2% |
| Pilot 1 | 2,97 | 33,0% |
| Pilot 2 | 2,97 | 29,7% |
| Pilot3 | 3,55 | 35,5% |
| Baseline 2 | 4,50 | 45,0% |

**Table 12 Average number of stops per route during each test period**

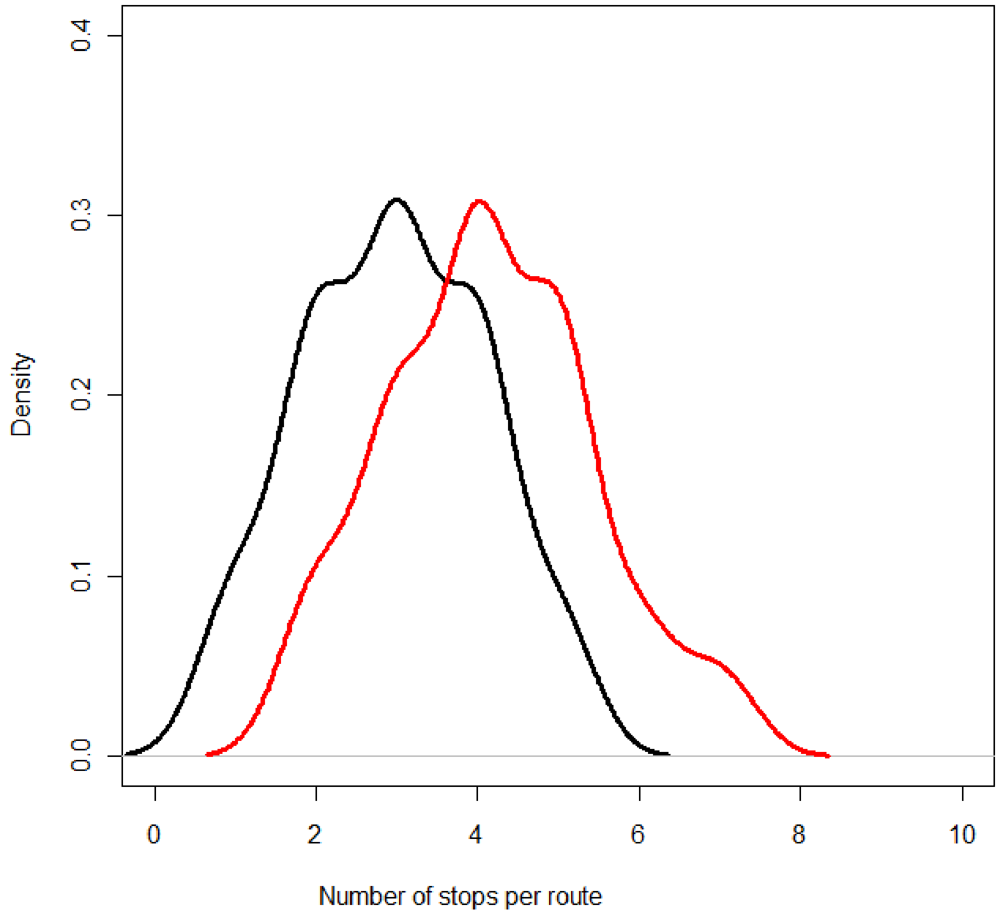



**Figure 16 Distribution of the number of stops per route (Pilot 1 in black and Baseline 1 in red).**

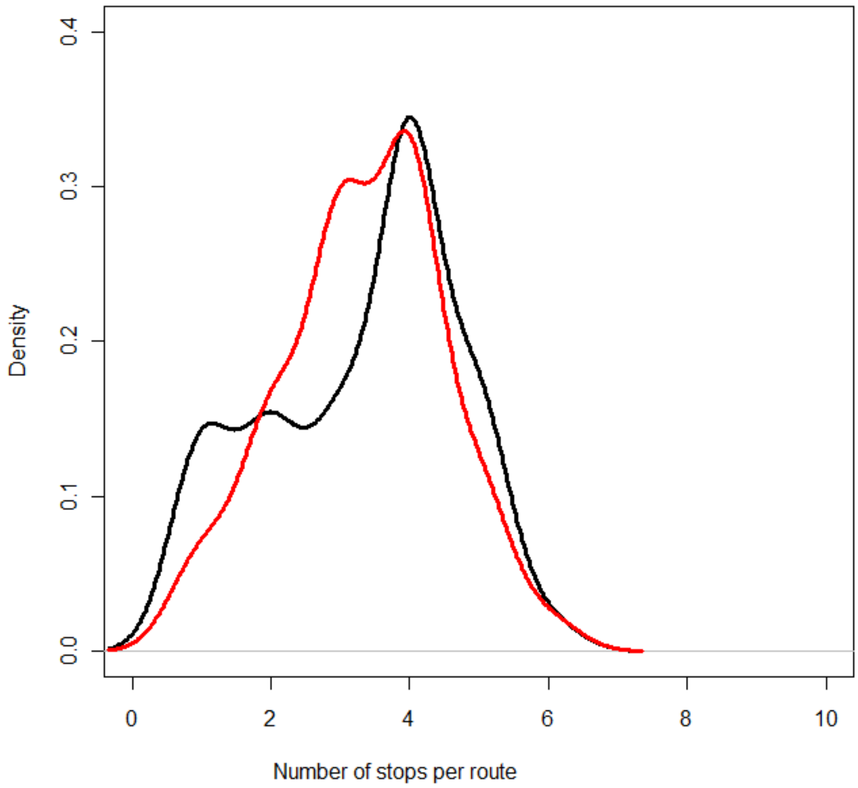



**Figure 17 The same as Figure 16 but with Pilot 3 in black and Baseline 2 in red.**

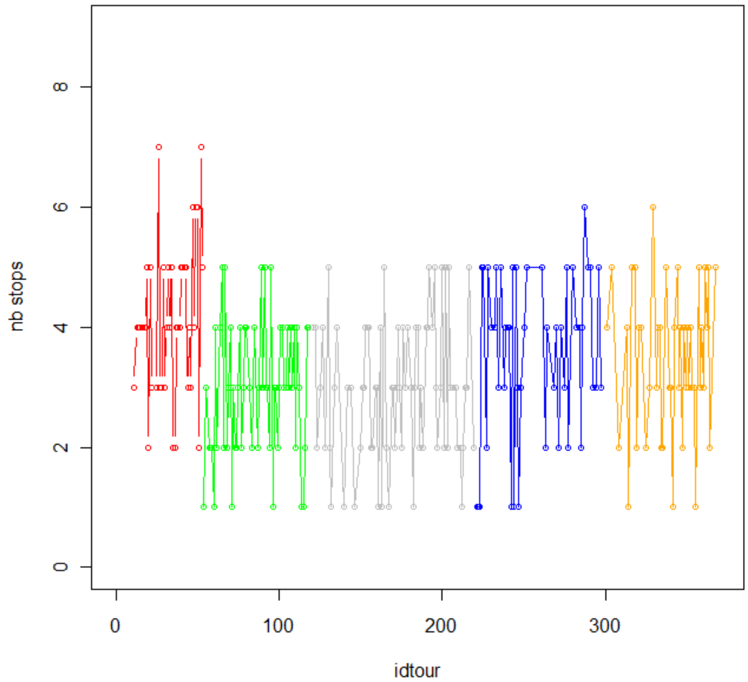



Figure 18 and Figure 19 report the yearly distribution of stops for each period. On the x-axis we report each route, i.e. id tour is the identification of each route that has been considered for this analysis. Then, on the y-axis we report the number of stops corresponding to each route. Since five different data collection periods have been defined, we use a colour code for each of them:

- Baseline 1 (9 intersections, EEIC disabled): red.
- Pilot 1 (9 intersections, EEIC enabled): green.

- Pilot 2 (10 intersections, EEIC enabled on 9 of them): grey.
- Pilot 3 (10 intersections, EEIC enabled on all of them): blue.
- Baseline 2 (10 intersections, EEIC disabled): orange.

If we compare baseline 1 and pilot 1 (green versus red), we observe that the introduction of EEIC has a clear impact on the number of stops, in both average and variability. Indeed, in pilot 1 the average number of stops decreases in average by about 2 with respect to baseline 1, and they vary between 1 and 5 (in baseline 1, they vary between 2 and 7 with a higher variability). Then, the introduction of a new light in summer (pilot 2, in grey) seems to have a small impact until September (the second half of the grey graph). This is due to the summer period that results on a lower number of buses in the section (most of the bus traffic is related to school transport, which is absent in summer). Finally, while observing the new situation (10 lights) and comparing baseline 2 (orange) to pilot 3 (blue), we observe that the introduction of a control on this light seems to have little impact on the number of stops with respect to the precedent situation. Indeed, the average number of stops per route decreases in average by 1, but the variability seems to be similar in both periods (baseline 2, blue versus pilot 3, orange).

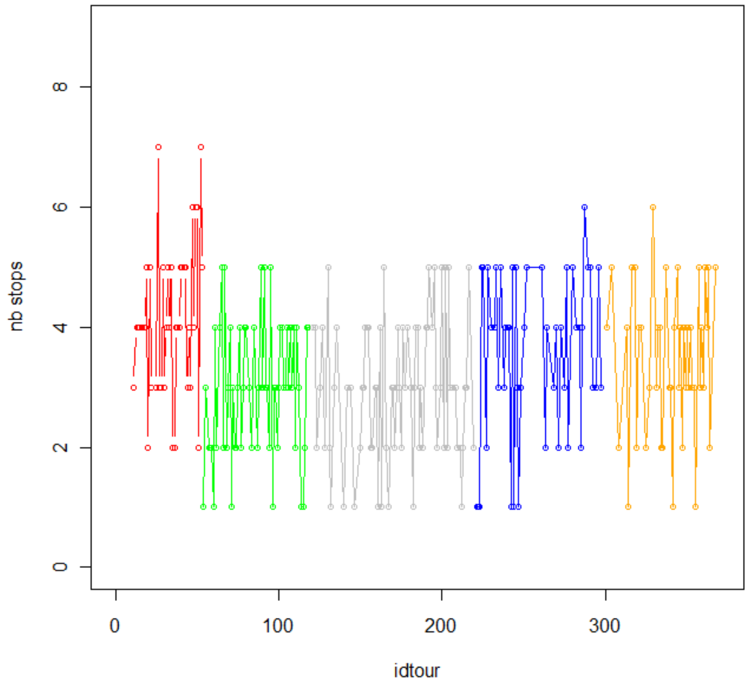
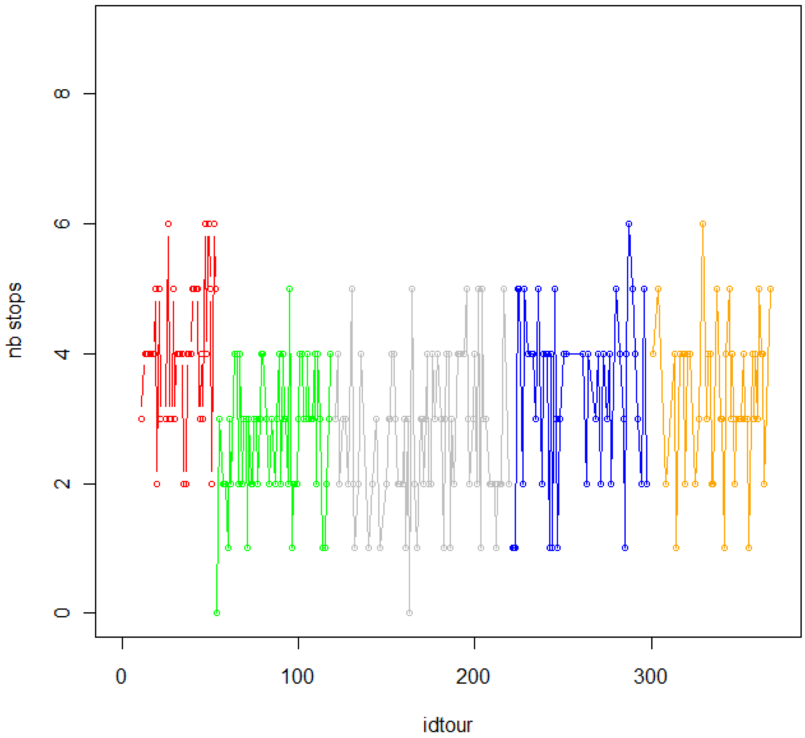



**Figure 18 Yearly distribution of the number of stops with the additional traffic light.**



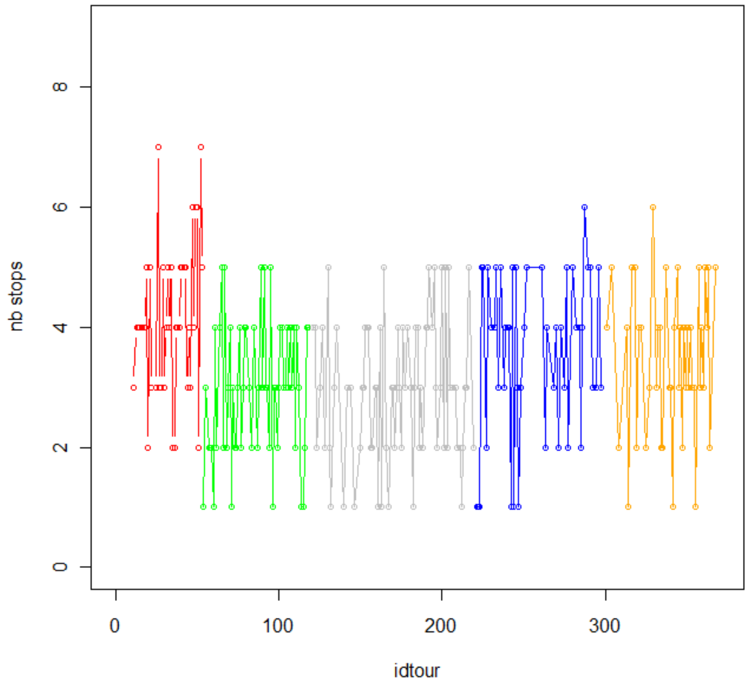




**Figure 19 The same as Figure 18 but without the additional traffic light.**

Figure 20 shows that the truck usually exceeds the speed limit. Indeed, the garbage truck driver seems to not follow the given advices and goes on a higher speed that the advised one. Then, more he goes close to the traffic light, more he has a trend to break.

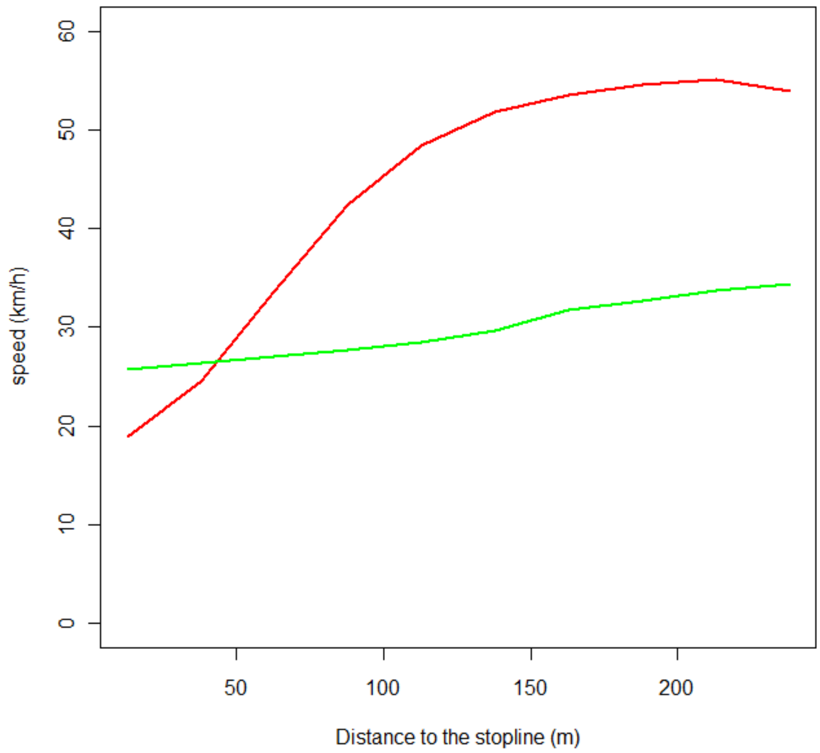



**Figure 20 Real speed of the truck (in red) compared with the advised speed (in green).**

This trend can explain the following tables. Indeed, although average speeds and accelerations can be close, if the instantaneous values follow different trends, the impacts on fuel consumption and gas emissions have different variations.

| | Nb vehicles | | Nb stops | | Fuel consumption | | | $CO_2$ emissions | | | $NO_x$ emissions | | | Speed | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intersection | Baseline | Pilot | Baseline | Pilot | Baseline | Pilot | Variation | Baseline | Pilot | Variation | Baseline | Pilot | Variation | Baseline | Pilot | Variation |
| 0 39 | 39 | 61 | 5 | 15 | 10,7 | 11,6 | 8,4% | 294 | 318 | 8,2% | 1,804 | 1,964 | 8,9% | 45 | 40 | -11,1% |
| 0 52 | 39 | 61 | 0 | 0 | 13,2 | 14,6 | 10,6% | 361 | 398 | 10,2% | 2,034 | 2,25 | 10,6% | 51 | 45 | -11,8% |
| 0 67 | 39 | 61 | 15 | 23 | 13,8 | 13,3 | -3,6% | 373 | 362 | -2,9% | 2,262 | 2,173 | -3,9% | 35 | 38 | 8,6% |
| 0 68 | 39 | 61 | 19 | 30 | 14,2 | 14,4 | 1,4% | 387 | 389 | 0,5% | 2,301 | 2,383 | 3,6% | 37 | 33 | -10,8% |
| 0 6 | 39 | 61 | 34 | 32 | 18,4 | 19,1 | 3,8% | 503 | 515 | 2,4% | 3,024 | 2,934 | -3,0% | 25 | 32 | 28,0% |
| 0 27 | 39 | 61 | 23 | 14 | 14,7 | 12,1 | -17,7% | 400 | 330 | -17,5% | 2,414 | 1,931 | -20,0% | 32 | 49 | 53,1% |
| 0 26 | 39 | 61 | 20 | 8 | 16,2 | 12,2 | -24,7% | 444 | 338 | -23,9% | 2,616 | 1,944 | -25,7% | 31 | 49 | 58,1% |
| 0 78 | 39 | 61 | 0 | 1 | 16 | 12,6 | -21,3% | 438 | 351 | -19,9% | 2,34 | 1,993 | -14,8% | 53 | 52 | -1,9% |
| 0 25 | 39 | 61 | 24 | 33 | 16 | 15,5 | -3,1% | 436 | 424 | -2,8% | 2,599 | 2,628 | 1,1% | 31 | 30 | -3,2% |
| 0 16 | 39 | 59 | 27 | 21 | 9,1 | 9,4 | 3,3% | 246 | 252 | 2,4% | 3,203 | 1,829 | -42,9% | 12 | 35 | 191,7% |

**Table 13 Emissions, consumptions and speed per intersection in baseline 1 and pilot 1.**

| | Nb vehicles | | Nb stops | | Fuel consumption | | | $CO_2$ emissions | | | $NO_x$ emissions | | | Speed | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intersection | Baseline | Pilot | Baseline | Pilot | Baseline | Pilot | Variation | Baseline | Pilot | Variation | Baseline | Pilot | Variation | Baseline | Pilot | Variation |
| 0 39 | 45 | 48 | 6 | 12 | 10,4 | 10,8 | 3,8% | 282 | 295 | 4,6% | 1,775 | 1,914 | 7,8% | 43 | 37 | -14,0% |
| 0 52 | 45 | 48 | 0 | 1 | 13,9 | 13,4 | -3,6% | 377 | 365 | -3,2% | 2,138 | 2,125 | -0,6% | 49 | 45 | -8,2% |
| 0 67 | 45 | 48 | 3 | 16 | 11,8 | 13,8 | 16,9% | 318 | 377 | 18,6% | 1,919 | 2,32 | 20,9% | 45 | 33 | -26,7% |
| 0 68 | 45 | 48 | 26 | 24 | 14 | 13,8 | -1,4% | 379 | 374 | -1,3% | 2,366 | 2,323 | -1,8% | 31 | 33 | 6,5% |
| 0 6 | 45 | 48 | 25 | 23 | 18 | 17,5 | -2,8% | 489 | 475 | -2,9% | 2,87 | 2,794 | -2,6% | 30 | 31 | 3,3% |
| 0 27 | 45 | 48 | 18 | 25 | 12,7 | 12,2 | -3,9% | 347 | 332 | -4,3% | 2,079 | 2,055 | -1,2% | 40 | 38 | -5,0% |
| 0 26 | 45 | 48 | 26 | 16 | 14,8 | 11,9 | -19,6% | 406 | 322 | -20,7% | 2,506 | 2,014 | -19,6% | 30 | 39 | 30,0% |
| 0 78 | 45 | 48 | 0 | 5 | 15,2 | 13,6 | -10,5% | 414 | 369 | -10,9% | 2,293 | 2,153 | -6,1% | 49 | 45 | -8,2% |
| 0 25 | 45 | 48 | 23 | 32 | 15,5 | 15,8 | 1,9% | 426 | 432 | 1,4% | 2,619 | 2,67 | 1,9% | 28 | 28 | 0,0% |
| 0 16 | 45 | 43 | 30 | 17 | 11,8 | 4 | -66,1% | 314 | 106 | -66,2% | 4,849 | 1,744 | -64,0% | 7 | 20 | 185,7% |

**Table 14 Emissions, consumptions and speed per intersection in baseline 2 and pilot 3.**

Table 13 and Table 14 show the increase in fuel consumption, emissions and speed from the baseline to the pilot period in each intersection. The average gains (Figure 21) are: 10% in fuel consumption, 10% in $CO_2$ emissions, 8% in $NO_X$ and a speed increase of 20%.

| | Baseline1 | Pilot1 | Rate of change | Baseline2 | Pilot3 | Gap |
|---|---|---|---|---|---|---|
| $CO_2$ emissions (g/km) | 388.2 | 368.0806 | -5% | 375.2 | 347.2126 | -8% |
| $NO_x$ emissions (g/km) | 2.4597 | 2.20413 | -11% | 2.5414 | 2.216118 | -15% |
| Fuel consumption (l/100km) | 14.07 | 13.03 | -8% | 13.10 | 13.35 | +2% |
| Speed (km/h) | 35.2 | 40.31743 | +13% | 35.2 | 35.05684 | -1% |

**Figure 21 Average speed, consumption and emissions.**

**- Jean Jaurès Avenue**

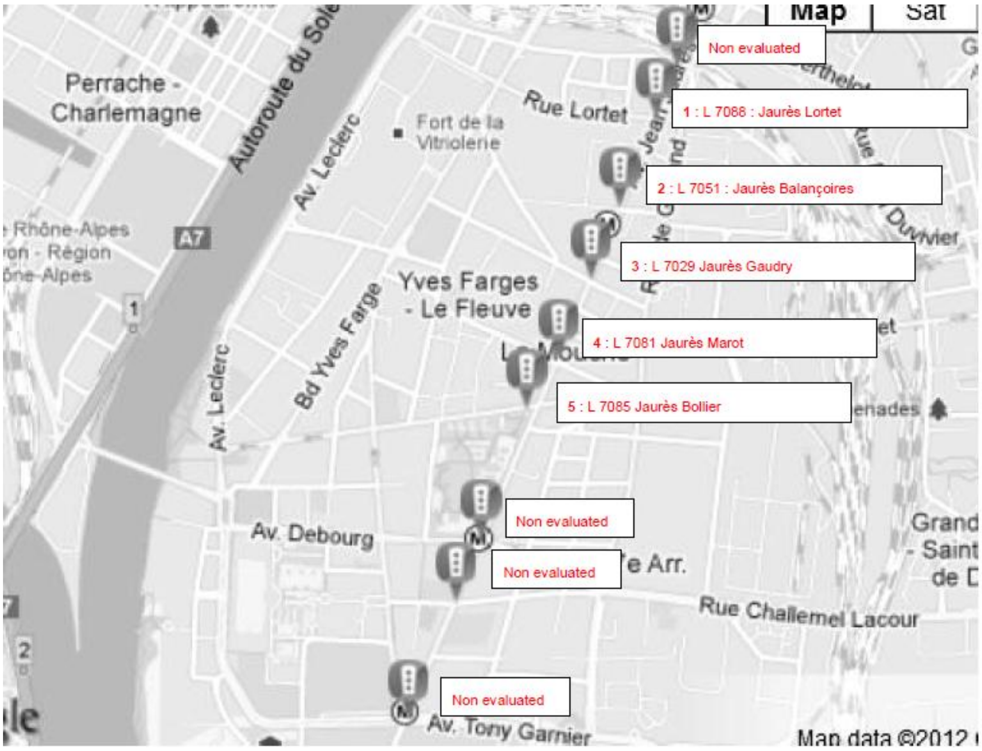



**Figure 22 Charasteristic of the pilot sarea of Jean Jaurés Avenue for EEIC.**

Another system was tested in Lyon on the Jean Jaurès Avenue (Figure 22 and Table 15 Baseline and pilot dates for EEIC Jean Jaurés Avenue.). This system consisted of a green wave of 35 km/h especially designed for trucks. This road had already developed a green wave of 50 km/h for cars. Green waves (of both types: cars or trucks) are almost equally efficient, in the sense that the number of consecutive green lights crossed (two or more), is approximately 57% in this case.

| Period | Dates |
|---|---|
| Pilot | From 26/03/2012 to 27/03/2012 |
| Baseline | From 29/03/2012 to 30/03/2012 |

**Table 15 Baseline and pilot dates for EEIC Jean Jaurés Avenue.**

| Wave type | Min 1 green light | Min 2 green lights | Min 3 green lights | Min 4 green lights |
|---|---|---|---|---|
| Car GW | 0,9787234 | 0,57446809 | 0,12765957 | 0,0212766 |
| Pilot | 0,71710526 | 0,57236842 | 0,09868421 | 0,01973684 |
| Baseline | 0,59067358 | 0,28497409 | 0,02590674 | 0 |

**Table 16 Proportion of vehicles crossing at least 1, 2, 3 or 4 green lights**

In comparison to the pilot, the number of consecutive green lights crossed (two, at least) drops to 28% during the baseline period.

The small difference between the cars green wave and the truck green wave can be explained by the habits of the truck drivers to adapt their speed to the cars green wave, which is a widely used system. This remark does not necessarily mean that the trucks green wave is energetically inefficient. Indeed, the pilot green wave stimulates to have a lower speed, allowing less consumption and emissions.

| Wavetype | Min 1 stop | Min 2 stops | Min 3 stops | Min 4 stops |
|---|---|---|---|---|
| Car GW | 0,74468085 | 0,0212766 | 0 | 0 |
| Pilot | 0,68421053 | 0,05263158 | 0 | 0 |
| Baseline | 0,87564767 | 0,31606218 | 0,02590674 | 0,01036269 |

**Table 17 Proportion of vehicles stopping to at least 1, 2, 3 or 4 red lights**

Through the analysis of the number of stops, it can be seen that the trucks system is more efficient concerning red light stops, because vehicles tend to stop less than in baseline and in car green wave. This can be explained by the fact that even if some truck can adapt to car speed, the biggest trucks cannot do such thing. Again, we can see the number of stops dropping from baseline to pilot. Thanks to the green wave system, no truck stops more than 2 times consecutively.

In the next graphs we can see for each type of vehicle the number of green wave passages compared to the total number of measures. It can be observed that the number of green waves taken thanks to the pilot system increases drastically (Figure 23 - Figure 24). The effect on particular types of vehicles is not significant. It can be however stated that large trucks benefit the most from this system.

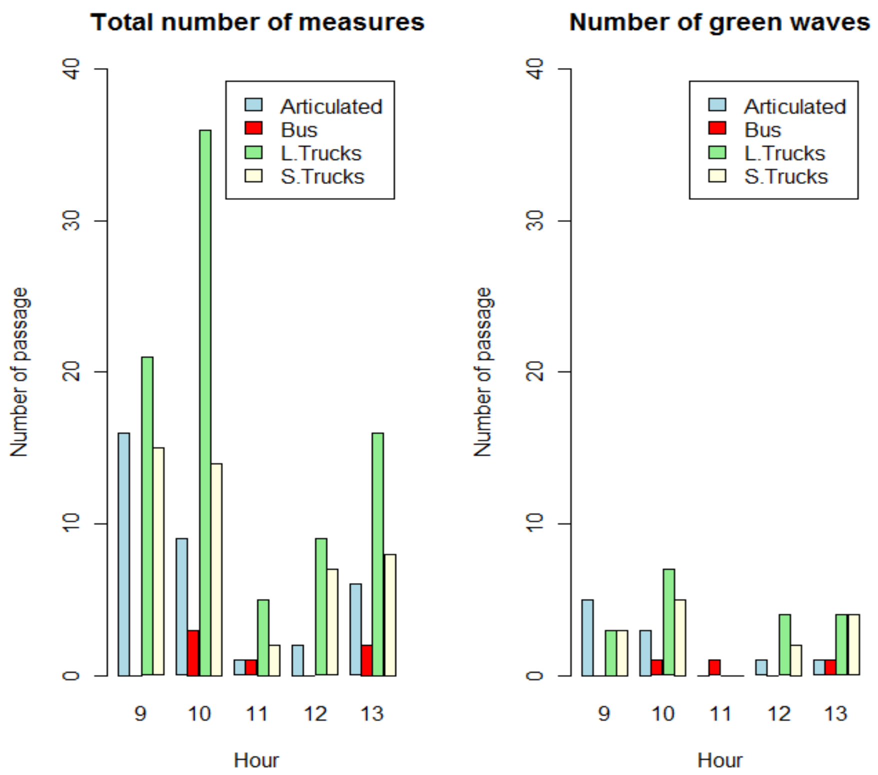



**Figure 23 Comparison of the number of measures to the number of green waves taken: no green wave.**

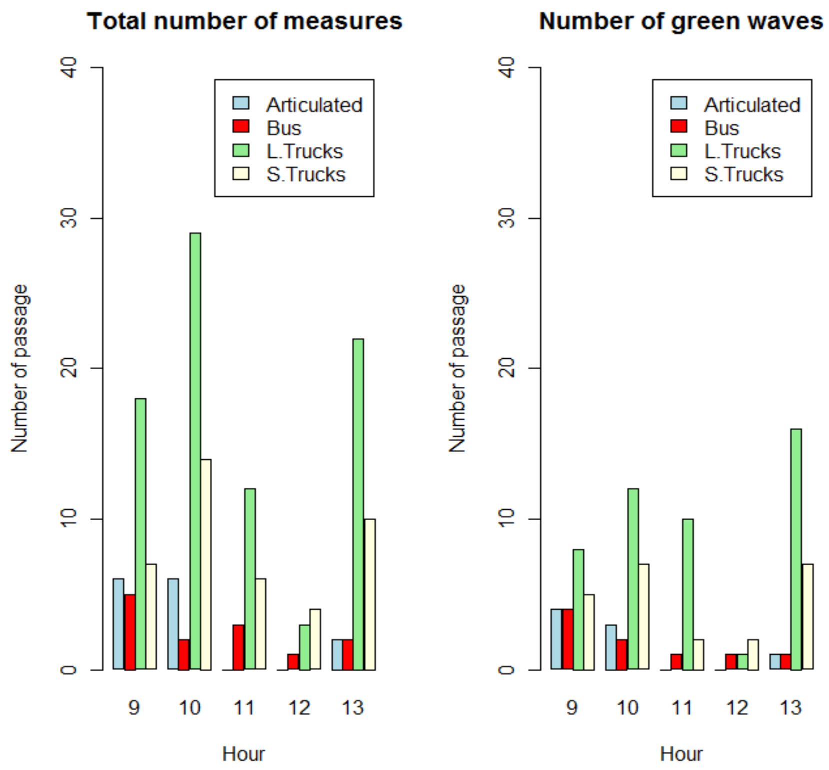



**Figure 24 Comparison of the number of measures to the number of green waves taken: truck (pilot) green wave.**

### 3.1.4. Results in Krakow

The tests on Krakow intersection control were chosen to be carried out on the road 75 near Krakow on eight traffic lights. This road consists of two lanes on the majority of its length, with a few sections with overtaking lanes. The global length of the studied portion is 22km (Figure 25).

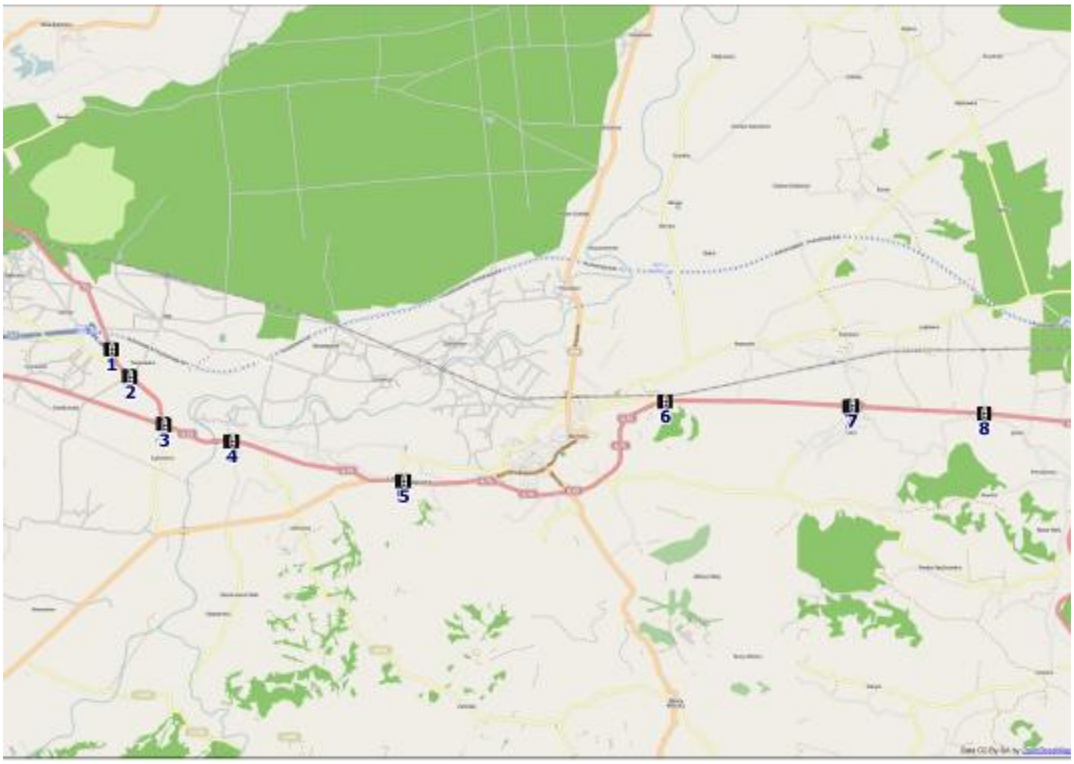



**Figure 25 Characteristics of the pilot area of Krakow for EEIC.**

The baseline period in Krakow started the 5 April 2011 and ended at the end of February 2012. From here the Pilot started, with data collection on vehicles going to the end of June 2012 (Table 18).

| Period | Dates | Fire brigade | Number of delivery rounds | Number of different vehicles |
|---|---|---|---|---|
| Baseline | From 05/04/2011 to 26/02/2012 | 0 | 79 | 6 |
| Pilot | From 27/02/2012 to 27/06/2012 | 0 | 17 | 2 |

**Table 18 Number of rounds and vehicles recorded in baseline and pilot periods.**

Figure 26 shows the number of crossings for each period. It is important to note that the number of measures during the pilot period is fairly low compared to the baseline. Therefore it is hard to prove the significance of the pilot period concerning the efficiency of the system.

Figure 27 measures the number of stops according to the number of traffic lights crossings, indicating the efficiency of the system with respect to the length of the delivery route. The absolute values show a clear improvement with fewer stops during the pilot period. This is confirmed by a ratio confronting the number of stops and the number of crossings. The high values observed for 7 consecutive traffic lights crossings are high due to the small number of observation (it appears that there is only one measure in which the truck stopped, according to Figure 26).

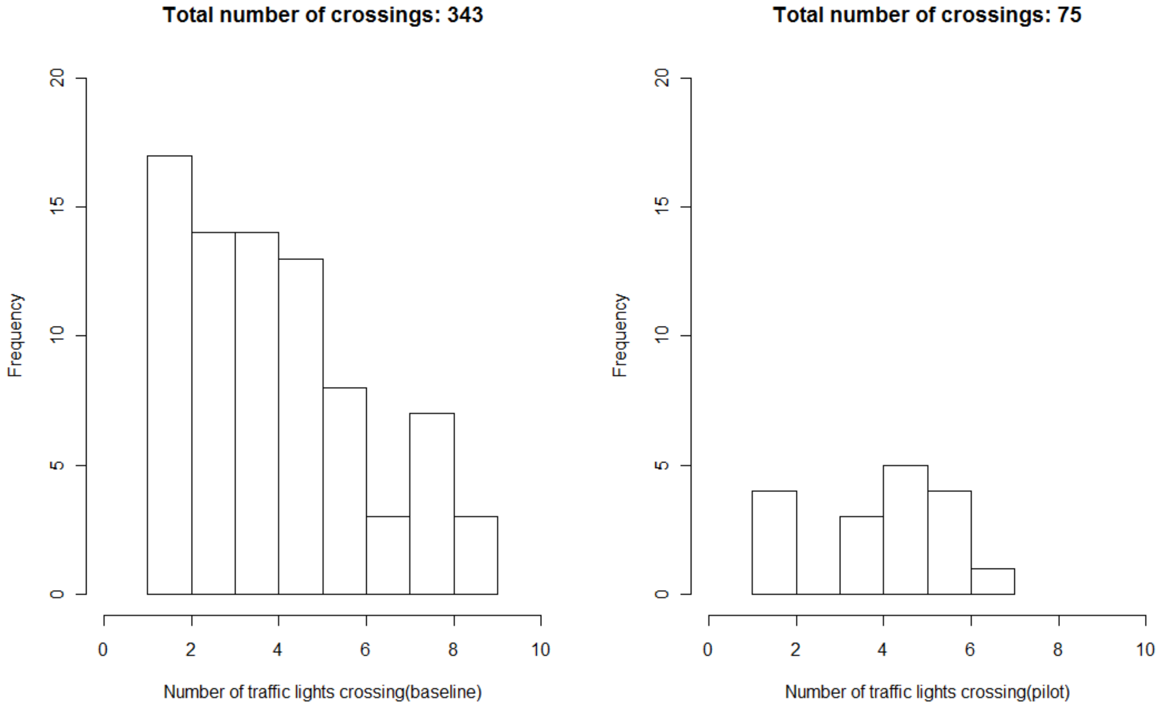



**Figure 26 Frequencies of measures according to the number of traffic lights crossed in a row (baseline on the left and pilot on the right).**

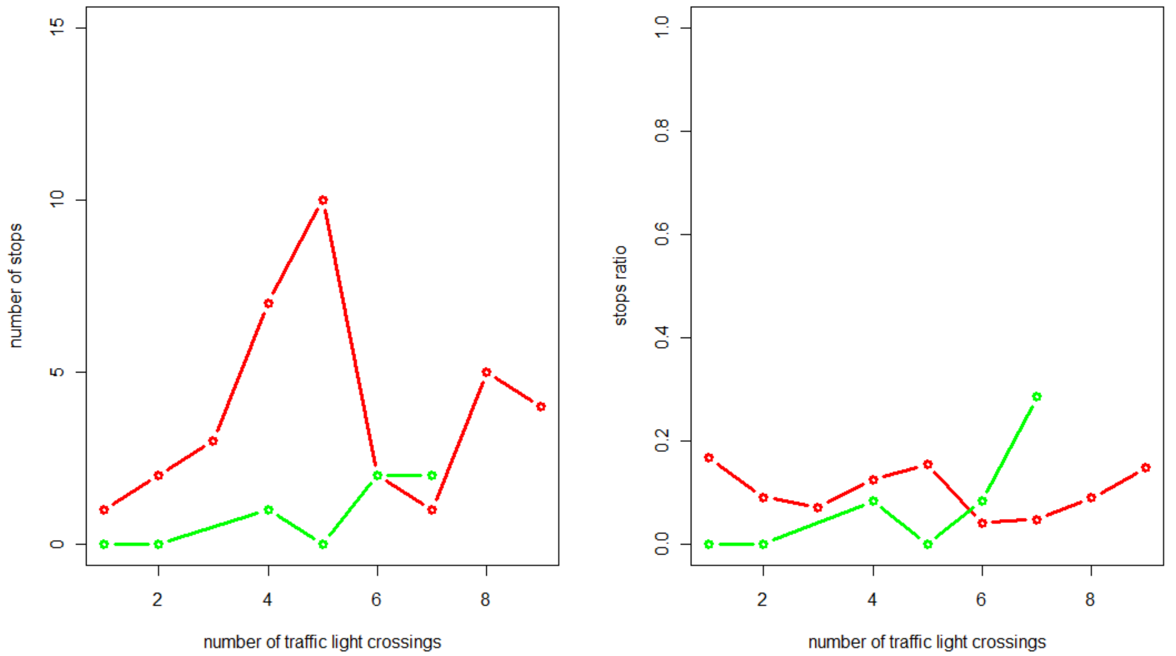



**Figure 27 Number of stops in function of the number of traffic lights crossed in a row, right is a ratio of the number of stops and the total number of measures (baseline in red and pilot in green).**

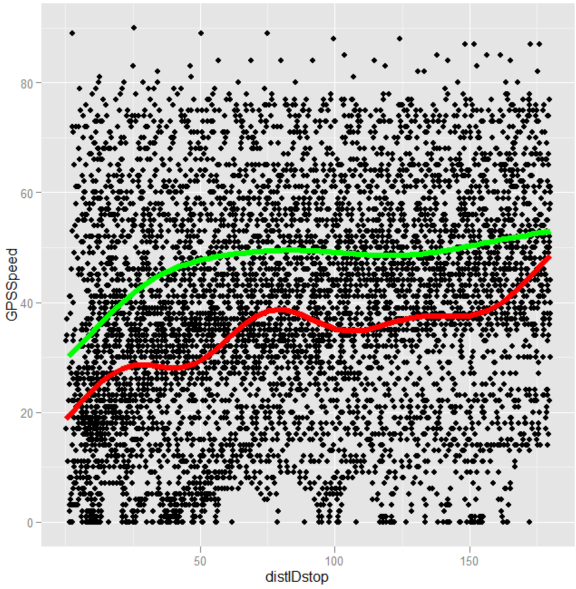



**Figure 28 Speed in function of the distance of the traffic light (baseline in red and pilot in green).**

After studying the speed (Figure 28), it is noticeable that the speed profile before a traffic light is mainly higher during the pilot period than during the baseline period, favouring shorter durations. Another important point confirming the prior analyses: the speed decreases as the trucks come closer to the traffic lights.

The global analysis on $CO_2$, speed and percentage of stops (Table 19) is globally positive for the pilot results. We can effectively see an improvement in speed and a decrease in the number of stops. However the higher speed does have an effect on the $CO_2$ emissions. The number of measures does not allow the production of reliable indicators for the pilot period. These results seem however rather positive.

| | Speed average (km/h) | | | $CO_2$ (g/km) | | | Number of stops | | |
|---|---|---|---|---|---|---|---|---|---|
| Intersections | Baseline | Pilot | Variation | Baseline | Pilot | Variation | Baseline | Pilot | Variation |
| 1EW | 30 | 45 | ++ | 803 | 1083 | -- | 0% | 0% | 0 |
| 2EW | 15 | 51 | ++ | 717 | 265 | ++ | 6% | 0% | ++ |
| 3EN | 34 | 53 | ++ | 549 | 970 | -- | 11% | 0% | ++ |
| 3NE | 9 | 38 | ++ | 1193 | 904 | ++ | 15% | 0% | ++ |
| 4EW | 49 | 63 | ++ | 654 | 990 | -- | 8% | 0% | ++ |
| 4WE | 37 | 58 | ++ | 507 | 590 | -- | 13% | 0% | ++ |
| 5WE | 46 | 41 | - | 431 | 571 | -- | 5% | 0% | ++ |
| 6WE | 49 | 60 | ++ | 689 | 657 | -- | 0% | 0% | 0 |
| 7EW | 33 | 55 | ++ | 579 | 779 | -- | 21% | 0% | ++ |
| 7WE | 30 | 42 | ++ | 690 | 585 | ++ | 8% | 11% | -- |
| 8WE | 42 | 32 | -- | 472 | 540 | -- | 0% | 50% | -- |

**Table 19 Speed, $CO_2$ and number of stops at each traffic light for Baseline and Pilot periods. Speed and $CO_2$ are calculated in a range of 220m before the traffic light. The indicator ++ indicates an improvement in comparison to the baseline period whereas the opposite signs – indicates a deterioration.**

| Intersection | Fuel(l/100km) Baseline | NOx (g/km) Baseline | Fuel(l/100km) Pilot | NOx (g/km) Pilot | Fuel (%) | NOx (%) |
|---|---|---|---|---|---|---|
| 1EW | 29,8 | 4,536 | 40,8 | 5,181 | 37% | 14% |
| 2EW | 25,5 | 5,33 | 9,8 | 1,89 | -62% | -65% |
| 3EN | 20,5 | 3,592 | 37,2 | 4,844 | 81% | 35% |
| 3NE | 43,4 | 9,034 | 34 | 4,568 | -22% | -49% |
| 4EW | 24,2 | 4,383 | 37,1 | 4,723 | 53% | 8% |
| 4WE | 18,6 | 3,484 | 21,9 | 4,546 | 18% | 30% |
| 5WE | 15,9 | 3,442 | 21,2 | 3,26 | 33% | -5% |
| 6WE | 25,6 | 4,61 | 24,4 | 3,889 | -5% | -16% |
| 7EW | 21,4 | 3,978 | 29,2 | 3,869 | 36% | -3% |
| 7WE | 25,3 | 5,102 | 21,6 | 3,275 | -15% | -36% |
| 8WE | 17,3 | 4,456 | 20 | 3,277 | 16% | -26% |

**Table 20 Comparation of $NO_x$ and fuel consumption for Baseline an pilot periods (data were calculated in a range of 220m before the traffic light)**

| | Baseline | Pilot | Gap |
|---|---|---|---|
| $CO_2$ emissions (g/km) | 645 | 716 | +11% |
| $NO_x$ emissions (g/km) | 4.46 | 3.95 | -11% |
| Fuel consumption (l/100km) | 24 | 27 | +12% |
| Speed (km/h) | 35 | 49 | +39% |

**Table 21 Average statistics for Krakow.**

We observe an average increase of fuel consumptions and $CO_2$ emissions about 11-12% and an average decrease of $NO_x$ emissions for an average increase of speeds about 40%. This shows that the main advantage of EEIC in an extra-urban context is that of increasing speed and also security on roads (by ensuring the green or at least a priority to have it in critical points). Moreover, the difference between $CO_2$ increase and $NO_x$ decrease is explained because of the lack of data (the statistical significance is not reached) and also because $NO_x$ is not directly correlated to $CO_2$ emissions (oppositely to $CO_2$ and fuel). $NO_x$ emissions depend strongly on the travel behaviour and on the instantaneous speeds and accelerations, mainly on how the brakes are used, so it is not unreasonable to see a $NO_x$ emission decrease (less usage of brakes, or softer braking) and a $CO_2$ emission increase (due to a redundancy of small accelerations). This behavioural fact makes also clear that on each site (Lyon, Helmond and Krakow) results depend strongly on the driver's reactions, so a homogeneous comparison is not possible and it has no sense to try to obtain equal results since the contexts are different (lyon: urban with a truck crossing all lights, Helmond: urban with several trucks making different trips and crossing a different number of lights, Krakow: extra-urban with several vehicles making different routes).

#### 3.1.5. Validation of hypothesis and conclusions

In D.FL. 4.1 Evaluation Methodology and Plan shows the hypothesis based on the research questions established to test the systems. Table 22 and Table 23 show the hypotheses to validate with the results collected and processed for EEIC.

Table 22 is related to the direct measurements and Table 23 to the data obtained from the questionnaires.

| T/F | Hypothesis | Comment |
|---|---|---|
| ✗ | Overall estimated fuel consumption in use case IC_SF will be lower than reference (default non-prioritised control) | Average values obtained for Krakow not representative (see chapter 3.1.4) |
| ✗ | Measured fuel consumption in the specific fleet in use case IC_SF will be 10% lower than reference (default non-prioritised control) | Average values obtained for Krakow not representative (see chapter 3.1.4) |
| ✓ | Overall estimated fuel consumption in use case GW_SF will be lower than reference (default non-prioritised control) | In Lyon the results showed a maximum decrease of energy consumption of –8% (see chapter 3.1.3). |
| ✗ | Measured fuel consumption in the specific fleet in use case GW_SF will be 10% lower than reference (default non-prioritised control) | The maximum achieved was of -8% (see chapter 3.1.3). |
| ✓ | Overall estimated fuel consumption in use case AC_SF will be lower than reference (default non-prioritised control) | In Helmond the results showed a maximum decrease of fuel consumption of -13% (see chapter 3.1.2) |
| ✓ | Measured fuel consumption in the specific fleet in use case AC_SF will be 12% lower than reference (default non-prioritised control) | In Helmond the results showed a maximum decrease of fuel consumption of -13% (see chapter 3.1.2) |
| ✗ | Overall travel times on main routes will remain unchanged in use case IC_SF | Average values obtained for Krakow not representative (see chapter 3.1.4) |
| ✓ | Overall travel times on main routes will remain unchanged in use case GW_SF | In Lyon the results showed a a slightly reduction in number of stops and an increase of 1% in speed (see chapter 3.1.3) |

**Table 22 Objective measurements of the hypothesis for EEIC.**

The validation of the hypotheseis in Table 22 is strongly conditioned by the shortage of vehicles in each pilot site: Helmond tested the EEIC with 7 trucks of Van den Broek, Route the Lyon with one garbage vehicle and Krakow with 5 vehicles. On the other hand, the services were tested for a long time, nearly 15 months in all the cases.

To validate the subjective hypothesis there are only four questionnaires received and only in Helmond so there are not enough data for providing a general validation. So, the comments provided in Table 23 cannot be generalized.

| T/F | Hypothesis | Comment |
|---|---|---|
| ✓ | Intersection Control service is appreciated by drivers | Four drivers answered with a positive score. |
| ✗ | Drivers will perceive that Intersection Control service is reliable | The participants considered that EEIC service is not reliable. |
| ✗ | Drivers will find the Intersection Control service is useful when driving | The users did not find the EEIC service useful when driving. |
| ✓ | Drivers will think the Intersection Control service is easy to use | According to the answer in question "It is easy to understand how the EEIC service works" the drivers consider the system is easy to use. |
| ✗ | Drivers stress perception will decrease with the Intersection Control service usage | Drivers stress perception not suffered changes after using the EEIC service. |
| ✗ | Perceived risk of accidents will decrease with the Intersection Control service usage | The participants considered that the use of EEIC service not improve of freight transport image in urban areas. |
| ✗ | According to the driver perception the Intersection Control service will improve of freight transport image in urban areas | The participants consider the use of EEIC service does not improve of freight transport image in urban areas. |
| ✗ | Drivers will trust the Intersection Control service. | The drivers answered with a medium score the question "I am confident of using EEIC service"." |

**Table 23 Subjective measurements of the hypothesis for EEIC.**

## 3.2. DSB

### 3.2.1. Analysis Methodology

The DSB application is tested in Bilbao and Lyon but not exactly in the same way because of the different needs of the local stakeholders in the two cities. In both cases, the DSB system allows an operator or/and his drivers to book a delivery space in advance via internet to load/unload the goods. In addition, in Bilbao the driver, when arrives to parking, can reserve a slot in a specific device in the parking while in Lyon the trucks takes an on board system able to reserve a space or communicate with the back-office system to get more information about the reservations. In this way, it is possible to understand the benefits and costs of the two compared solutions.

The whole FREILOT project is tested with delivery spaces dedicated only to FREILOT partners.

### 3.2.2. Results in Bilbao

In the pilot site of Bilbao the evaluation is based on three analysis:

- The reservation system database.
- GPS data collected from vehicle stopping at the delivery space.
- Traffic and infraction countings.

Each experimental design is composed of an experimental period (without any FREILOT service) and a pilot period (with the FREILOT services). During the pilot, the same indicators are analysed with and without the services in order to show the benefits.

The baseline period in Bilbao began the 7th of July 2010 and finished the 28th of October 2010. August data are not considered because in this month the traffic is different. The pilot period began in November 2010 and ended in November 2011. After the pilot's end, the system remained active and used by the companies until July 2012.

The DSB of Bilbao consists of four pilot spots (Figure 29): Licenciado Poza with three parking zones and Pérez Galdós, General Concha, and Santutxu with two parking zones (D.FL.2.1 Implementation plan).


**Figure 29 Characteristics of the pilot area of Bilbao for DSB.**

#### 3.2.2.1. Data from the reservations system

Figure 30 and Figure 31 contain five histograms (represented monthly on the pilot period), the first including the four DSB then one diagram per single DSB.

Figure 30 shows the evolution of the number of companies per month where it can be seen the effect of the entrance of new companies, since 15 companies had access from the beginning but 37 companies were included in January 2011 and 10 in Spring 2011. It is observed that the pilot site with more activity is Licenciado Poza probably because is the one situated in the city center (Figure 29).

Figure 31 shows an almost constant number of reservations in all the cases being evidently Licenciado Poza the site with more bookings as it is the site with more trucks. At the beginning, the number of companies is less, so from October 2010 to January 2011 the companies have tested the system and then the number of reservations per company has decreased. It is also observed a small decrease in April (Easter holidays) and August (Summer holidays). During the pilot period 62 trucks had access to the DSB and 49 made at least one reservation.

The procedure sets that the same truck can reserve as many slots as required in one day, however the same truck could never book two consecutive slots. It is also important to note that during the pilot period the loading/unloading timetable is established from Monday to Friday from 8h to 13:30h. In Figure 32 it is observed a different behaviour on each delivery space that probably depends on the transport plans independently of the DSB. Figure 33 shows a few impact of the day of the week on the number of reservations.

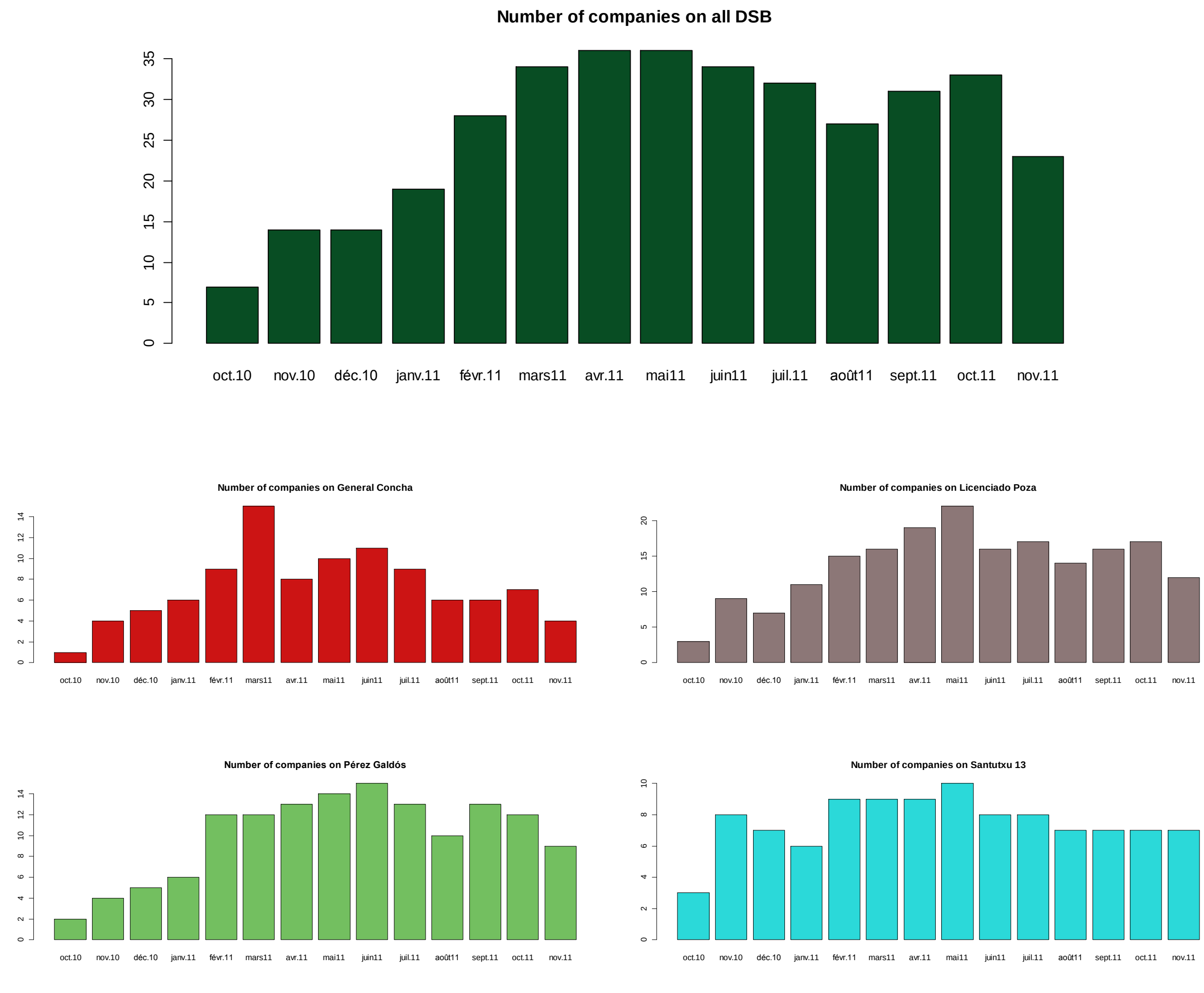



**Figure 30 Distribution of companies along the pilot period.**

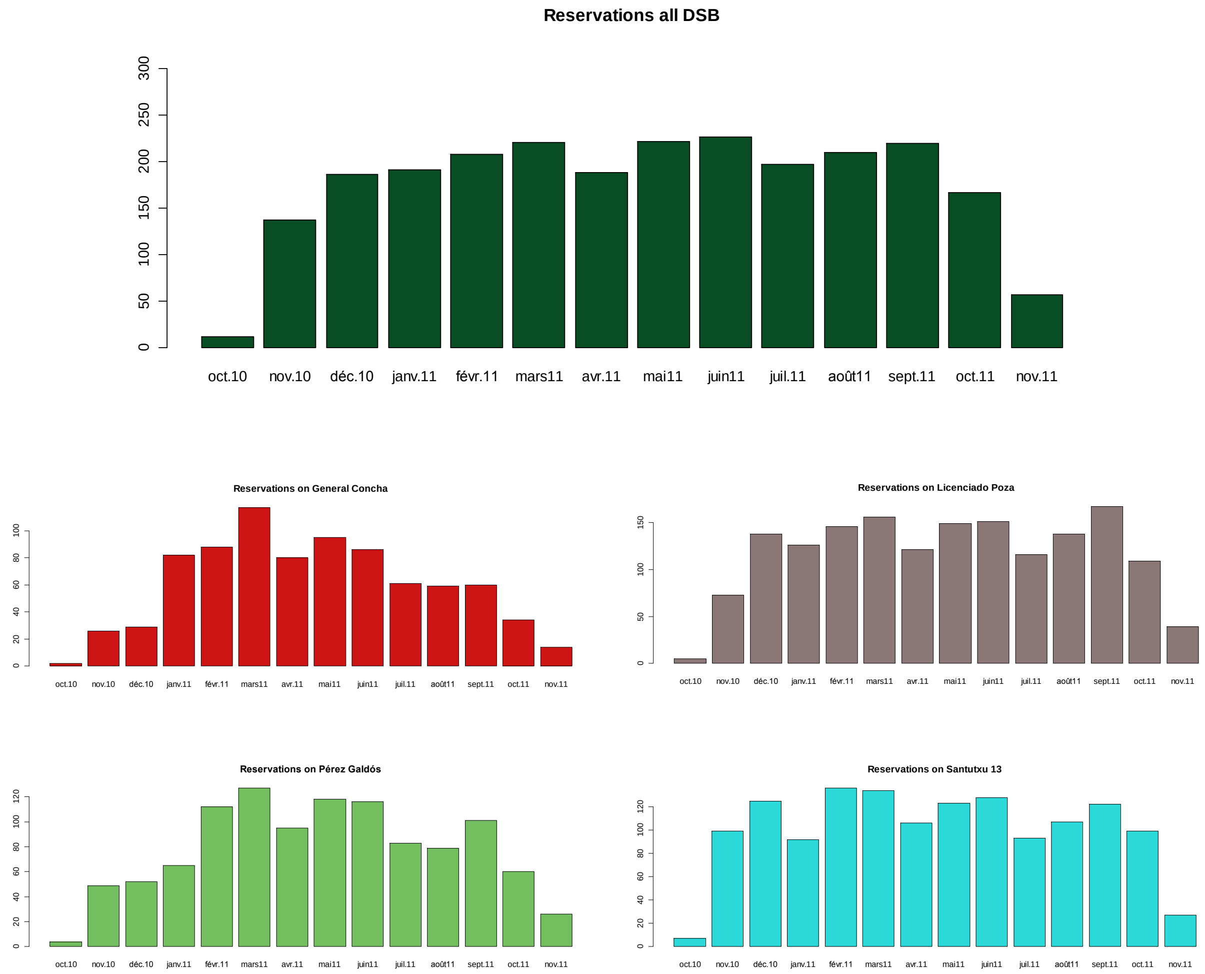



**Figure 31 Distribution of reservations along the pilot period.**

The procedure sets that the same truck can reserve as many slots as required in one day, however the same truck could never book two consecutive slots. It is also important to note that during the pilot period the loading/unloading timetable is established from Monday to Friday from 8h to 13:30h. In Figure 32 it is observed a different behaviour on each delivery space that probably depends on the transport plans independently of the DSB. Figure 33 shows a few impact of the day of the week on the number of reservations.

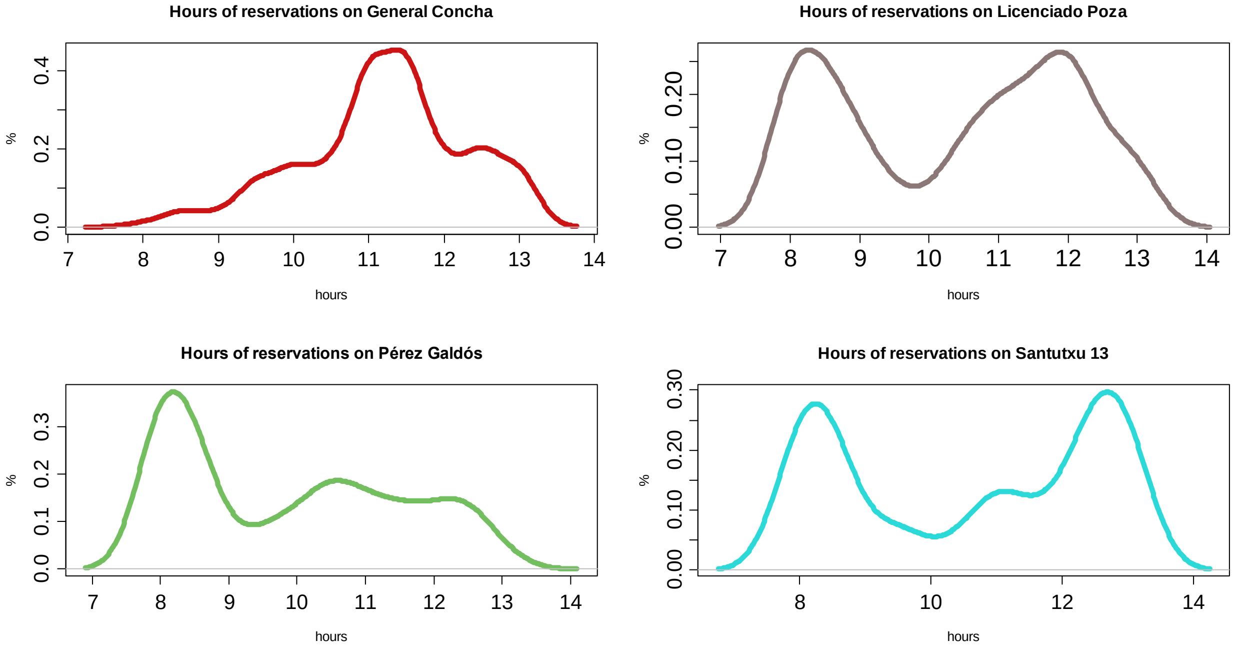



**Figure 32 Distribution of reservations during the day period in each pilot site.**

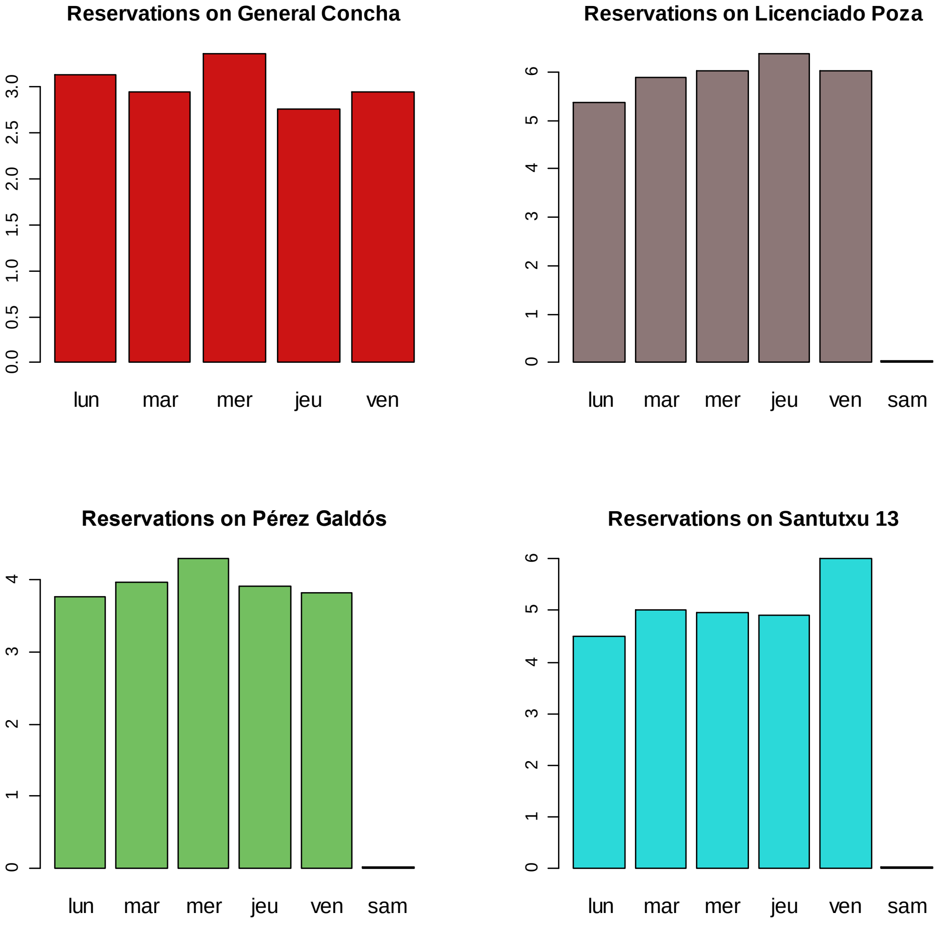



**Figure 33 Distribution of reservations per day of week in each site pilot.**

In **Figure 34- Figure 38**, it is reported for all DSB and for each DSB respectively a) the evolution per week of the number of reservations, b) the reservations effectively parked on the delivery space at the right time and identified in the system, c) the number of companies reserving, and d) the number of infractions. In the latter case, the infractions are considered as unauthorized vehicle parking on the delivery bay. Each figure contains three graphs, the first reports the weekly evolution of the number of users (continuous green), the number of reservation (discontinuous green), the number of validations, i.e., the number of reserved slots trucks effectively parked by the reserved vehicle at the reserved hours, and the number of infractions, i.e. the number of trucks or cars parking on a reserved slot without authorisation. The second graph the weekly evolution of the validations (uin percentage), i.e. the evolution of the number of slots reserved and effectively used. The last figure

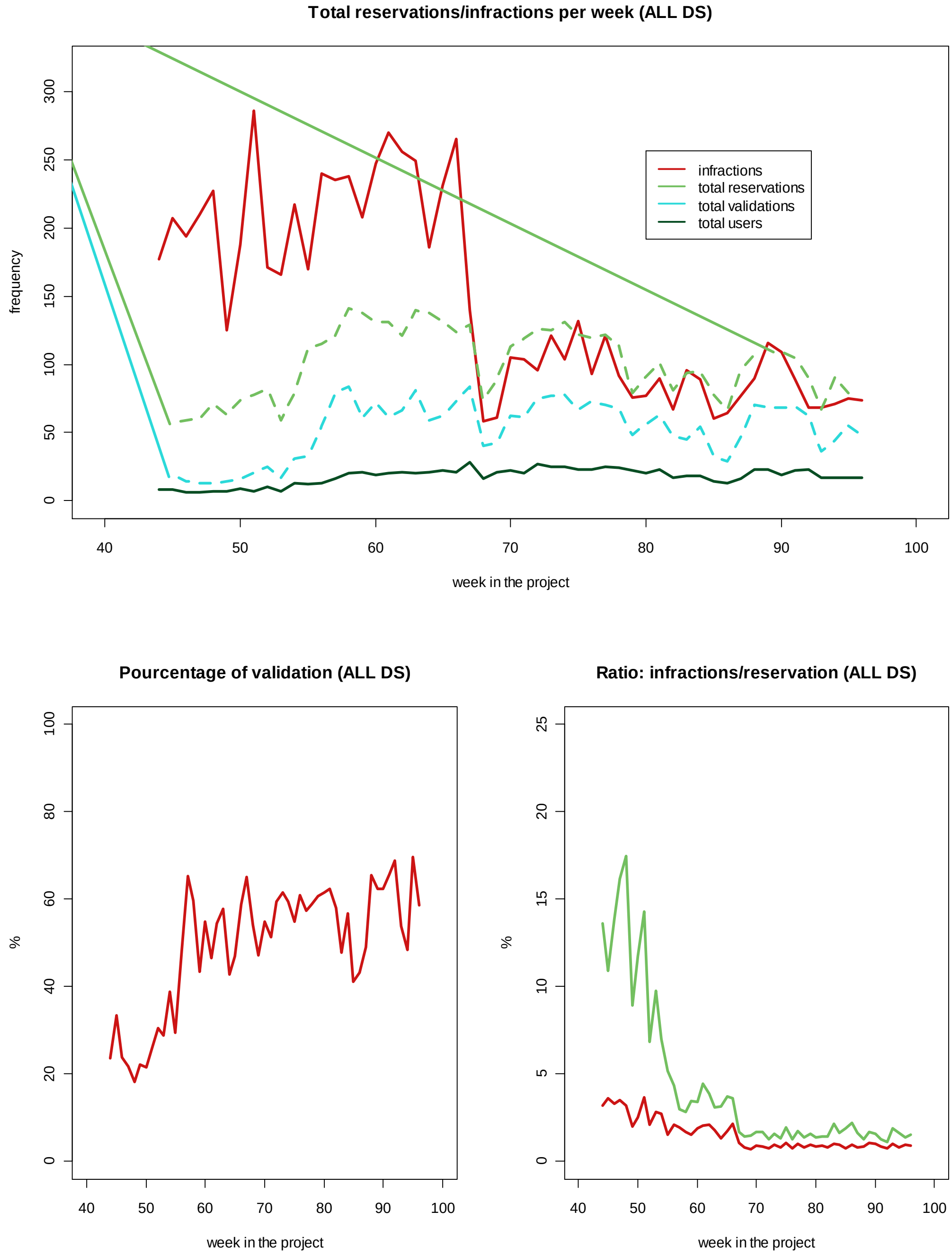



**Figure 34 Overall evolution per week of: the total number of reservations (in green), the total number of validations (in light blue), the total number of users (in black), and the total number of infractions (in red).**

We observe a big increase of validations after few month of pilot (week 55) then a constant oscillation with a light general trend to increase. Moreover, the number of infractions, which decreases strongly after the police control reinforcement, is strongly conditioned by the number of overall reservations, which decreases strongly at the same moment. In other works, after a first emphasis on using the system, an equilibrium is reached and the number of reservations present a stable oscillatory trend (with a light decreasing trend) after week 70, However, the number of validations does not increase (the increase int eh percentage is due to the fact the overall number of reservations decrease, not to the fact the number of validations increase) and remains lower that that of infractions, even after the police control reinforcement.

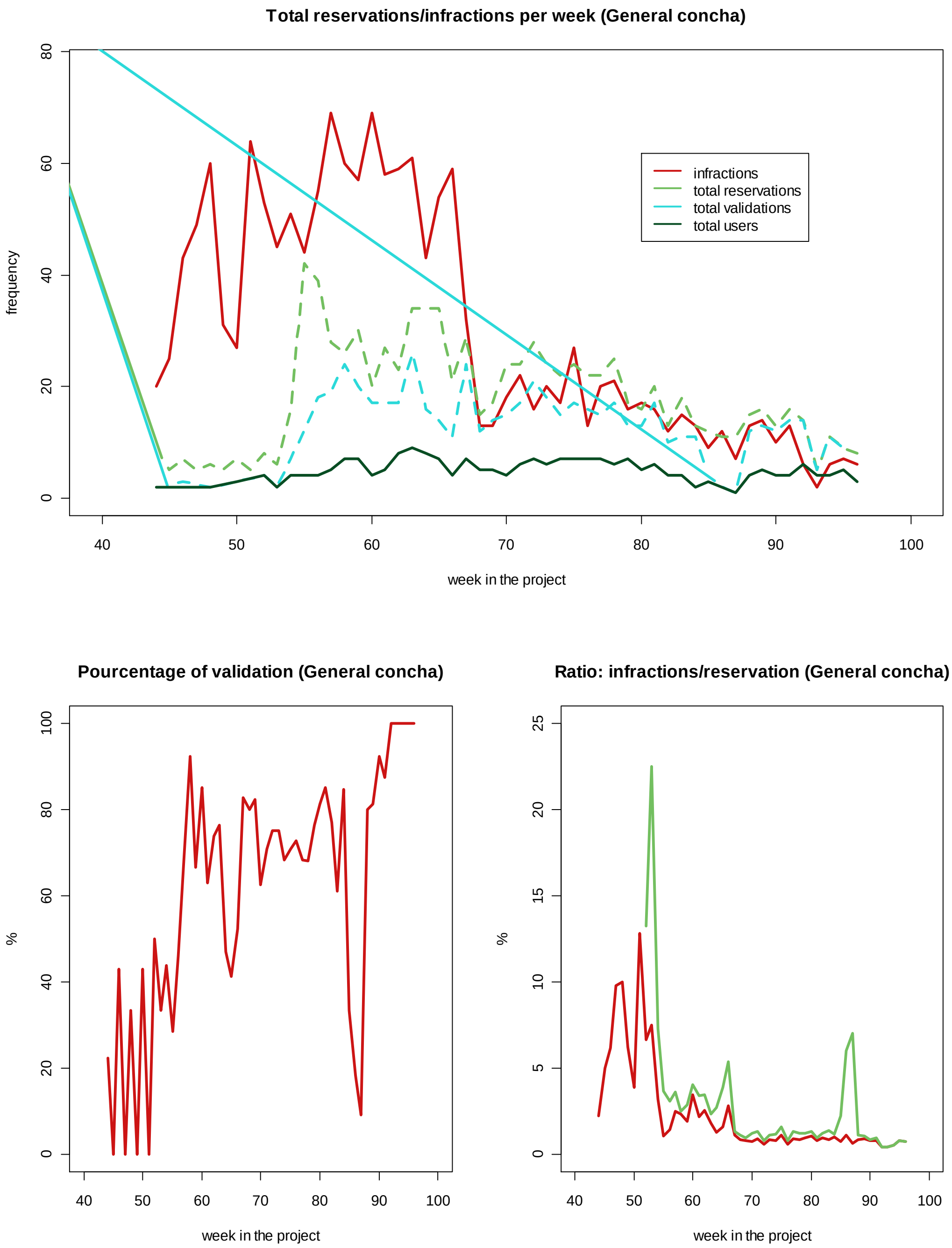
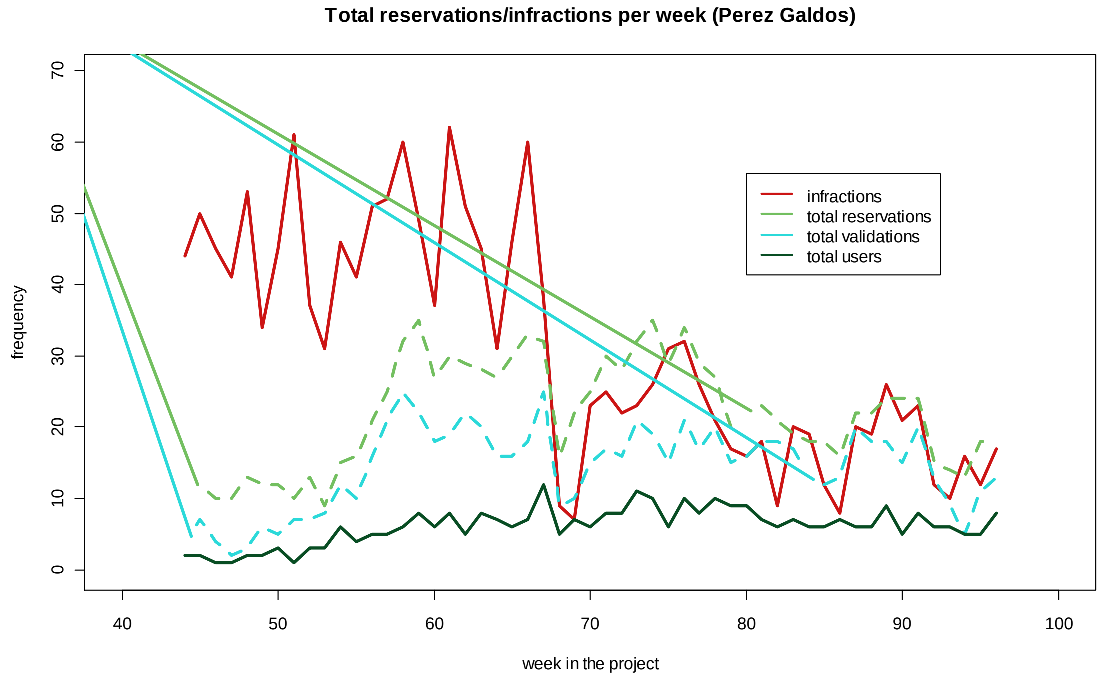
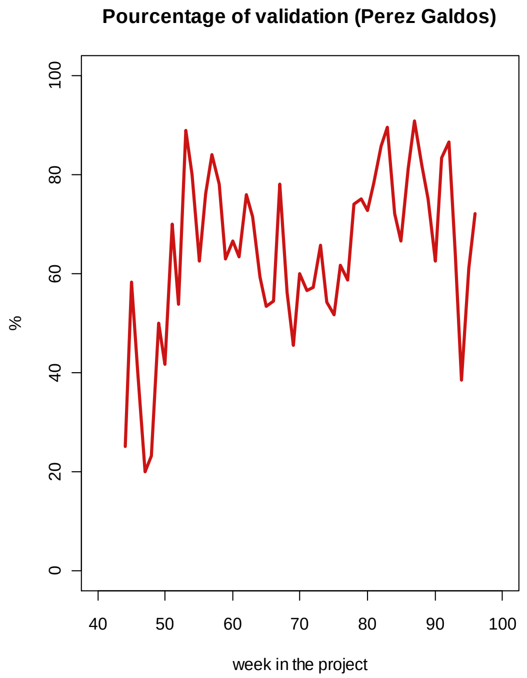



**Figure 35 The same as Figure 34 but for the pilot site of General Concha.**



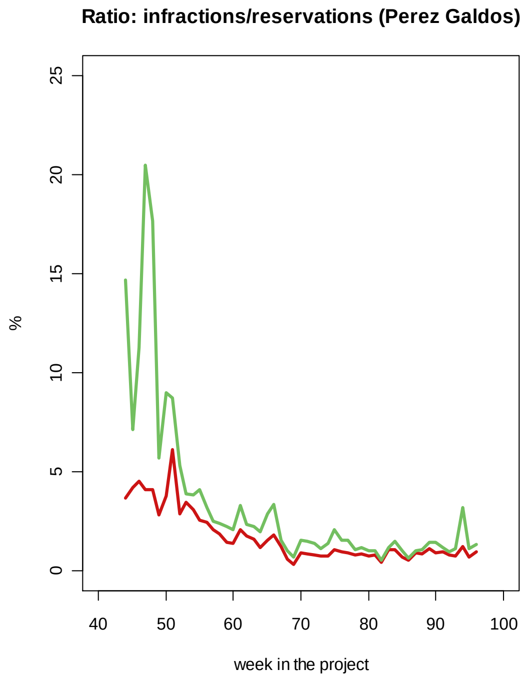




**Figure 36 The same as Figure 34 but for the pilot site of Pérez Galdós.**

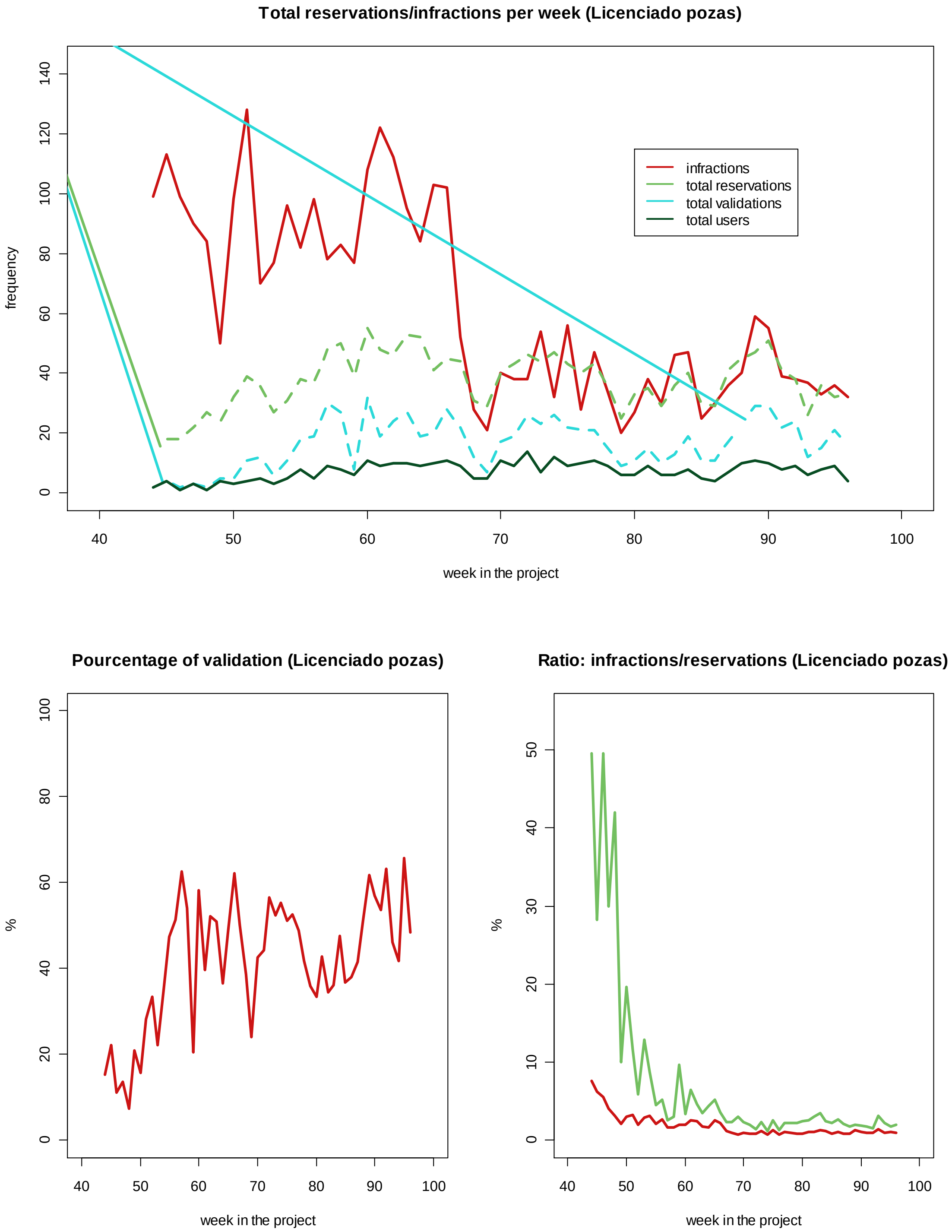



**Figure 37 The same as Figure 34 but for the pilot site of Licenciado Poza.**

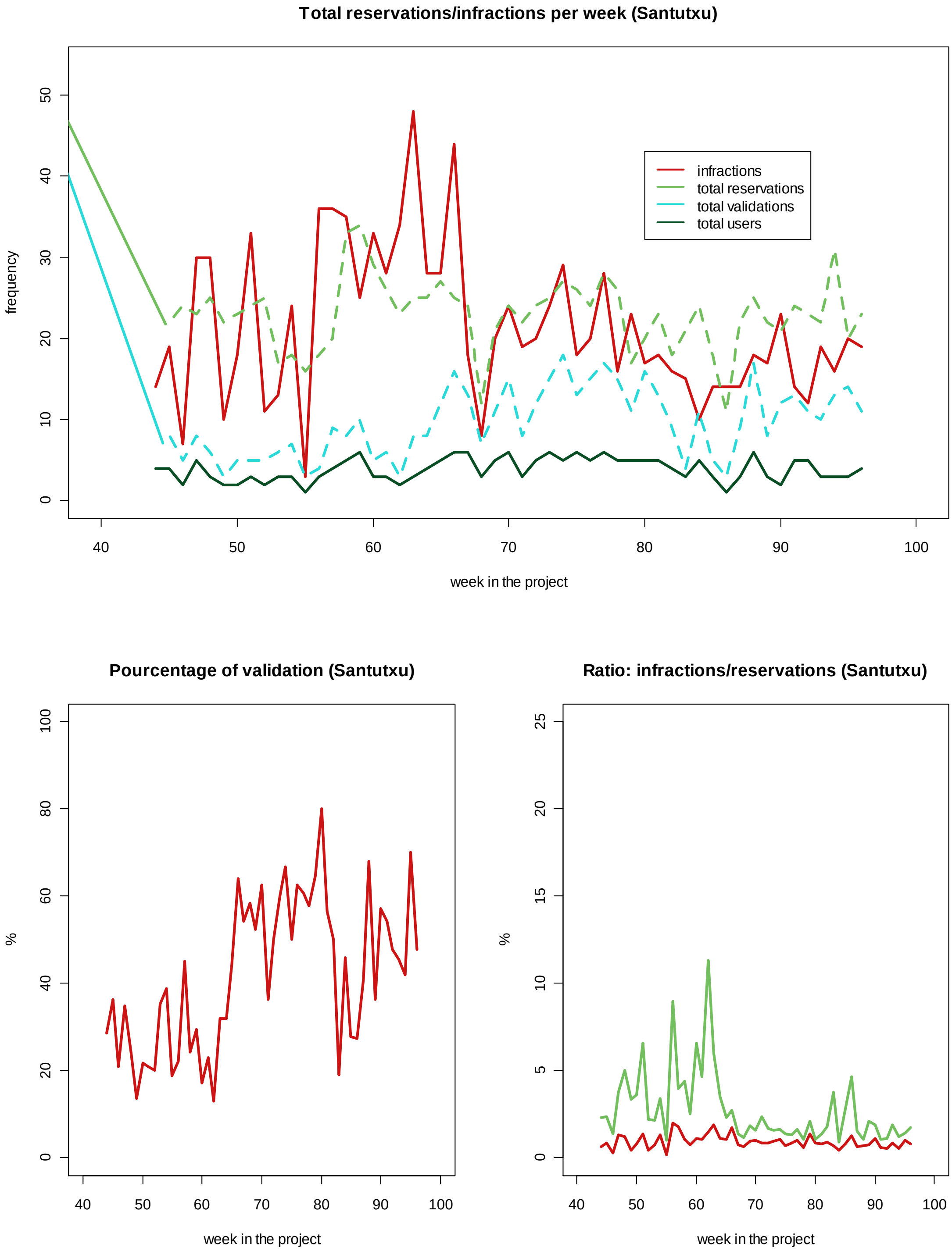



**Figure 38 The same as Figure 34 but for the pilot site of Santutxu.**

In all the cases the total number of infractions decreases in the week 69 so it is important to note that the enforcement schemes by local police have started after Easter 2011. It can be concluded that the number of infractions remains still important and can be related to the fact the DSB system is far from being saturated. There are no significant differences among distinct pilot sites (Figure 35 - Figure 38).

#### 3.2.2.2. GPS data

Each driver logs in to the Blackberry's GPS system before starting the journey and records all GPS data of the journey. This device collects GPS Time, Latitude and GPS Longitude, travelled distance and GPS speed every two seconds. At the end of the journey, files are sent via GPRS to the Bilbao local FTP server. The data recorded with this data logger is processed in order to identify possible bugs, clean the GPS data and track the delivery stops. This information is treated with a data processing algorithm, using the R language (http://www.r-project.org/), that manages the information as follows:

- Distances and speeds are recalculated to check the accuracy of GPS efficiency.
- Some errors are identified in these files:
  - Repetition of a same point – It is produced when the GPS system looses connection with the satellites so the same position is repeated several times. This error can be tracked easily because the calculated distance between two points is equal to zero. It can be corrected by interpolation of GPS positions.
  - Speed or acceleration problems – It can happen that the speed or the acceleration were unrealistic.
- The criterion to consider delivery stops are a speed less than 3 km/h and duration greater than 120 s. It allows excluding stops caused by traffic lights.
- It is used the OpenMapStreet data and it is aggregated streets in three groups: motorway, main road and residential. The affectation is made with the GIS software named PostGIS which looks for each recorded point the corresponding street.
- The last step is to identify the GPS points into the influence areas of each studied delivery space. Therefore, the delivery stops can be identified around the delivery spaces.

Combining this GPS Data with CMEM software fuel consumption is obtained. CMEM model was chosen (D.FL.4.1 Evaluation methodology and plan) because it takes into account accelerations, it is valid for distinct weights of vehicles and it can be easily automated in a computing program. Table 24 shows the official fleet operators taking part in the pilot period classified according the weight of the vehicles. Since fuel consumption and pollutants emissions are proportionally related to this model values such as $CO_2$, $CO$, $NO_x$ and $HC$ emissions are also obtained.

| Id Group | Group | Companies | Mean of weight including the load | percentage of collected delivery routes |
|---|---|---|---|---|
| 1 | Small vehicles | Azkar, Bizkai, DHL, Medrano, MRW and SEUR | 3,15 tonnes | 15% |
| 2 | Medium vehicles | Coca Cola and Patxi | 6,95 tonnes | 10% |
| 3 | Heavy vehicles | Euskodis, Nanuk, Unialco Rulasan-Eroski and Zubieta-Eroski | 18 tonnes | 75% |

**Table 24 Official fleet operators.**

CMEM uses the American model so to calibrate the obtained estimations with the European references is used the ARTEMIS model. In such a way, for each point of the route the instantaneous fuel consumption and $CO_2$ and $NO_X$ emissions are obtained taking into account the coefficient factor $S$ (Table 25) between the American and the European model. This adjustment is not valid for other pollutants emissions.

| | Small vehicles | Medium vehicles | Big vehicles |
|---|---|---|---|
| *S* | 0,4 | 0,41 | 0,47 |

**Table 25 Factors of multiplication to pass from CMEM to ARTEMIS.**

1693 GPS files were loaded and 1601 are considered valid routes. 1248 routes have at least one delivery stop around the studied delivery spaces. 625 of them (Table 27) were selected because the truck stops at a delivery space during the possible hours of reservations (between 8h and 13:30h).

| Group | Travelled distance | Route duration | Average number of deliveries |
|---|---|---|---|
| Small vehicles | 46 km | 4,9 h | 21 (max = 44) |
| Medium vehicles | 62 km | 6,9 h | 26 (max = 44) |
| Big vehicles | 73 km | 3,9 h | 11 (max = 22) |
| All | 68 km | 4,3 h | 14 |

**Table 26 Characteristics of delivery routes.**

| Pilot site | Number of baseline stops | Number of pilot stops |
|---|---|---|
| General Concha | 9 | 46 |
| Pérez Galdós | 30 | 122 |
| Licenciado Poza | 31 | 102 |
| Santutxu | 40 | 208 |

**Table 27 Recorded stops per delivery space.**

#### 3.2.2.3. Counting in the street

Automatic traffic counting sensors are installed at streets near the intersections to estimate the traffic intensity in each road. Not all the streets are equipped with sensors but it is possible to estimate the traffic flow taking into account the adjacent equipped streets (D.FL.4.1 Evaluation methodology and plan).

It is assumed that the booking of the delivery space allows the driver not to look for a place in order to deliver the goods. Therefore, the distance and the time between the arrival into the influence area and the real stop are lower when the system works. In addition, fuel consumptions and gas emissions have to be also lower. The situations when the trucks arrive at the proximity of the delivery space can be summarized in three situations:

- The ideal situation: the driver finds a free space and does not look for one.
- The bad situation: the driver does not find a free space and must wait or look for one before the delivery. He may then get around the buildings block in order to find a place. Indeed, distances and times increase and there are more consumptions and emissions.
- The illegal situation: the driver does not find a free space and chooses an illegal space or double parking. There are no impacts on distances however there can be more congestion according to traffic. With GPS data, it is impossible to separate this situation to the ideal one.

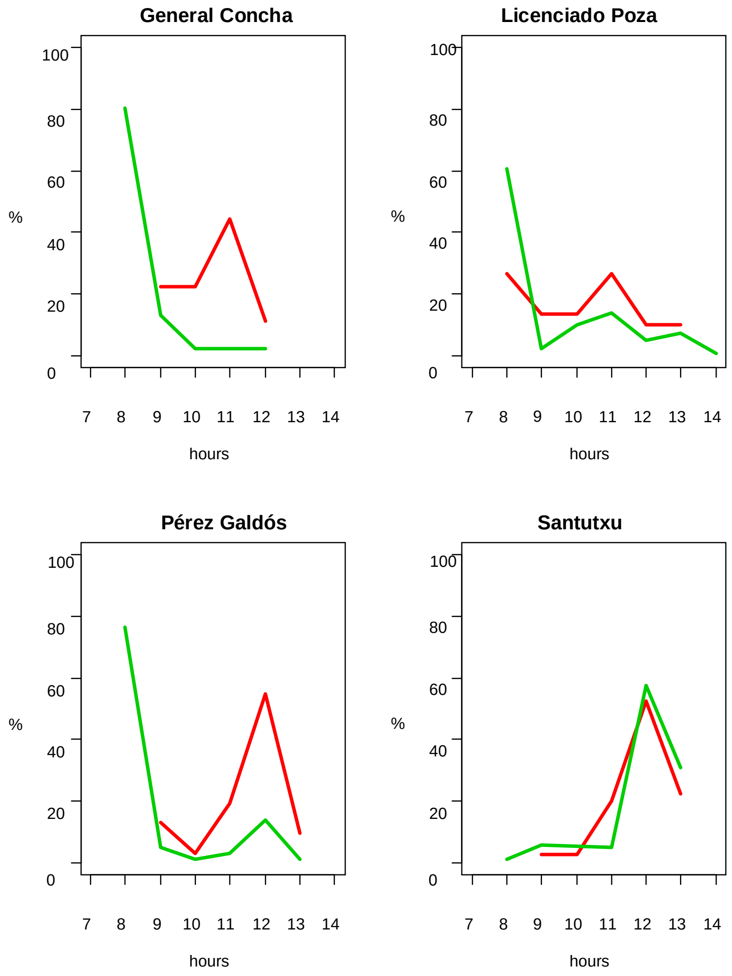



**Figure 39 Hours of deliveries (baseline in red and pilot in green).**

Figure 39 reports the time distribution of deliveries near the delivery bays. There are big differences between the baseline and the pilot in General Concha and Pérez Galdós. In both cases, the peak of deliveries moves from the late morning (11h/12h) to 8h/9h. In Pérez Galdós, it is observed that the pilot delivery peak corresponds to that of reservations (Figure 32) so the changes could be related to the usage of the DSB system.

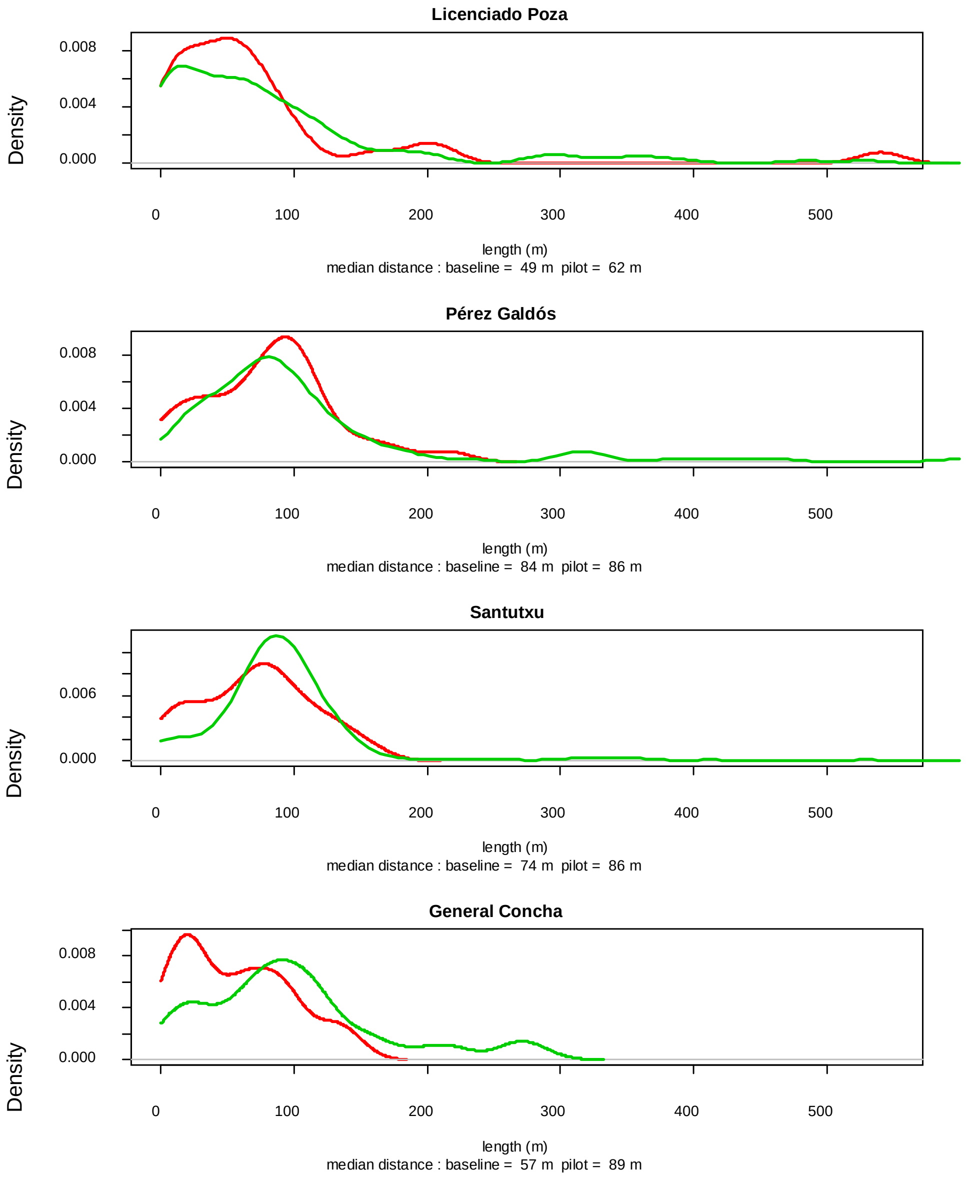



**Figure 40 Distribution of the distances before parking (baseline in red and pilot in green).**

| Delivery spaces | Period | Q1 | Q2 | Q3 | Q3 - Q1 |
|---|---|---|---|---|---|
| Pérez Galdós | baseline | 43 | 84 | 104 | 61 |
| Pérez Galdós | pilot | 59 | 86 | 131 | 72 |
| Santutxu | baseline | 37 | 74 | 100 | 63 |
| Santutxu | pilot | 68 | 86 | 105 | 37 |
| General Concha | baseline | 22 | 57 | 88 | 66 |
| General Concha | pilot | 56 | 89 | 119 | 64 |
| Licenciado Poza | baseline | 23 | 49 | 82 | 59 |
| Licenciado Poza | pilot | 22 | 62 | 120 | 99 |

**Table 28 Quartile distances for each site in each period.**

The delivery space is located at 70m from the limits of the influence area. If the distance is above 140m, it is considered that the driver makes a move to be well-parked (a U-turn or a bypass). In the baseline period the driver choose easily free spaces along the road and during the pilot period he uses the reserved slots for the DSB system. Moreover, during the baseline period there are very few situations when the driver must be a manoeuvre to be well-parked. However, some of these situations exists during the pilot period due certainly to a extraordinary traffic.

The considered distances in Figure 40 are the length between the first point into the influence area and the first point of the delivery stop between 8h and 13:30h.

The distribution of the distance travelled to park presents some differences between baseline and pilot and more precisely each delivery bay has a specific behaviour. From now on, General Concha data set is not considered in the analysis because the number of countings is not significant (Figure 41).

Table 28 reports for each DSB and period the quartiles Q1, Q2 and Q3 as well as the inter-quartile distance (Q3-Q1). It is observed that the median (Q2) is slightly higher in the pilot period than in the baseline period for all the pilot sites and only for Santutxu the interquartile distance (Q3-Q1) decreases significantly.

Figure 41 is a results screen from R software that shows that in Licenciado Poza and Pérez Galdos the average of distances during the baseline period is lower than the one of the pilot period (that are upper 140m) but only Pérez Galdós has a p-value with a positive significance. In Santutxu the average of distances is higher in the baseline with a positive significance possibly because the system added a new delivery space, keeping the existing one for deliveries not using the system, but increasing the delivery parking capacity. This is the only transformation of an existing delivery bay into a DSB system.

| dsb | count | baseline | pilot | pvalue | sign |
|---|---|---|---|---|---|
| GENERAL CONCHA | 88 | 173.9 | 115.3 | 0.101003 | |
| LICENCIADO POZA | 771 | 112.5 | 143.3 | 0.105192 | |
| PEREZ GALDÓS | 153 | 97.9 | 176.3 | 0.035738 | * |
| SANTUTXU | 427 | 142.4 | 108 | 0.014528 | * |

**Figure 41 Pilot site, number of routes, average of distances in baseline and pilot periods, p-value and its significance**

In order to produce a more detailed analysis the distance distribution per category of vehicle is carried out. Table 29 shows that although the median is slighty higher in the pilot period the interquartile distance decreases in all pilos sites, except Licenciado Poza. This reflects a dec rease of the variability in the travelled distance to park Table 30 and Figure 44 show better gains for pilot period in medium vehicles. Figure 43 and Figure 44 show that only Pérez Galdós breaks the trend and for medium vehicles and big vehicles Q2 is lower in the pilot period but on the contrary the average of distances increases. Except for Santutxu, the DSB seems to have a negative impact on distances for heavy vehicles, which is directly related to the characteristics of the vehicles. Indeed, these vehicles are long and heavy and have more difficulties to travel and park in city centres.

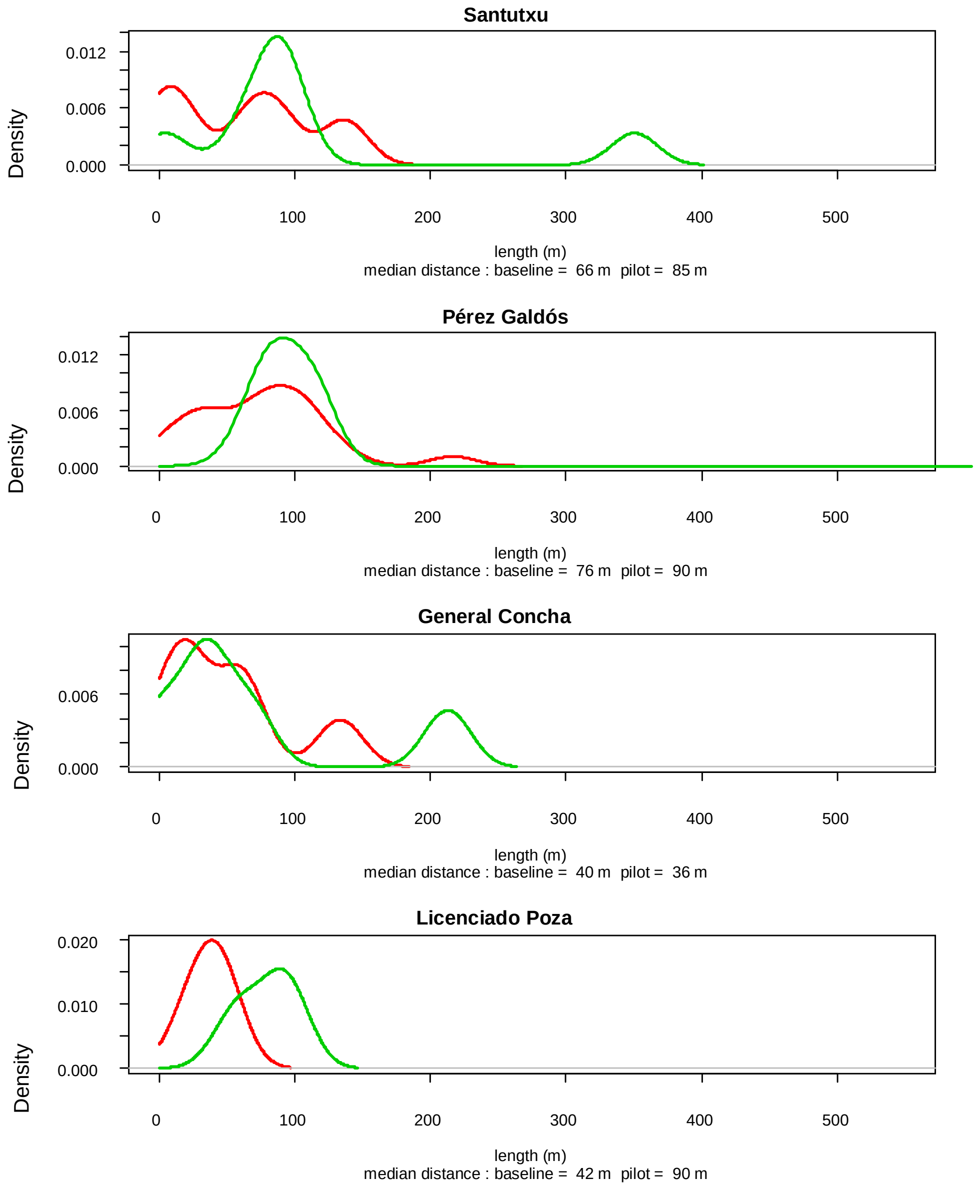



**Figure 42 The same as Figure 40 but for small vehicles.**

| Delivery spaces | Period | Q1 | Q2 | Q3 | Q3 - Q1 |
|---|---|---|---|---|---|
| Pérez Galdós | baseline | 41 | 76 | 102 | 61 |
| Pérez Galdós | pilot | 82 | 90 | 113 | 32 |
| Santutxu | baseline | 17 | 66 | 88 | 71 |
| Santutxu | pilot | 72 | 85 | 95 | 23 |
| General Concha | baseline | 22 | 40 | 62 | 40 |
| General Concha | pilot | 34 | 36 | 68 | 35 |
| Licenciado Poza | baseline | 33 | 42 | 44 | 11 |
| Licenciado Poza | pilot | 61 | 90 | 92 | 32 |

**Table 29 The same as Table 28 but for small vehicles.**

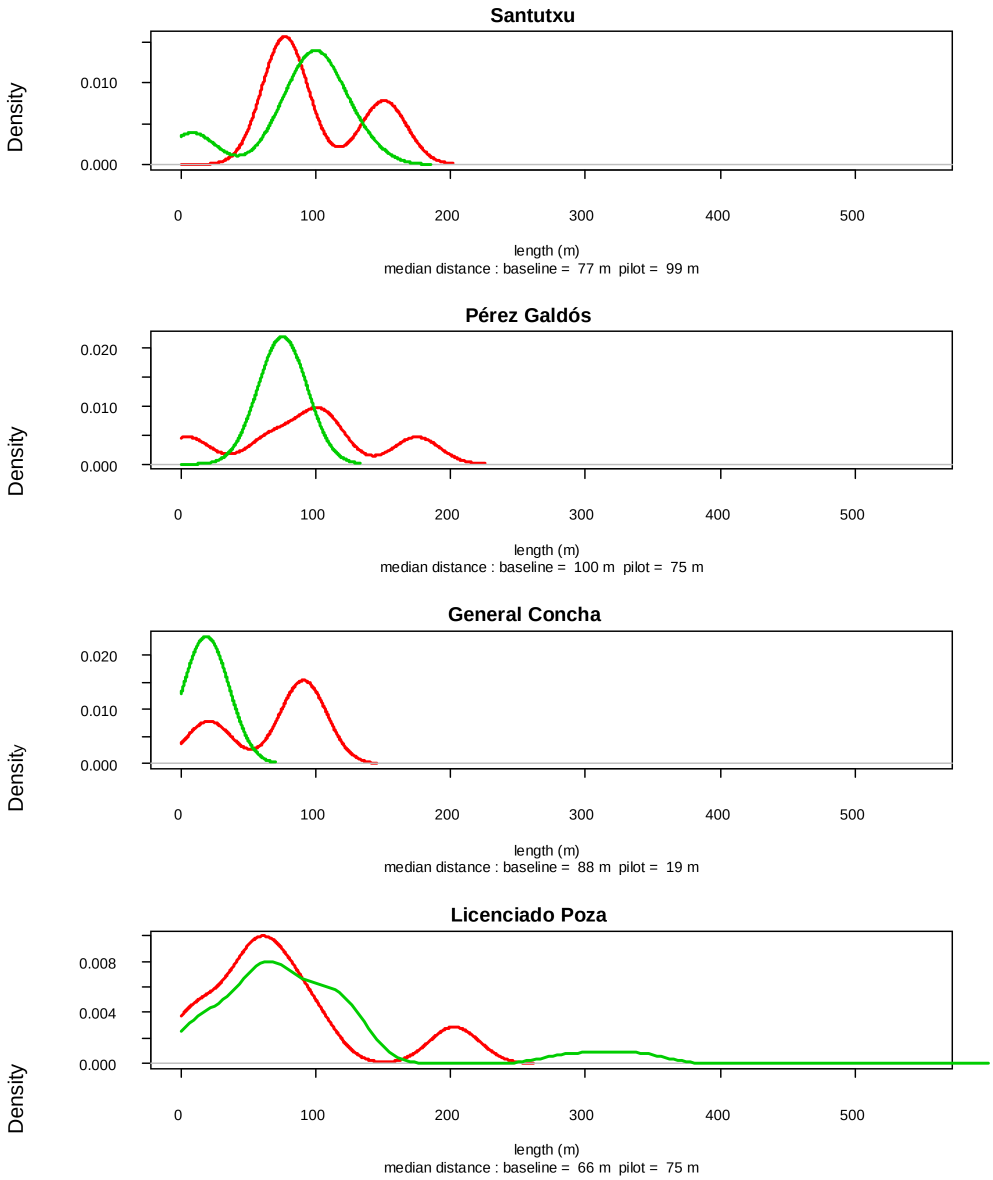



**Figure 43 The same as Figure 40 but for medium vehicles.**

| Delivery spaces | Period | Q1 | Q2 | Q3 | Q3 - Q1 |
|---|---|---|---|---|---|
| Pérez Galdós | baseline | 67 | 100 | 106 | 40 |
| Pérez Galdós | pilot | 72 | 75 | 78 | 6 |
| Santutxu | baseline | 77 | 77 | 114 | 37 |
| Santutxu | pilot | 81 | 99 | 106 | 25 |
| General Concha | baseline | 54 | 88 | 91 | 37 |
| General Concha | pilot | 19 | 19 | 19 | 0 |
| Licenciado Poza | baseline | 44 | 66 | 89 | 45 |
| Licenciado Poza | pilot | 54 | 75 | 117 | 62 |

**Table 30 The same as Table 28 but for medium vehicles.**

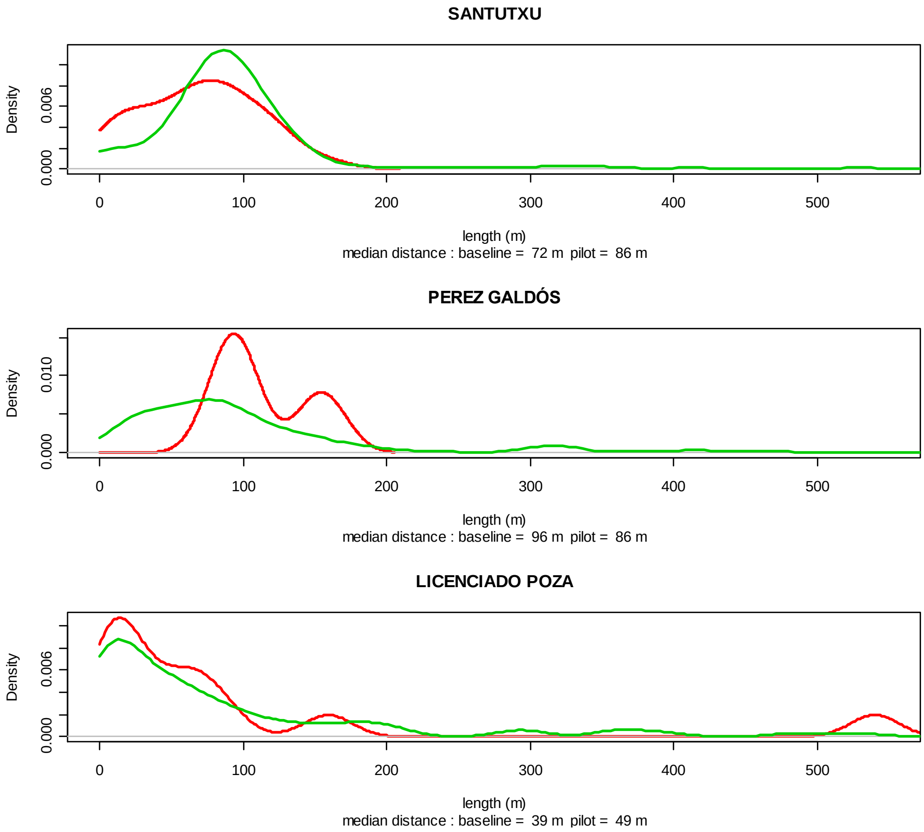



**Figure 44 The same as Figure 40 but for heavy vehicles.**

| Delivery spaces | Period | Q1 | Q2 | Q3 | Q3 - Q1 |
|---|---|---|---|---|---|
| Pérez Galdós | baseline | 93 | 96 | 125 | 32 |
| Pérez Galdós | pilot | 51 | 86 | 145 | 93 |
| Santutxu | baseline | 37 | 72 | 100 | 63 |
| Santutxu | pilot | 68 | 86 | 105 | 37 |
| Licenciado Poza | baseline | 12 | 39 | 72 | 60 |
| Licenciado Poza | pilot | 14 | 49 | 129 | 115 |

**Table 31 The same as Table 28 but for heavy vehicles.**

| categorie | dsb | count | baseline | pilot | pvalue | sign |
|---|---|---|---|---|---|---|
| 1 | GENERAL CONCHA | 20 | 196.6 | 82.2 | 0.2983 | |
| 1 | LICENCIADO POZA | 15 | 38.7 | 111.8 | 0.2832 | |
| 1 | PEREZ GALDÓS | 49 | 95.9 | 128.3 | 0.3756 | |
| 1 | SANTUTXU | 11 | 80.3 | 136.4 | 0.4825 | |
| 2 | GENERAL CONCHA | 7 | 105.7 | 21.1 | 0.1264 | |
| 2 | LICENCIADO POZA | 85 | 111.6 | 128.3 | 0.6509 | |
| 2 | PEREZ GALDÓS | 9 | 104.3 | 115.6 | 0.8231 | |
| 2 | SANTUTXU | 17 | 105.8 | 89.8 | 0.4342 | |
| 3 | LICENCIADO POZA | 671 | 115 | 145.5 | 0.1653 | |
| 3 | PEREZ GALDÓS | 95 | 101.5 | 188.2 | 0.4785 | |
| 3 | SANTUTXU | 399 | 147 | 108.1 | 0.0093 | * |

**Figure 45 The same as Figure 41 but for each category of vehicle.**

Figure 46 - Figure 48 show the emissions when trucks arrive into the influence are until parking. As shown by the results, the environmental benefits of the system is not evident. The effects on the vehicles emissions are not significant and depend on the distance that the vehicle makes to park. The analysis of distances shows that there is not a positive impact on average and mean distances but only on its variability. In conclusion, the fuel consumption and environmental impacts are not significant. The DSB seems to have a negligible effect on the route performance but can have an impact on overall traffic (see analysis of double lines and parking infractions).

| categorie | dsb | count | baseline | pilot | pvalue | sign |
|---|---|---|---|---|---|---|
| 1 | GENERAL CONCHA | 20 | 73.3 | 31.3 | 0.2627 | |
| 1 | LICENCIADO POZA | 15 | 12 | 77.5 | 0.3424 | |
| 1 | PEREZ GALDÓS | 49 | 39 | 48.4 | 0.6227 | |
| 1 | SANTUTXU | 11 | 17.1 | 62.8 | 0.3726 | |
| 2 | GENERAL CONCHA | 7 | 30 | 20.6 | 0.6447 | |
| 2 | LICENCIADO POZA | 85 | 73 | 82 | 0.7144 | |
| 2 | PEREZ GALDÓS | 9 | 34 | 66.9 | 0.0767 | |
| 2 | SANTUTXU | 17 | 49.3 | 25.2 | 0.1071 | |
| 3 | LICENCIADO POZA | 671 | 86 | 124.9 | 0.0524 | |
| 3 | PEREZ GALDÓS | 95 | 43.9 | 140.8 | 0.2691 | |
| 3 | SANTUTXU | 399 | 101.4 | 71.5 | 0.0416 | * |

**Figure 46 Pilot site, number of routes, fuel consumption in baseline and pilot periods, p-value and its significance**

| categorie | dsb | count | baseline | pilot | pvalue | sign |
|---|---|---|---|---|---|---|
| 1 | GENERAL CONCHA | 20 | 213 | 86.2 | 0.2284 | |
| 1 | LICENCIADO POZA | 15 | 30.9 | 231.7 | 0.3141 | |
| 1 | PEREZ GALDÓS | 49 | 116.9 | 148.1 | 0.5989 | |
| 1 | SANTUTXU | 11 | 48.1 | 190.2 | 0.3642 | |
| 2 | GENERAL CONCHA | 7 | 95.4 | 70.4 | 0.701 | |
| 2 | LICENCIADO POZA | 85 | 242 | 273.2 | 0.7037 | |
| 2 | PEREZ GALDÓS | 9 | 115.1 | 226.7 | 0.1039 | |
| 2 | SANTUTXU | 17 | 162.1 | 80.2 | 0.1064 | |
| 3 | LICENCIADO POZA | 671 | 284.9 | 414.9 | 0.0517 | |
| 3 | PEREZ GALDÓS | 95 | 142.1 | 466.5 | 0.2643 | |
| 3 | SANTUTXU | 399 | 336.3 | 235.1 | 0.0383 | * |

**Figure 47 Pilot site, number of routes, $CO_2$ emissions in baseline and pilot periods, p-value and its significance.**

| categorie | dsb | count | baseline | pilot | pvalue | sign |
|---|---|---|---|---|---|---|
| 1 | GENERAL CONCHA | 20 | 0.8 | 0.3 | 0.2558 | |
| 1 | LICENCIADO POZA | 15 | 0.1 | 0.7 | 0.3646 | |
| 1 | PEREZ GALDÓS | 49 | 0.4 | 0.5 | 0.7057 | |
| 1 | SANTUTXU | 11 | 0.2 | 0.6 | 0.3656 | |
| 2 | GENERAL CONCHA | 7 | 1 | 0.9 | 0.8904 | |
| 2 | LICENCIADO POZA | 85 | 3.1 | 3.4 | 0.7261 | |
| 2 | PEREZ GALDÓS | 9 | 1.7 | 3.5 | 0.154 | |
| 2 | SANTUTXU | 17 | 1.9 | 0.9 | 0.0946 | |
| 3 | LICENCIADO POZA | 671 | 3.4 | 4.9 | 0.0476 | * |
| 3 | PEREZ GALDÓS | 95 | 1.3 | 5.3 | 0.2088 | |
| 3 | SANTUTXU | 399 | 4.1 | 2.7 | 0.0153 | * |

**Figure 48 Pilot site, number of routes, $NO_x$ emissions in baseline and pilot periods, p-value and its significance.**

Last part remaining it the evaluation of the impact of the DSB on traffic. To do this, an infraction counting campaign has been carried out. The baseline took place in 2010 (June - September) and the pilot in 2011 (January-June). Figure 49 - Figure 50 show a significant reduction of infractions, but it is not uniform.

Table 32 - Table 41 report the difference in the infractions between baseline and pilot periods for all DSB. It is observed that double lines increase in Santutxu, mainly those of big trucks. These results are contradictory with the expected situation, since a capacity increase should lead on a truck double lines decrease. But although small trucks remain the same, van decrease and car increase (which is a logical result) big trucks, the most able to use the DSB, are more incline to make double lines. However, illegal parking has decreased significantly (from almost 20 to 2 vehicles per day), and since it is sometimes difficult to distinguish double lines from illegal parking or to define what is a double line parking and what a small stop to wait the delivery space to be free, it can be considered that overall the effects on illegal parking actions are quite positive.

In DSB evaluation, different operators carried out the infraction counting data collection. After a deep analysis of all data, we stated that several operators did not complete in an accurate way the forms. Although it was stated a control had to be done, LET had not a margin to correct this data, even if several contacts had been established. A correction process of the data has been done, but it is statistically difficult to say if they are significant.

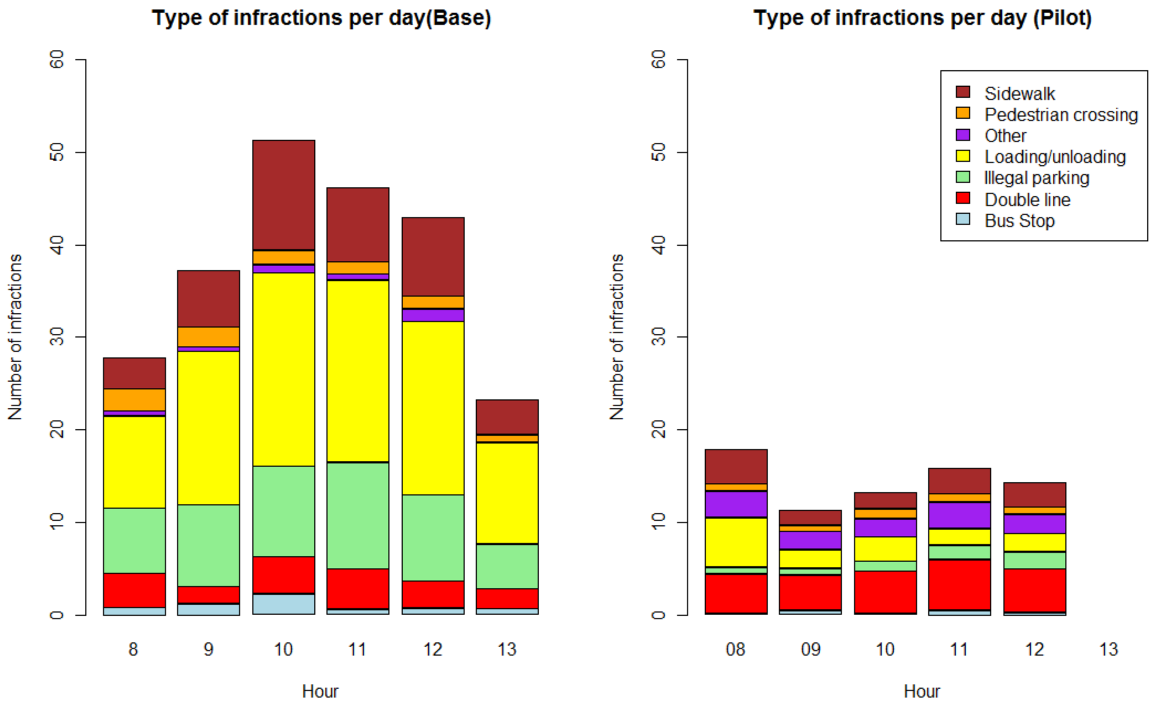



**Figure 49 Average number of infractions per day (by our and type of infraction).**

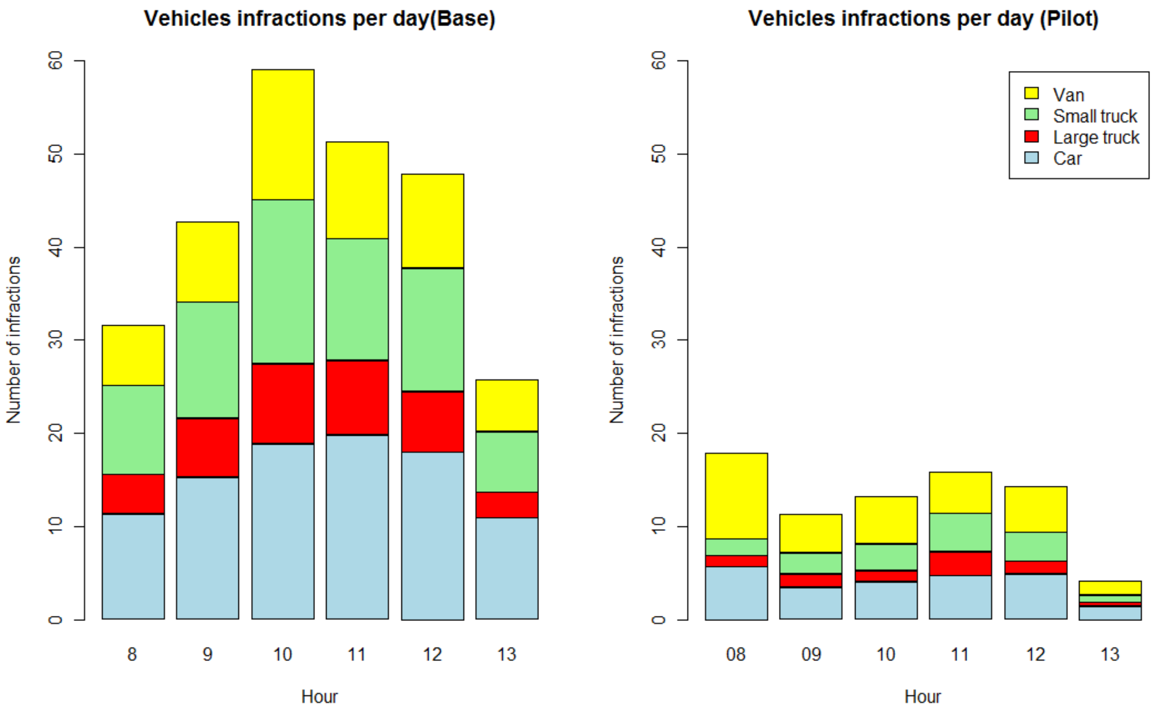



**Figure 50 Average number of infractions per day (by our and type of infraction)**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Other | Parking for disabled | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|---|---|
| Car | 1,18 | 5,09 | 18,45 | 41,73 | 17,18 | 1,27 | 0,55 | 8,45 | **93,91** |
| Large truck | 1,82 | 3,00 | 8,55 | 6,27 | 2,09 | 0,00 | 3,45 | 11,27 | **36,45** |
| Small truck | 1,64 | 6,00 | 13,18 | 24,73 | 6,18 | 1,27 | 4,09 | 15,64 | **72,73** |
| Van | 1,36 | 5,09 | 11,27 | 24,00 | 4,18 | 1,55 | 1,55 | 6,27 | **55,27** |
| **Total** | **6,00** | **19,18** | **51,45** | **96,73** | **29,64** | **4,09** | **9,64** | **41,64** | **258,36** |

**Table 32 Infractions counting results in baseline period for all DSB.**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Other | Parking for disabled | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|---|---|
| Car | 0,27 | 7,57 | 2,93 | 4,90 | 2,51 | 0,00 | 1,02 | 2,62 | **21,82** |
| Large truck | 0,27 | 3,80 | 0,67 | 0,07 | 1,73 | 0,00 | 0,07 | 0,87 | **7,47** |
| Small truck | 0,53 | 5,80 | 2,27 | 0,47 | 1,38 | 0,00 | 0,07 | 3,33 | **13,85** |
| Van | 0,20 | 6,74 | 1,27 | 9,24 | 1,58 | 0,00 | 3,18 | 6,65 | **28,86** |
| **Total** | **1,27** | **23,92** | **7,13** | **14,67** | **7,21** | **0,00** | **4,34** | **13,46** | **72,00** |

**Table 33 Infractions counting results in pilot period for all DSB.**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Other | Parking for disabled | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|---|---|
| Car | 0,73 | 0,27 | 3,27 | 13,82 | 15,36 | 1,00 | 0,55 | 3,18 | **38,18** |
| Large truck | 1,73 | 0,91 | 4,64 | 0,64 | 0,91 | 0,00 | 0,00 | 3,18 | **12,00** |
| Small truck | 0,91 | 0,27 | 3,00 | 11,27 | 2,73 | 0,64 | 0,82 | 7,18 | **26,82** |
| Van | 1,27 | 0,55 | 3,09 | 11,73 | 2,64 | 1,27 | 0,18 | 4,27 | **25,00** |
| **Total** | **4,64** | **2,00** | **14,00** | **37,45** | **21,64** | **2,91** | **1,55** | **17,82** | **102,00** |

**Table 34 The same as Table 32 but for General Concha.**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Other | Parking for disabled | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|---|---|
| Car | 0,07 | 0,73 | 2,53 | 0,00 | 0,87 | 0,00 | 0,07 | 1,80 | **6,07** |
| Large truck | 0,20 | 0,87 | 0,33 | 0,00 | 1,73 | 0,00 | 0,00 | 0,80 | **3,93** |
| Small truck | 0,27 | 2,13 | 1,40 | 0,00 | 1,33 | 0,00 | 0,00 | 3,20 | **8,33** |
| Van | 0,13 | 1,27 | 1,13 | 0,00 | 0,93 | 0,00 | 0,07 | 3,27 | **6,80** |
| **Total** | **0,67** | **5,00** | **5,40** | **0,00** | **4,87** | **0,00** | **0,13** | **9,07** | **25,13** |

**Table 35 The same as Table 33 but for General Concha.**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Other | Parking for disabled | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|---|---|
| Car | 0,00 | 1,00 | 0,00 | 3,09 | 0,09 | 0,00 | 0,00 | 1,18 | **5,36** |
| Large truck | 0,09 | 1,55 | 0,09 | 1,45 | 0,09 | 0,00 | 1,09 | 2,00 | **6,36** |
| Small truck | 0,45 | 1,82 | 0,36 | 1,36 | 0,00 | 0,00 | 0,82 | 1,36 | **6,18** |
| Van | 0,00 | 1,36 | 0,00 | 2,18 | 0,09 | 0,00 | 0,55 | 0,09 | **4,27** |
| **Total** | **0,55** | **5,73** | **0,45** | **8,09** | **0,27** | **0,00** | **2,45** | **4,64** | **22,18** |

**Table 36 The same as Table 32 but for Pérez Galdós.**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Other | Parking for disabled | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|---|---|
| Car | 0,00 | 1,19 | 0,00 | 2,71 | 0,10 | 0,00 | 0,62 | 0,00 | **4,62** |
| Large truck | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** |
| Small truck | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** |
| Van | 0,00 | 2,14 | 0,00 | 2,19 | 0,00 | 0,00 | 0,67 | 0,38 | **5,38** |
| **Total** | **0,00** | **3,33** | **0,00** | **4,90** | **0,10** | **0,00** | **1,29** | **0,38** | **10,00** |

**Table 37 The same as Table 33 but for Pérez Galdós.**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Other | Parking for disabled | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|---|---|
| Car | 0,09 | 0,00 | 6,73 | 18,64 | 1,73 | 0,27 | 0,00 | 4,09 | 31,55 |
| Large truck | 0,00 | 0,09 | 2,91 | 2,45 | 1,09 | 0,00 | 2,00 | 6,09 | 14,64 |
| Small truck | 0,00 | 0,27 | 3,18 | 5,00 | 3,45 | 0,64 | 1,91 | 7,09 | 21,55 |
| Van | 0,09 | 0,27 | 4,45 | 3,36 | 1,45 | 0,27 | 0,27 | 1,91 | 12,09 |
| **Total** | **0,18** | **0,64** | **17,27** | **29,45** | **7,73** | **1,18** | **4,18** | **19,18** | **79,82** |

**Table 38 The same as Table 32 but for Licenciado Poza.**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Other | Parking for disabled | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|---|---|
| Car | 0,00 | 0,05 | 0,00 | 1,85 | 1,55 | 0,00 | 0,00 | 0,75 | **4,20** |
| Large truck | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | **0,00** |
| Small truck | 0,00 | 0,00 | 0,00 | 0,00 | 0,05 | 0,00 | 0,00 | 0,00 | **0,05** |
| Van | 0,00 | 1,60 | 0,00 | 7,05 | 0,65 | 0,00 | 2,45 | 3,00 | **14,75** |
| **Total** | **0,00** | **1,65** | **0,00** | **8,90** | **2,25** | **0,00** | **2,45** | **3,75** | **19,00** |

**Table 39 The same as Table 33 but for Licenciado Poza.**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|
| Car | 0,36 | 3,82 | 8,45 | 6,18 | 0,00 | 0,00 | **18,82** |
| Large truck | 0,00 | 0,45 | 0,91 | 1,73 | 0,36 | 0,00 | **3,45** |
| Small truck | 0,27 | 3,64 | 6,64 | 7,09 | 0,55 | 0,00 | **18,18** |
| Van | 0,00 | 2,91 | 3,73 | 6,73 | 0,55 | 0,00 | **13,91** |
| **Total** | **0,64** | **10,82** | **19,73** | **21,73** | **1,45** | **0,00** | **54,36** |

**Table 40 The same as Table 32 but for Santutxu.**

| Type of vehicle | Bus Stop | Double line | Illegal parking | Delivery space | Pedestrian crossing | Sidewalk | Total |
|---|---|---|---|---|---|---|---|
| Car | 0,20 | 5,60 | 0,40 | 0,33 | 0,33 | 0,07 | **6,93** |
| Large truck | 0,07 | 2,93 | 0,33 | 0,07 | 0,07 | 0,07 | **3,53** |
| Small truck | 0,27 | 3,67 | 0,87 | 0,47 | 0,07 | 0,13 | **5,47** |
| Van | 0,07 | 1,73 | 0,13 | 0,00 | 0,00 | 0,00 | **1,93** |
| **Total** | **0,60** | **13,93** | **1,73** | **0,87** | **0,47** | **0,27** | **17,87** |

**Table 41 The same as Table 33 but for Santutxu.**

### 3.2.2.4. Questionnaires

Bilbao drivers filled in a questionnaire to assess their impressions and perceptions about DSB service in Bilbao. They answered a specific questionnaire developed for evaluating the service and, moreover, they wrote back the CVIS questionnaire. They replied both questionnaires in two different set of times with the aim of studying if there were differences between both times.

Specific questionnaire is composed by questions for having knowledge about the profile of the sample, while other set of them were provided for understanding the acceptance of DSB service. The first part of this report present general descriptive information for the sample:

- Demographic characteristics: age, gender, educational level or occupation.
- Driving experience: type of driving license, what age drivers began to start to drive, experience as truck drivers, how often they drive, timetable, how may kilometres they drive per year (average), type of road they usually drive and how many fines they received by driving offence.

Later on, a set of 30 questions express the degree of agreement or disagreement with each statement related with DSB assessment ticking in a Likert scale from 0 (Totally disagree) to 10 (Totally agree).

Finally, this report finalise with the results for CVIS questionnaire. CVIS questionnaire is a survey designed to support the evaluation of the Co-operative Vehicle and Infrastructure Systems (CVIS) project of the Urban Parking Zones application on a mixed-use street in central London to manage a freight loading bay in Earl's Court Road. This questionnaire was adapted to FREILOT pilot with the aim of obtaining relevant information. This questionnaire consists of 3 sections and 17 questions in total.

Sample was composed by 24 participants who answered anonymously and voluntarily both questionnaires. These ten organizations belong to diverse area of businesses: Panrico, Azkar, Zubigane, Hermanos Leiva, Danone, Eroski, Heineken, Nanuk, Uriarte and Kas.

Finally, averages and standard deviation for all the items regarding both times is provided in Table 42 and represented in Figure **51**. The results of the questionnaires are explained in Annex 2.

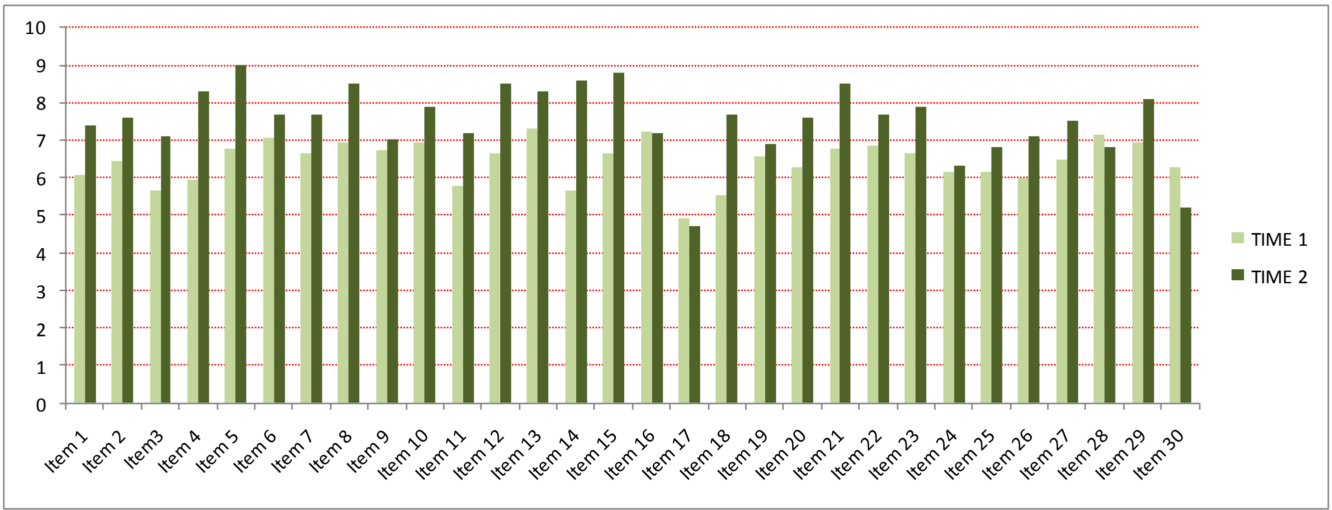



**Figure 51 Averages for all the items in both times for Bilbao drivers.**

At first questionnaire, the items with highest scores are:

- "I consider the Delivery Space Booking service improves the freight image in urban areas because decrease the number of double lane stops" (M=7,29).
- "After using Delivery Space Booking I like the service" (M=7,23).
- "I find the Delivery Space Booking service is easy to use" (M=7,14).

The items with lowest values are:

- "My safety has increased since I used the Delivery Space Booking service" (M=5,64).
- "More I use the Delivery Space Booking service, I feel more apprehensive about it" (5,54).
- "I believe the Delivery Space Booking service works properly" (4,93).

At the second questionnaire, the items with highest values are:

- "I think that using the Delivery Space Booking service increases the efficacy of my work" (9,00).
- "I think that the Delivery Space Booking service facilitates my delivery operations" (8,80).
- "I have experience that the delivery efficiency on urban areas increased with the use of Delivery Space Booking" (8,60).

The items with lowest values are:

- "I believe the Delivery Space Booking service works properly" (M=4,70)
- "Delivery Space Booking service reduces the length of travels" (M=5,20)
- "I trust the Delivery Space Booking service" (M=6,30)

| | First Questionnaire | | SecondQuestionnaire | |
|---|---|---|---|---|
| **Item** | **Average** | **Standard Deviation** | **Average** | **Standard Deviation** |
| 1. I am confident of using Delivery Space Booking service | 6,07 | 3,050 | 7,40 | 3,239 |
| 2. Since I use the Delivery Space Booking service is easier to me to find free spaces to the delivery/unloading task | 6,43 | 2,875 | 7,60 | 2,757 |
| 3. My safety has increased since I used the Delivery Space Booking service | **5,64** | 2,620 | 7,10 | 2,079 |
| 4. I think I have achieved a higher driving comfort using Delivery Space Booking service | 5,93 | 2,526 | 8,30 | 1,567 |
| 5. I think that using the Delivery Space Booking service increases the efficacy of my work | 6,79 | 2,940 | **9,00** | 1,414 |
| 6. More I use the Delivery Space Booking service, I feel less stressed | 7,07 | 2,947 | 7,70 | 2,497 |
| 7. The freight transport image in urban areas is improved with the usage of Delivery Space Booking service | 6,64 | 2,925 | 7,70 | 1,829 |
| 8. The Delivery Space Booking service facilitates my delivery task because I don't need to look for free spaces | 6,93 | 2,895 | 8,50 | 1,581 |
| 9. I have less tickets/fines because of double-parked since I used Delivery Space Booking service | 6,71 | 2,894 | 7,00 | 2,867 |
| 10. I believe that my work conditions have improved with use of Delivery Space Booking service | 6,93 | 2,973 | 7,90 | 1,792 |
| 11. I think the traffic flow gets benefits with the Delivery Space Booking service (the rest of the drivers do not hold up because of double lines, less congestions… | 5,79 | 2,607 | 7,20 | 2,348 |

| | | | | |
|---|---|---|---|---|
| 12. I think the Delivery Space Booking service does not disturb me in my driving task | 6,64 | 2,468 | 8,50 | 1,650 |
| 13. I consider the Delivery Space Booking service improves the freight image in urban areas because decrease the number of double lane stops | **7,29** | 2,614 | 8,30 | 1,636 |
| 14. I have experience that the delivery efficiency on urban areas increased with the use of Delivery Space Booking | 5,64 | 2,134 | **8,60** | 1,350 |
| 15. I think that the Delivery Space Booking service facilitates my delivery operations | 6,64 | 2,977 | **8,80** | 1,229 |
| 16. After using Delivery Space Booking I like the service | **7,23** | 2,743 | 7,20 | 1,814 |
| 17. I believe the Delivery Space Booking service works properly | **4,93** | 3,362 | **4,70** | 3,093 |
| 18. More I use the Delivery Space Booking service, I feel more apprehensive about it | **5,54** | 3,455 | 7,70 | 1,889 |
| 19. I think that the use of the Delivery Space Booking service has provide me more efficient and controlled delivery practices | 6,57 | 2,709 | 6,90 | 1,969 |
| 20. I believe the rest of the drivers appreciate the Delivery Space Booking service because they will find easier to drive in the city without double lines and trucks parked on the pavement, less stress… | 6,29 | 2,840 | 7,60 | 1,955 |
| 21. I feel safe when I unload the goods using the space obtained by the Delivery Space Booking service | 6,79 | 2,940 | 8,50 | 1,650 |
| 22. Using the Delivery Space Booking service, I consider the driving is more safety | 6,86 | 2,905 | 7,70 | 1,889 |
| 23. I think it is easier to find a free space since I used the Delivery Space Booking service | 6,64 | 2,590 | 7,90 | 1,792 |
| 24. I trust the Delivery Space Booking service | 6,14 | 3,035 | **6,30** | 3,234 |
| 25. I appreciate Delivery Space Booking service because it helps me to reduce fuel consumption | 6,14 | 2,983 | 6,80 | 2,573 |
| 26. I consider that there are more availability space with the Delivery Space Booking service usage | 6,00 | 2,572 | 7,10 | 2,726 |
| 27. I am confident in my ability to drive the truck safely with the Delivery Space Booking service | 6,50 | 2,970 | 7,50 | 1,958 |
| 28. I find the Delivery Space Booking service is easy to use | **7,14** | 2,568 | 6,80 | 3,360 |
| 29. I think the Delivery Space Booking service is effective to reduce double lane stops | 6,93 | 2,973 | 8,10 | 2,183 |
| 30. Delivery Space Booking service reduces the length of travels | 6,29 | 2,894 | **5,20** | 2,573 |

**Table 42 Averages and Standard deviation for questionnaire items (Time1 / Time2).**

Bilbao fleet operators also filled in a specific questionnaire to assess their impressions and perceptions about DSB service in Bilbao. Once again, they answered both questionnaires in two different set of times with the aim of studying if there were differences between Time 1 and Time 2. The structure of questionnaire is similar to drivers' questionnaires.

The tests performed did not reveal any difference statistically significant then only a descriptive study is taking into consideration for all the items.

Sample was composed by 22 participants who answered anonymously and voluntarily both questionnaires. There are twelve organizations that belong to diverse area of businesses: TUSK, VIVA AQUA SERVICE, PATXI SCOOP, CARTONAJES ERABIL, MRW-LEGEMON, SERTRAYCO, UNIALCO, NANUK, AZKAR, DISLOBITZ, MANTEQUERÍAS SANTI, and CARPINTERÍA DE ALUMNIO SAN INAZIO.

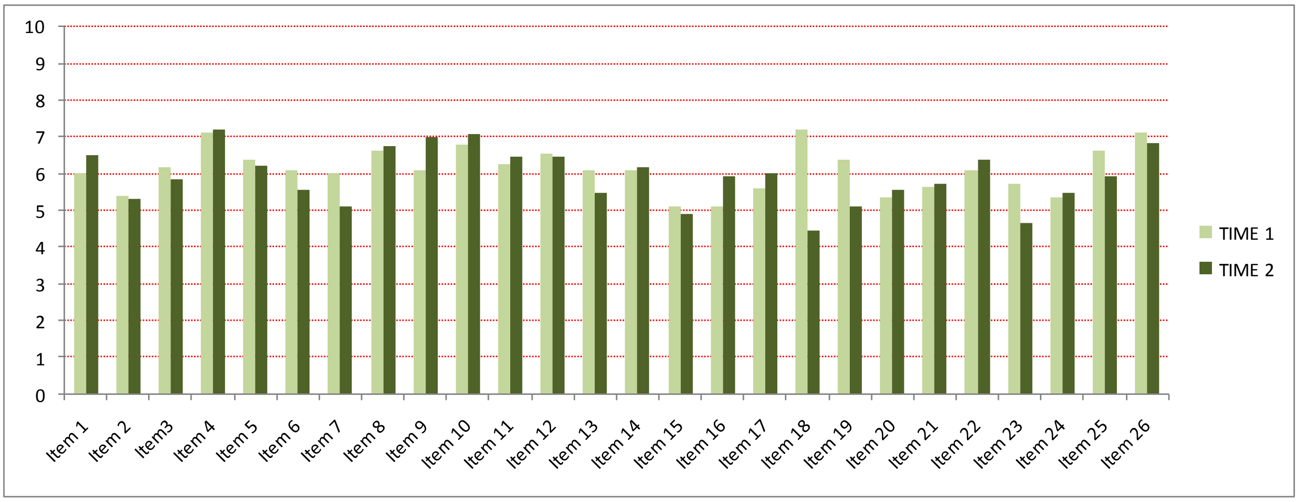



**Figure 52 The same as Figure 51 but for fleet operators.**

Finally, averages and standard deviation for all the items regarding both times is provided in Table 43 and

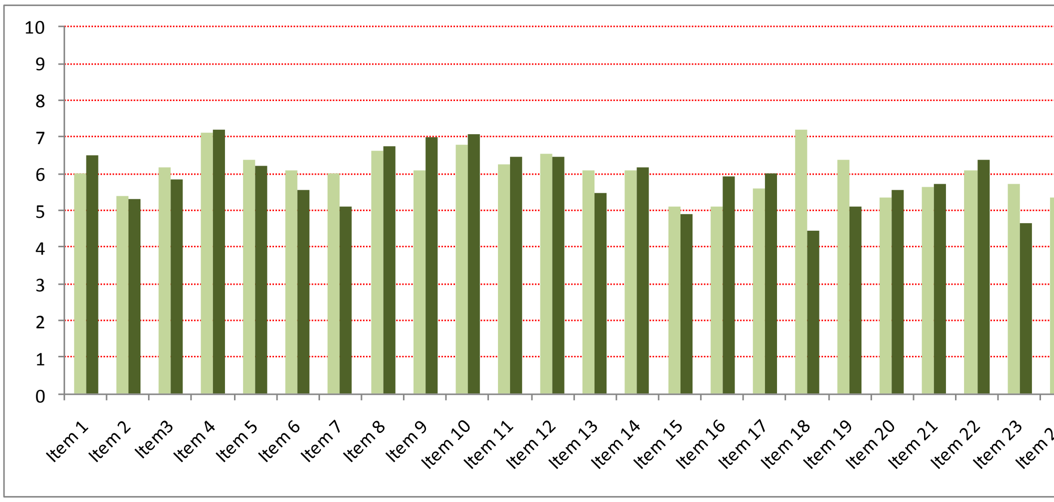



**Figure 52.**

At first questionnaire, the items with highest scores are:

- "When our company unload the goods using the space obtained by Delivery Space Booking service we think that the delivery load is safer" (M=7,18).

- "We believe that the freight transport image in urban areas is improved with the usage of Delivery Space Booking service" (M=7,10).
- "The Delivery Space Booking service facilitates my delivery task because I don't need to look for free spaces" (M=6,64).
- "We find the Delivery Space Booking service is easy to use" (M=6,64).

The items with lowest values are:

- "We perceive that the safety of our drivers increased since I used the Delivery Space Booking service" (M=5,40).
- "More we use the Delivery Space Booking service, we feel more apprehensive about it" (5,10).
- "We think our company distributes more goods in less time since we are using Delivery Space Booking service" (5,10).

At the second questionnaire, the items with highest values are:

- "We believe that the freight transport image in urban areas is improved with the usage of Delivery Space Booking service" (7,18).
- "We consider the Delivery Space Booking service improves the freight image in urban areas because decrease the number of double lane stops" (7,09).
- "We think the Delivery Space Booking service does not disturb our drives in their driving task" (7,00).

The items with lowest values are:

- "More we use the Delivery Space Booking service, we feel more apprehensive about it" (M=4,70)
- "We appreciate Delivery Space Booking service improves the environmental image of our company" (M=4,64)
- "When our company unload the goods using the space obtained by Delivery Space Booking service we think that the delivery load is safer" (M=4,45)

| | First Questionnaire | | Second Questionnaire | |
|---|---|---|---|---|
| Item | Average | Standard Deviation | Average | Standard Deviation |
| 1. Since our company use the Delivery Space Booking service is easier to us to realize the delivery/unloading task | 6,00 | 2,60 | 6,50 | 2,59 |
| 2. We perceive that the safety of our drivers increased since I used the Delivery Space Booking service | **5,40** | 3,09 | 5,30 | 3,26 |
| 3. We think that using the Delivery Space Booking service increases the efficacy of our company work | 6,18 | 3,12 | 5,82 | 3,15 |
| 4. We believe that the freight transport image in urban areas is improved with the usage of Delivery Space Booking service | **7,10** | 2,51 | **7,18** | 2,67 |
| 5. The Delivery Space Booking service facilitates the delivery task of company because our drivers don't need look for free spaces | 6,36 | 3,26 | 6,20 | 2,97 |
| 6. We believe that our company improves the organization and management of urban distribution processes | 6,09 | 3,20 | 5,55 | 3,04 |

| | | | | |
|---|---|---|---|---|
| 7. Our company have less tickets/fines because of double-parked since we used Delivery Space Booking service | 6,00 | 3,55 | 5,09 | 2,77 |
| 8. The Delivery Space Booking service facilitates my delivery task because I don't need to look for free spaces | **6,64** | 2,90 | 6,73 | 2,24 |
| 9. We think the Delivery Space Booking service does not disturb our drives in their driving task | 6,09 | 2,84 | **7,00** | 2,28 |
| 10. We consider the Delivery Space Booking service improves the freight image in urban areas because decrease the number of double lane stops | 6,80 | 2,44 | **7,09** | 2,50 |
| 11. I think the traffic flow gets benefits with the Delivery Space Booking service (the rest of the drivers do not hold up because of double lines, less congestions… | 6,27 | 2,90 | 6,45 | 2,46 |
| 12. After using Delivery Space Booking we like the service | 6,55 | 2,29 | 6,45 | 2,69 |
| 13. We believe the Delivery Space Booking service works properly | 6,09 | 2,11 | 5,45 | 3,32 |
| 14. The image of the city has improved with the use of Delivery Space Booking | 6,09 | 2,50 | 6,18 | 2,22 |
| 15. More we use the Delivery Space Booking service, we feel more apprehensive about it | **5,10** | 3,24 | **4,91** | 3,08 |
| 16. We think our company distributes more goods in less time since we are using Delivery Space Booking service | **5,10** | 3,57 | 5,91 | 2,70 |
| 17. Our company believe the our appreciate the Delivery Space Booking service because they will find easier to drive in the city without double lines and trucks parked on the pavement, less stress… | 5,60 | 3,47 | 6,00 | 2,86 |
| 18. When our company unload the goods using the space obtained by Delivery Space Booking service we think that the delivery load is safer | **7,18** | 1,77 | **4,45** | 3,01 |
| 19. We think our company distributes more goods in less time since we are using Delivery Space Booking service | 6,36 | 2,50 | 5,09 | 3,27 |
| 20. We think it is easier to find a free space for our company since we used the Delivery Space Booking service | 5,36 | 3,04 | 5,55 | 2,62 |
| 21. According our perception, the Delivery Space Booking service improves the environmental image of our company | 5,64 | 2,94 | 5,73 | 2,93 |
| 22. Our company trust the Delivery Space Booking service | 6,09 | 2,94 | 6,36 | 3,07 |
| 23. We appreciate Delivery Space Booking service improves the environmental image of our company | 5,70 | 3,09 | **4,64** | 3,26 |
| 24. We consider that there are more availability space with the Delivery Space Booking service usage | 5,36 | 3,38 | 5,45 | 3,47 |
| 25. We find the Delivery Space Booking service is easy to use | **6,64** | 1,91 | 5,91 | 2,94 |

| | | | | |
|---|---|---|---|---|
| 26. We think the Delivery Space Booking service is effective to reduce double lane stops | 7,10 | 2,84 | 6,82 | 2,82 |

**Table 43 Averages and Standard deviation for questionnaire items (Time1 / Time2).**

Additional information and graphics about the results of Bilbao DSB questionnaires is included in Annex II.

### 3.2.3. Results in Lyon

For the Lyon DSB analysis no GPS traces were produced. However in-situ counting were performed in the rue de la Charité (Figure 53 Charasteristic of the pilot area of Rué de la Charité for DSB Lyon.),3 DSBs,, and in the Croix-Rousse (Figure 54 Characteristic of the pilot area of Croix-Rousse for DSB Lyon.),2 DSBs, neighbourhood.


**Figure 53 Charasteristic of the pilot area of Rué de la Charité for DSB Lyon.**


**Figure 54 Characteristic of the pilot area of Croix-Rousse for DSB Lyon.**

In Lyon's pilot, only 3 carriers were participating, with a total of 3 trucks. Moreover, due to technical problems, the DSB devices in Croix Rousse were not operational. In Charité, the lack of data (less than 20 valid routes inbaseline and less than 15 in pilot) does not make possible a quantitative analyis like in Bilbao. Moreover, only one reservation per day, and not always respected) was made, which is not enough to say the system has a visible effect. For that reason, the only analysis we make is on traffic counting to confirm this fact.

Unfortunately no reservations were recorded during the pilot period of the pilot period in the Croix-Rousse site. Therefore, only the Charité results will be analysed. The baseline period lasted 20 work days. The pilot period lasted 15 work days.

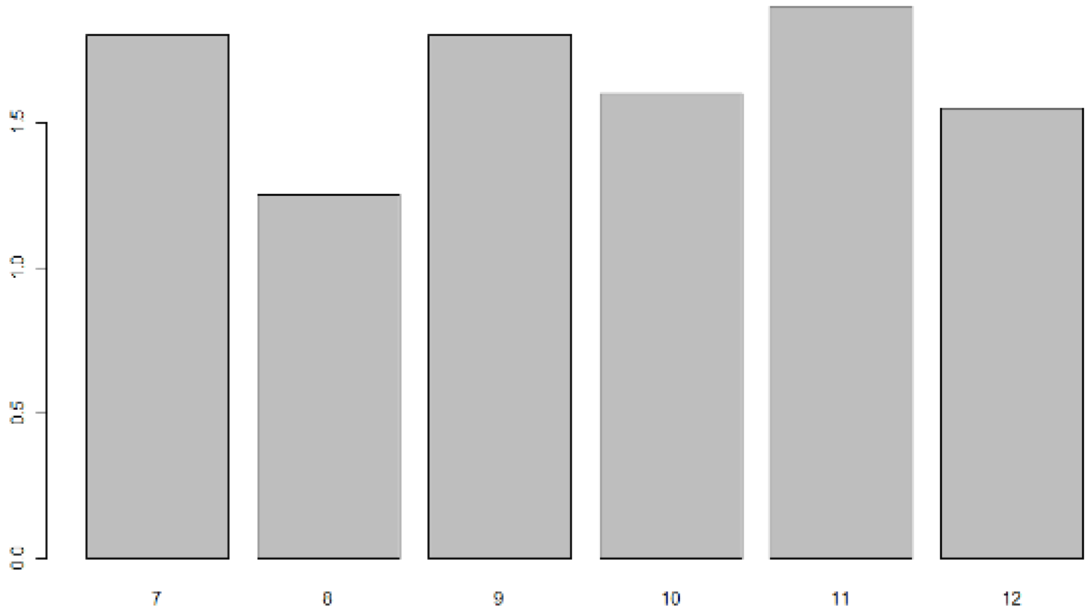



**Figure 55 Average number of pick-up_and_deliveries per hours in DS (baseline).**

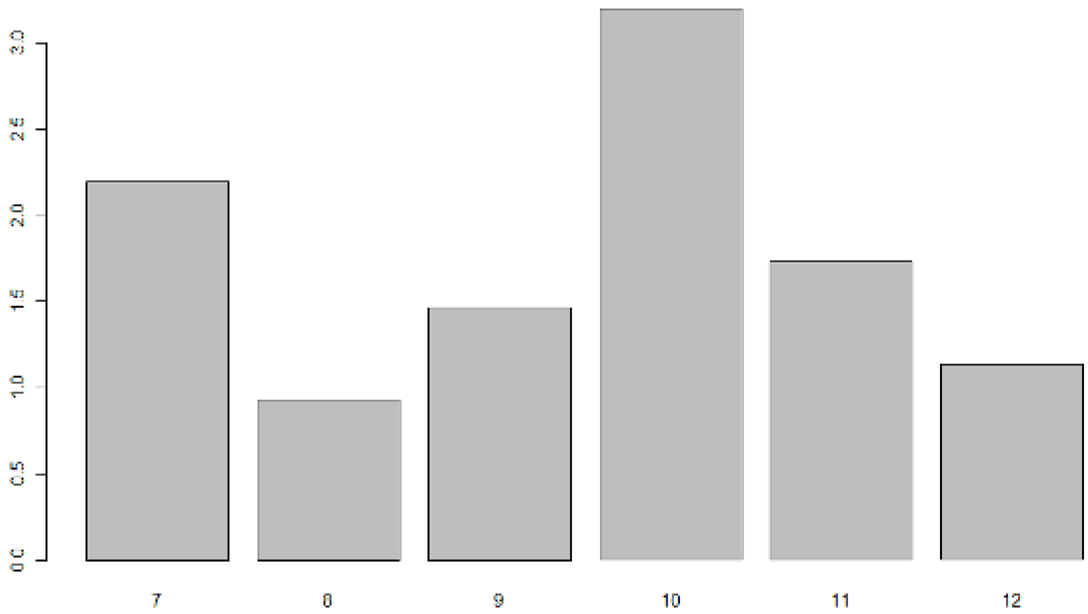



**Figure 56 Average number of pick-up_and_deliveries per hours in DS (pilot).**

We can see from the previous graphs, that during the pilot period, the number of pick-up deliveries in the DS increased significantly.

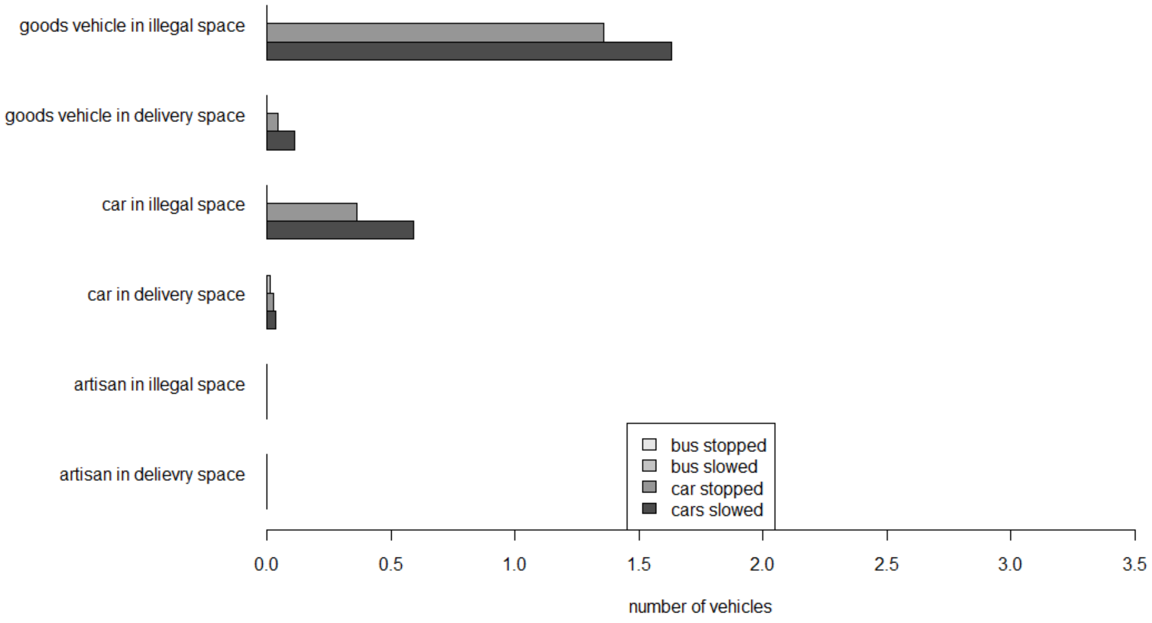



**Figure 57 Average number of vehicles stopped or slowed per hour (baseline).**

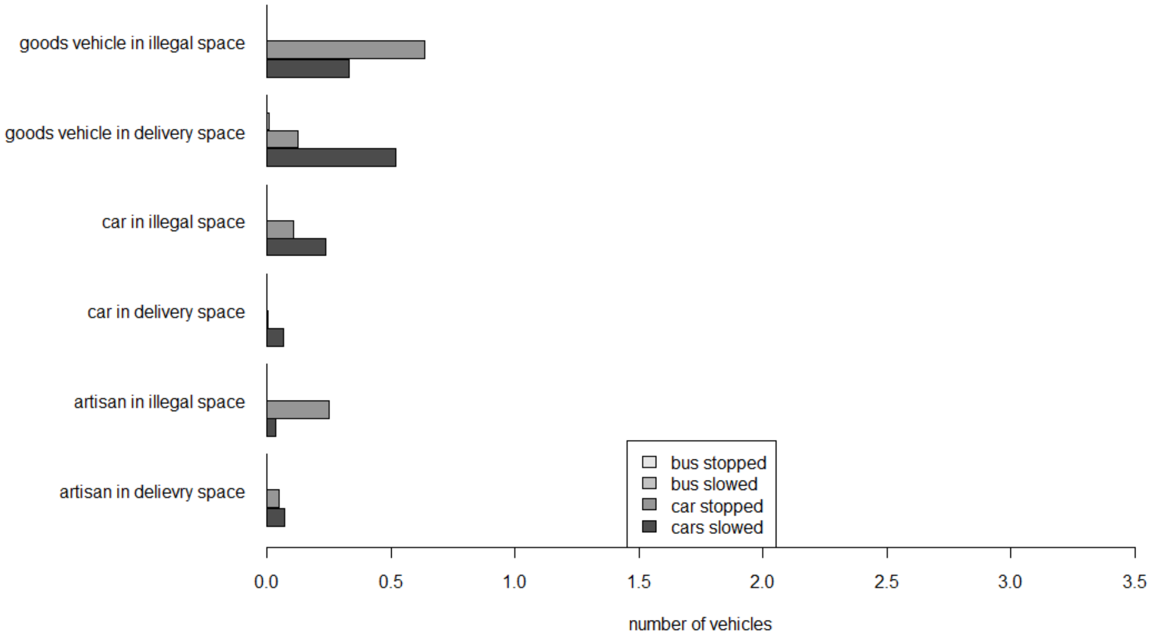



**Figure 58 Average number of vehicles stopped or slowed per hour (pilot).**

We note a significant decrease of vehicles stopped or slowed by goods vehicles in illegal spaces. Other increases can be explained by the facts that works took place during a few days on the rue de la Charité, near the DSBs.

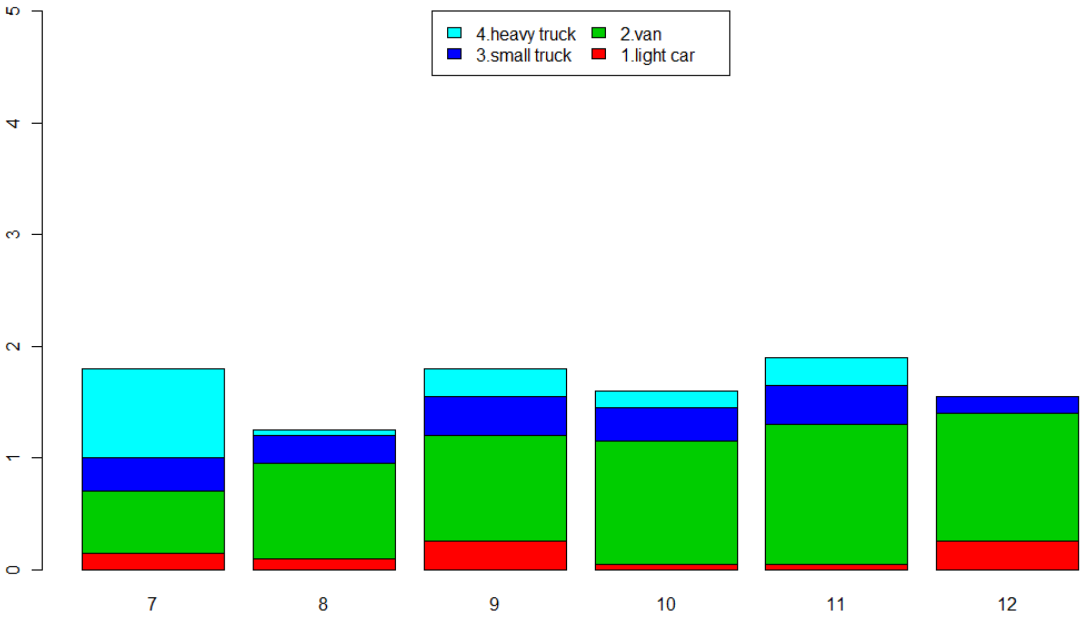



**Figure 59 Average number of goods vehicles in delivery space per hour (baseline)**

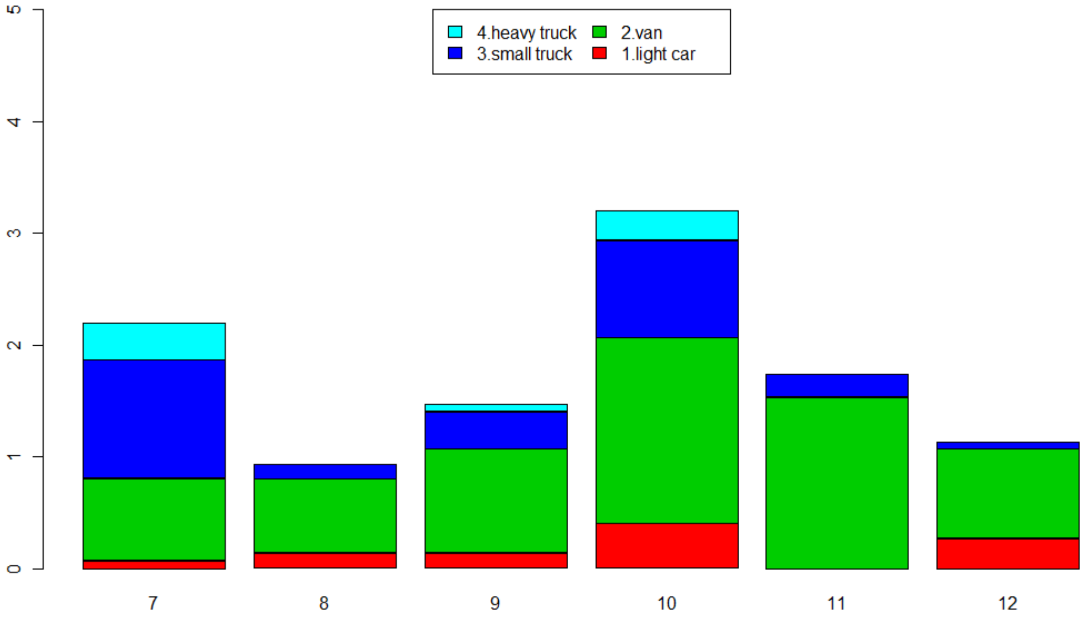



**Figure 60 Average number of goods vehicles in delivery space per hour (pilot)**

The number of deliveries in the delivery space globally increased during the pilot period, with a special increase for vans and small trucks. Data for cars and large trucks are insignificant.

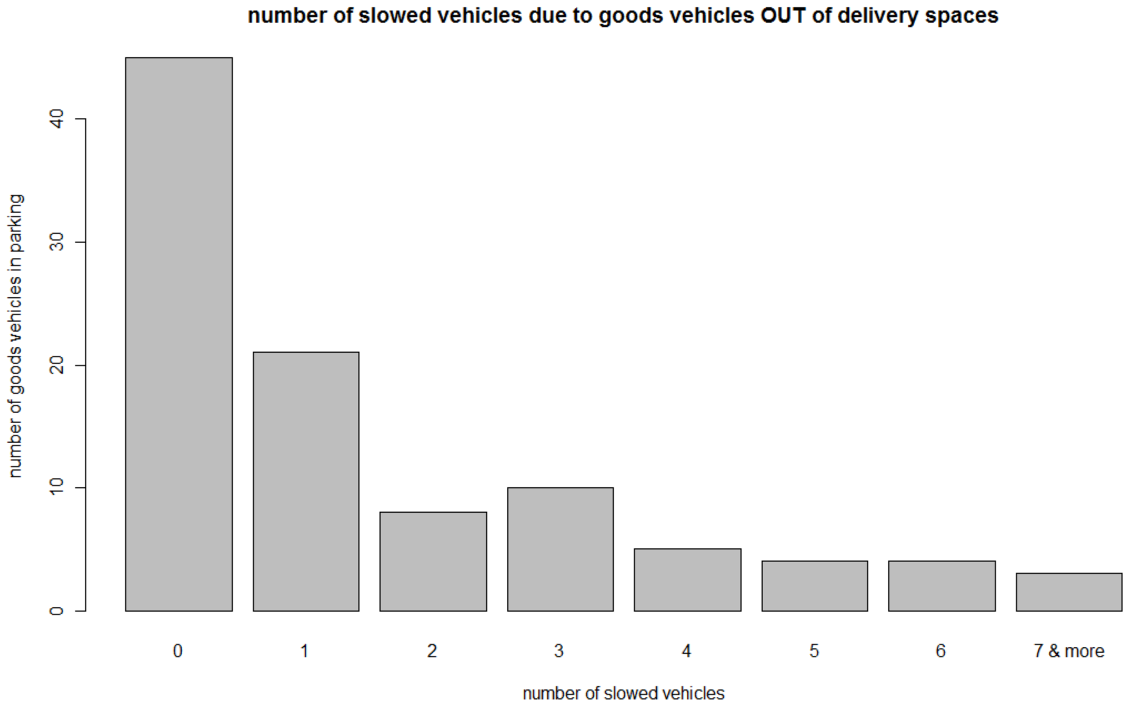



**Figure 61 Number of vehicles slowed during baseline.**

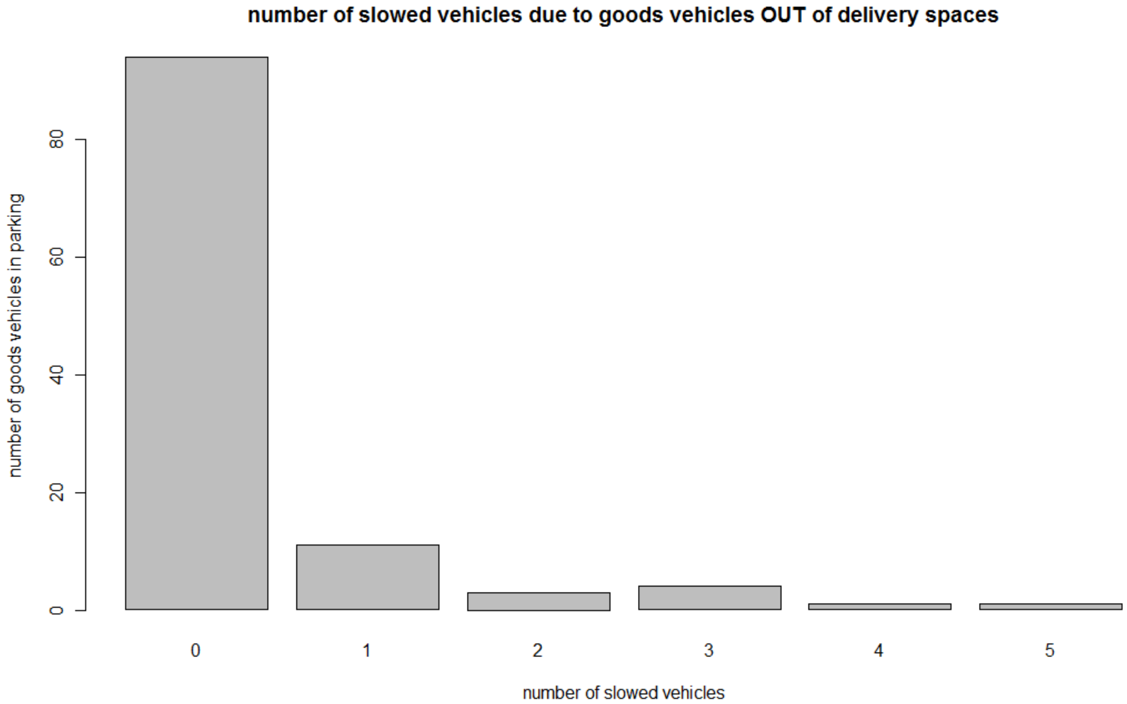



**Figure 62 Number of vehicles slowed during pilot.**

The global number of vehicles slowed due to vehicles out of delivery spaces decreased drastically from the baseline to the pilot period. The distribution of slowed vehicles was clearly moved towards 0, demonstrating the lesser impact of DSB on traffic conditions.

### 3.2.4. Validation of hypothesis and conclusions

Below the results related with the hypotheses proposed are indicated. Results included in Table 44 are extracted from Bilbao pilot site because the number of participants in Lyon is not enough to obtain reliable results. The comments included in Table 45 reference also Bilbao answers, since in Lyon there are not questionnaires. Anyway there are only 4 fleet operators answering the questions.

| T/F | Hypothesis | Comment |
|---|---|---|
| ✗ | Delivery space booking reduces the lengths of delivery journeys | DSB system has not an impact on the average travelled distance (Figure 41 - Figure 45 and Table 28 - Table 31). |
| ✗ | Delivery space booking reduces the time of delivery journeys | An attempt to estimate them from GPS data has been made. However, the data accuracy and the data collection protocol introduce big error sources that make this estimation less precise. Moreover, it seems that the delivery routes in the pilot period have not always the same configuration as those of the baseline, which makes difficult to compare. It can be presumed that the delivery times will present few changes because of the roads and deliveries' characteristics (illegal place to park near intersections, short delivery time), which makes that if a vehicle does not quickly find a place, it is parked on an illegal place without taking time to search. |
| ✗ | Delivery Space Booking service decreases the fuel consumption | No impact on fuel consumption (Figure 46). |
| ✗ | Delivery Space Booking decreases the $CO_2$ emissions | No impact on $CO_2$ emissions (Figure 47). |
| ✗ | Delivery Space Booking decreases the emission of other pollutants | No impact on other pollutans (Figure 47and Figure 48) |
| ✗ | Drivers decreases the double lane stops with the Delivery Space Booking usage | Double lines increase (Table 32 - Table 41) mainly because of big trucks, the most able to use the DSB. However, illegal parking has decreased significantly. |

**Table 44 The same as Table 22 but for DSB.**

| T/F | Hypothesis | Comment |
|---|---|---|
| ✓ | Delivery space booking avoids the need of searching for free spaces | Drivers and fleets operators consider positive the use of the system and also the test confirm the differences are statistically significant. |
| ✓ | Drivers will perceive delivery conditions safer while delivery operations in a dedicated delivery space | The answer of drivers is positive. |
| ✓ | Drivers will perceive that delivery space booking facilitate their delivery operations | The punctuation to the question "I think that using the DSB service increases the efficacy of my work" indicates that the system really improve the work of drivers. |

| | | |
|---|---|---|
| ✓ | Delivery space booking service is appreciated by drivers | DSB service is positively appreciated by drivers and fleets operators, specially to the scores to the question “After using DSB, I like the service”. |
| ✗ | Drivers will perceive that delivery space booking service is reliable | Drivers and fleets operators think the DSB service is very effective to reduce double lane stops but they do not believe the service works properly. |
| ✓ | Delivery space booking service will not disturb driver in his driving task | Drivers and fleets operators do not see at all the DSB service as a service that disturbs the driver in his driving task. |
| ✓ | Drivers will find the delivery space booking system easy to use | In general, all the drivers find the DSB system easy to use. |
| ✓ | Drivers' stress perception will decrease with the delivery space booking usage | Really the use of DSB system decreases drivers’ stress perception. |
| ✓ | Perceived risk of accidents will decrease with the delivery space booking usage | Using the DSB service, drivers consider their driving is more safety. |
| ✓ | According to the driver perception the delivery space booking system will improve of freight transport image in urban areas | After using the DSB system drivers and fleets operators consider the system improves of freight transport image in urban aereas. |
| ✓ | Drivers will trust the delivery space booking service | Confidence of drivers in DSB system is positive. |
| ✓ | Drivers consider that there are more availability space with the delivery space booking usage | Punctuations regarding the questions about this hypothesis are positive for drivers and fleets operators. |
| ✓ | The rest of the drivers will appreciate the delivery space booking system because they will find easier to drive in the city without double lines and trucks parked on the pavement , less stress | In general, drivers and fleets operators value the DSB service positively because the system facilitates driving in the city. |
| ✓ | The traffic flow gets benefits with the delivery space booking (the rest of the drivers do not hold up because of double lines, less congestions) | Drivers and fleets operators consider DSB improves the traffic flow. |
| ✓ | Less tickets (fines) because of double lines | Since they use DSB service, the drivers have less tickets /fines because of double lines. |

**Table 45 The same as Table 23 but for DSB.**

## 3.3. In-Vehicle Services

### 3.3.1. Analysis Methodology

The three-step methodology followed for evaluating the results of the FREILOT in-vehicle technologies is described below.

1. Collection of all the txt files of all trucks and creation of the database with all the collected raw data.
2. First filtering and logical checks of the raw data and processing of the data for the final analyses.
3. Second filtering and logical tests of the processed data and execution of the final analyses for obtaining the pilot results.

In the first step all txt files (Figure 63) are collected every day from all the trucks by VOLVO-RENAULT and uploaded to their data server. The name of the file contains the following data: Date, City id, System id, Truck id and Company id.

| | | | |
|---|---|---|---|
| 2011-04-04_IDCity_4_IDSystem_4_IDTruck_BT-DB-24_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:36 μμ | Text Document | 139 KB |
| 2011-04-04_IDCity_4_IDSystem_4_IDTruck_BT-NZ-86_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:36 μμ | Text Document | 131 KB |
| 2011-04-04_IDCity_4_IDSystem_4_IDTruck_BT-NZ-87_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:36 μμ | Text Document | 121 KB |
| 2011-04-04_IDCity_4_IDSystem_4_IDTruck_BV-JT-43_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:36 μμ | Text Document | 67 KB |
| 2011-04-05_IDCity_4_IDSystem_4_IDTruck_BT-DB-24_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:38 μμ | Text Document | 190 KB |
| 2011-04-05_IDCity_4_IDSystem_4_IDTruck_BT-NZ-86_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:38 μμ | Text Document | 185 KB |
| 2011-04-05_IDCity_4_IDSystem_4_IDTruck_BT-NZ-87_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:39 μμ | Text Document | 160 KB |
| 2011-04-05_IDCity_4_IDSystem_4_IDTruck_BV-JT-43_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:39 μμ | Text Document | 75 KB |
| 2011-04-06_IDCity_4_IDSystem_4_IDTruck_BT-DB-24_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:41 μμ | Text Document | 220 KB |
| 2011-04-06_IDCity_4_IDSystem_4_IDTruck_BT-NZ-86_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:41 μμ | Text Document | 187 KB |
| 2011-04-06_IDCity_4_IDSystem_4_IDTruck_BT-NZ-87_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:41 μμ | Text Document | 149 KB |
| 2011-04-06_IDCity_4_IDSystem_4_IDTruck_BV-JT-43_IDCompany_VAN-DEN-BROEK.txt | 29/4/2011 3:41 μμ | Text Document | 86 KB |

**Figure 63 Example of the database sample with the txt files collected from the trucks.**

The data collected in each txt file depends on the trigger and is presented in Figure 64.

```
driverId:000239336000000
trigger:EDS
time:2011-04-04 09:35:42
IDLE_FUEL:0.050000
IDLE_TIME:82
ACC_PED_RESULT:60.700000
ACC_SFT_RESULT:100.000000
STD_SFT_RESULT:100.000000
HRD_BRK_RESULT:98.200000
TARGET_FUEL_CONS:40.630000
FUEL_CONS:42.050000
TOTAL_DISTANCE:2063
ACCEL_DISTANCE:699
STD_DISTANCE:1004
DECEL_DISTANCE:379
ACCEL_FUEL:0.530000
STD_FUEL:0.260000
DECEL_FUEL:0.020000
FUEL_CONS_MOV:39.620000
SPEED_MOV:34.410000
SPEED:24.950000
FUEL_LOSS:0.020000
FUEL_LOSS_PRCTG:3.300000
TOTAL_FUEL:0.870000
ACCEL_TIME:75
DECEL_TIME:48
STD_TIME:93
ACCEL_ACC_PED_POS:64.510000
ACCEL_ENGINE_SPEED:1256.000000
ACCEL_ENGINE_TORQUE:58.880000
STD_ENGINE_SPEED:1021.000000
STD_ENGINE_TORQUE:27.880000
DECEL_HRD_BRK:0.603000
```

```
driverId:NONE
trigger:PERIODIC / 120
time:2011-04-04 08:36:00
POSITION_LATITUDE:52.399754
POSITION_LONGITUDE:4.810536
POSITION_ALTITUDE:-50.000000
POSITION_HEADING:89.000000
SPEED:8.000000
LOV_VEHICLE_DISTANCE:337391200
TOTALFUEL_USED:105990.796875
BRAKE_COUNT:16356
STOP_COUNT:3962

driverId:NONE
trigger:PERIODIC / 120
time:2011-04-04 08:38:00
POSITION_LATITUDE:52.397079
POSITION_LONGITUDE:4.806801
POSITION_ALTITUDE:-8.000000
POSITION_HEADING:159.000000
SPEED:50.000000
LOV_VEHICLE_DISTANCE:337391968
TOTALFUEL_USED:105991.367188
BRAKE_COUNT:16363
STOP_COUNT:3963
```

```
driverId:000111969000000
trigger:DRIVER_LOGIN
time:2011-04-04 16:54:39
LOV_VEHICLE_MOVING_FUEL:98033.578125
LOV_VEHICLE_MOVING_TIME:20428292
LOV_VEHICLE_DISTANCE:322490848
TOTALFUEL_USED:101800.226563
BRAKE_COUNT:11334
STOP_COUNT:3365
AL_MAPD_ACTIVE_DISTANCE:299940224
AL_MAPD_ACTIVE_FUEL:2547.800049
AL_MAPD_ACTIVE_TIME:648582720

driverId:000111969000000
trigger:DRIVER_LOGOUT
time:2011-04-04 17:06:12
LOV_VEHICLE_MOVING_FUEL:98033.679688
LOV_VEHICLE_MOVING_TIME:20428324
LOV_VEHICLE_DISTANCE:322491008
TOTALFUEL_USED:101800.507813
BRAKE_COUNT:11342
STOP_COUNT:3369
AL_MAPD_ACTIVE_DISTANCE:299940416
AL_MAPD_ACTIVE_FUEL:2548.079834
AL_MAPD_ACTIVE_TIME:1950319488
```

```
driverId:000254158000000
trigger:ZONE_ENTRY / 4151
time:2011-04-06 04:23:46
LOV_VEHICLE_MOVING_FUEL:81824.140625
LOV_VEHICLE_MOVING_TIME:17198398
LOV_VEHICLE_DISTANCE:266263552
TOTALFUEL_USED:85707.101563
BRAKE_COUNT:12569
STOP_COUNT:3758
SL_VALUE:255.000000

driverId:000254158000000
trigger:ZONE_EXIT / 4151
time:2011-04-06 04:25:50
LOV_VEHICLE_MOVING_FUEL:81824.750000
LOV_VEHICLE_MOVING_TIME:17198500
LOV_VEHICLE_DISTANCE:266264608
TOTALFUEL_USED:85707.718750
BRAKE_COUNT:12572
STOP_COUNT:3759
SL_VALUE:255.000000
```

**Figure 64 Samples of the raw data of the txt files. From left to right: a) EDS data, b) periodic data, c) driver login-logout data and d) zone entry-exit data.**

The data recorded by the EDS logger (Figure 64a) contains basically the scores of the driver for the whole cycle, the distance, the time and the fuel consumption of each phase of the cycle. The four scores are related to the acceleration (pedal and shift), to the steady phase and to the breaking behavior of the driver. In this case the event definition is a whole cycle composed by 4 phases (acceleration, steady, breaking and idle).

The data recorded by the Periodic logger (Figure 64b) contains the position of the truck and general data of the truck such as instantaneous speed, total distance, total fuel, break and stop counters. The event in this case has duration of two minutes, and the consumed fuel, the distance travelled and the number of breaks and stops are obtained by the difference of the total values before and after the event.

The data recorded by the driver login-logout (Figure 64c) contains the same total counters described above for the Periodic logger (distance, fuel consumption, brake and stops), but it also contains special counters related to the moving distance and fuel or to active, limiting and overridden distance and fuel. The event in this case is defined by the driver login-logout, having higher durations than the other two loggers defined above. It represents the whole daily driving period of the driver.

Finally, the zone entry-exit logger (Figure 64d) has exactly the same data commented for the driver login-logout logger, but it is logged each time the driver enters or leaves a zone. The event definition in this case is the time within the zone.

For the rest of the document the word event will be used for describing any of the four events definition presented above, depending on the system. The analysis have two parts, a first part where the fuel reduction is Analysed and a second part where the utilization of the system is Analysed, trying to link the fuel consumption reduction (or increase) to the utilization (or not) of the system. For the EDS the event used is the EDS cycle, since there is data related to the utilization of the system (the scores) and to the fuel consumption. For the other two systems the Periodic data is used for obtaining fuel consumption (average values for the two minute periods) while the other two loggers (driver login-logout and zone entry-exit, with higher duration) are used for analyzing the utilization of the system during the same period.

The FREILOT database is created from all the raw data of all the txt files. Different tables for different triggers and systems are created. This database contains more than 16.000 files with a total of 4.500.000 events. In the second step all raw data is Analysed, filtered and formatted for standardizing it before the final analysis. After the formatting phase the data is processed in pairs for the triggers zone entry-exit, driver login-logout and the periodic one for obtaining the different values in each interval. For the EDS trigger, data is already a formatted data “pair” since it calculates the data related to each cycle. The new database contains the values of the different parameters and variables presented above for each interval (2 minutes for the periodic trigger, time within the zone for the zone entry-exit, driving time for the driver login-logout and cycle duration for the EDS). The filters of this phase are used for deleting wring data entries, very short events on inconsistent entries. In the third step these new database is filtered and not desired values are deleted (e. g. very small cycles with moving distance 0 or false zone entry / driver login due to a restart on the machine). The new database is processed by truck, system and period for the final analyses presented below.

### 3.3.2. AL

The methodology followed for analyzing the AL data files is applied to each truck and presented below. The event used in this case is the two minute period for the calculation of the fuel consumption reduction and the driver login-logout for the system utilization.

- Analysis of the data of all trucks in all periods: number of events, distance, fuel consumption and time are calculated
- Identification of the principal drivers and the truck utilization for the selected drivers
    - Percentage of distance covered by each drivers per period: the aim of this analysis is to select the principal drivers that have significantly used the system, i.e. with a percentage of total distance over 10%
    - Number of events, distance, average moving fuel consumption, average speed, average scores per day: the aim of this analysis is to understand the truck utilization and to control how regular it is during the whole pilot. It should be noticed that the average speed and fuel consumption parameters include stops.

- Distribution of distance in each speed range: this analysis permits to understand the use of the truck (urban, suburban or long haul). This speed profile is very important for the presented analysis since the fuel consumption depends on the speed. In order to have comparable data, the speed profiles should be similar, reducing in this way the uncertainty of the fuel consumption due to the difference of distance repartition. Two distributions of speed ranges are used in the deliverable: from 0 to 100 km/h with 10 km/h steps (all events which speed is comprised between S and S+10 km/h); from 0 to 100 km/h in three steps, 0-30 km/h (urban), 30-50 km/h (suburban) and 50-100 km/h (interurban). This last speed profile is used for the Business Models.

- Comparison of the number of events, distance, fuel consumption, time, brake and stop between periods per speed range for the selected drivers: the aim of the comparison is to check, if there are any deviations between periods which could mean that the truck has been used in different routes with consequences on the evaluation (all period characteristics must be consistent during the pilot).
- Percentage of distance covered in zones and outside of the zones (for the acceleration maps working in concrete zones) for the selected drivers: this analysis provides the zones have been used during the pilot and the percentage of distance covered. Zones where the percentage is low will give results with high uncertainty (in the example, zone 3170).
- Fuel consumption, limitations and overridden profiles for the selected drivers: in the case of the AL, the system performance can be depicted by the evolution of the limitations during the pilot. Not only the number of activations but also the fuel consumption and the distance covered during limitation should be analyzed. The fuel saving is only a part (order of magnitude 5%) of the fuel consumed during limitation. On another hand, during overridden, the truck over consumes, so this situation must also be taken into account to understand the complete balance. This analysis gives the fuel savings per 10 km/h speed range. It should be noticed that it is difficult to characterize and analyze the speed range 0-10 km/h due to the uncertainty of the processes at very low speeds. Because of this there will be enormous variation during the analyses for this speed range, but the effects on the total fuel consumption are insignificant due to the low quantity of fuel consumption at this speed in relation to the total fuel consumption.
  In order to provide global values the fuel consumption of each speed range is applied to the global speed profile for obtaining the average fuel consumption of the whole period (independent of the speed). The fuel saving' values are corrected in this way with the reference of the overall distribution of distance (all selected drivers and all periods). This correction is done in order to have comparable values.
  The corrected fuel consumption is given by the equation: $\sum_{S=0}^{S=9} d_{S,S+10} \Delta FC_{S,S+10}$
  Where $d_{S,S+10}$ is the percentage of distance in the speed range [S,S+10] and $\Delta FC_{S,S+10}$ is variation of fuel consumption in the speed range [S,S+10].
- Results
  - Fuel consumption: the difference between periods is expressed with the speed ranges used for the Business Models. The methodology is the same, but using different speed ranges. Absolute and relative fuel reduction consumptions for the two periods are calculated. The absolute value is the fuel consumption reduction of each speed range, while the relative value is the reduction of total fuel consumption for all the speed ranges due to the events occurred at each speed range.
  - Number of limitations and overridden distance per 100 km: there are calculated from the Login-Logout data. It gives an indication of how the system works (limiting or overridden situations) and the fuel consumption involved during these phases. As the fuel savings are a part of the fuel consumption during limitation (5% in average estimated from calibrations).

An example of the above methodology is detailed in Annex III. It is applied to all trucks in order to have different results depending on the use of the truck. General results are presented below, while detailed results for each truck are presented in Annex III.

#### 3.3.2.1. Results in Bilbao

- B04 / Bilbao / Nanuk / 8594-GHY

AL was activated in period 2.

| DriverID | *Period* | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | *Total* |
| E03095687W000010 | 42% | 46% | 30% | *40%* |
| E03110308H000000 | 18% | 46% | 17% | *24%* |
| E08995819J000000 | 22% | 2% | 0% | 13% |

**Table 46 Distribution of distance between drivers for each period**

Driver E08995819J000000 is excluded from the evaluation due to the low distances in periods 1 and 2.

| Speed range | *DriverID* | | |
|---|---|---|---|
| | E03090857W000010 | E03110308H000000 | *All drivers* |
| 0-30 | 1% | 1% | *1%* |
| 30-50 | 2% | 3% | *2%* |
| 50-100 | 97% | 96% | 97% |

**Table 47 Distribution of distance per speed range for each driver**

| Speed range | *Period* | |
|---|---|---|
| | 1 | *2* |
| 0-30 | 0,1% | *0,1%* |
| 30-50 | 0,0% | *0,0%* |
| 50-100 | 2,7% | *1,9%* |
| **0-100** | **2,8%** | **2,0%** |

**Table 48 Relative fuel consumption variation per speed range and period**

| Speed range | *Period* | |
|---|---|---|
| | 1 | *2* |
| 0-30 | 6,5% | *6,0%* |
| 30-50 | 0,1% | *0,6%* |
| 50-100 | 2,8% | *2,0%* |
| **0-100** | **2,8%** | **2,0%** |

**Table 49 Absolute fuel consumption variation per speed range and period**

| | Total | Limiting | *Overridden* |
|---|---|---|---|

| Period | Fuel cons. | Count | Distance | Fuel | Count | Distance | *Fuel cons.* |
|---|---|---|---|---|---|---|---|
| | (l/100km) | (-/100km) | (km/100km) | (l/100km) | (-/100km) | (km/100km ) | *(l/100km)* |
| 0 | 27,3 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 1 | 27,6 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 2 | 27,4 | 12 | 0,0 | 0,0 | 1 | 0,3 | 0,3 |

**Table 50 Distance and fuel consumption in limiting and overridden situations per period**

Conclusion

- 2 principal drivers; both in long haulage utilization
- In the speed ranges 0-50 km/h, the fuel consumption increase can be considered as noise in the data due to the very low mileage covered; in the speed range 50-100 km/h, since there are some conditions that are not measured and can have an impact on the results (load factor, congestion levels, road slopes), such a small percentage of fuel consumption variation can be considered as normal uncertainty
- Some limitations but on very short distance with negligible impact on fuel consumption; a single overridden with negligible impact on fuel consumption

- B05 / Bilbao / Nanuk / 8602-GHY

AL was activated in period 1 and period 2.

| DriverID | *Period* | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | *Total* |
| E03076129V000000 | 0% | 46% | 46% | *46%* |
| E03104242R000000 | 0% | 49% | 40% | 41% |

**Table 51 Distribution of distance between drivers for each period**

Second selected driver changed of driverID during the pilot; driverID corresponds to E03104242R000000 + E03104242R000001.

| Speed range | *DriverID* | | |
|---|---|---|---|
| | E03076129V000000 | E03104242R000000 | *All drivers* |
| 0-30 | 1% | 1% | *1%* |
| 30-50 | 2% | 2% | *2%* |
| 50-100 | 97% | 96% | 97% |

**Table 52 Distribution of distance per speed range for each driver**

| Speed range | *Period* | |
|---|---|---|
| | 1 | *2* |
| 0-30 | - | *0,0%* |
| 30-50 | - | *0,0%* |
| 50-100 | - | *-2,2%* |
| **0-100** | **-** | **-2,2%** |

**Table 53 Absolute fuel consumption variation per speed range and period**

| Speed range | *Period* |
|---|---|

| | 1 | *2* |
|---|---|---|
| 0-30 | - | *-0,6%* |
| 30-50 | - | *0,8%* |
| 50-100 | - | *-2,3%* |
| **0-100** | **-** | **-2,2%** |

**Table 54 Relative fuel consumption variation per speed range and period**

| Period | Total | Limiting | | | *Overridden* | | |
|---|---|---|---|---|---|---|---|
| | Fuel cons. | Count | Distance | Fuel | Count | Distance | *Fuel cons.* |
| | (l/100km) | (-/100km) | (km/100km) | (l/100km) | (-/100km) | (km/100km) | *(l/100km)* |
| 0 | 26,7 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 1 | 27,8 | 9 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 2 | 27,1 | 4 | 0,0 | 0,0 | 0 | 0,0 | 0,0 |

**Table 55 Distance and fuel consumption in limiting and overridden situations per period**

Conclusion

- 2 principal drivers; both in long haulage utilization
- In the speed ranges 0-50 km/h, the fuel consumption variation can be considered as noise in the data due to the very low mileage covered; in the speed range 50-100 km/h, since there are some conditions that are not measured and can have an impact on the results (load factor, congestion levels, road slopes), such a small percentage of fuel consumption variation can be considered as normal uncertainty
- Some limitations but on very short distance with negligible impact on fuel consumption; no overridden

#### 3.3.2.2. Results in Helmond

- H14 / Helmond / Van Den Broek / BT-BR-21

AL was activated in period 1

| DriverID | *Period* | | |
|---|---|---|---|
| | 0 | 1 | *Total* |
| 111969000000 | 98% | 75% | 82% |

**Table 56 Distribution of distance between drivers for each period**

| Speed range | *% of distances* |
|---|---|
| 0-30 | *9%* |
| 30-50 | *15%* |
| 50-100 | 76% |

**Table 57 Distribution of distance per speed range for driver (111969000000)**

| Speed range | *Period* |
|---|---|

| | *1* |
|---|---|
| 0-30 | *0,4%* |
| 30-50 | *-0,4%* |
| 50-100 | *6,4%* |
| **0-100** | **6,4%** |

**Table 58 Absolute fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *3,8%* |
| 30-50 | *-2,7%* |
| 50-100 | *8,5%* |
| **0-100** | **6,4%** |

**Table 59 Relative fuel consumption variation per speed range and period**

| **Period** | **Total** | **Limiting** | | | ***Overridden*** | | |
|---|---|---|---|---|---|---|---|
| | **Fuel cons.** | **Count** | **Distance** | **Fuel** | **Count** | **Distance** | ***Fuel cons.*** |
| | **(l/100km)** | **(-/100km)** | **(km/100km)** | **(l/100km)** | **(-/100km)** | **(km/100km)** | ***(l/100km)*** |
| 0 | 30,7 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 1 | 30,2 | 0 | 0,0 | 0,0 | 0 | 0,0 | 0,0 |

**Table 60 Distance and fuel consumption in limiting and overridden situations per period**

Conclusion

- 1 principal driver in suburban utilization
- Important fuel consumption increase which can be caused by variations load factors and routes that haven't been measured
- No limitation; no overridden (no impact on fuel consumption)

- H16 / Helmond / Van Den Broek / BT-DB-24

AL activated in period 1

| **DriverID** | ***Period*** | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 239336000000 | 78% | 22% | 39% |

**Table 61 Distribution of distance between drivers for each period**

| **Speed range** | ***% of distance*** |
|---|---|
| 0-30 | *7%* |
| 30-50 | *12%* |
| 50-100 | 81% |

**Table 62 Distribution of distance per speed range for driver 239336000000**

| **Speed range** | ***Period*** |
|---|---|
| | *1* |
| 0-30 | *0,3%* |
| 30-50 | *0,1%* |
| 50-100 | *-0,4%* |
| **0-100** | **0,0%** |

**Table 63 Absolute fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *4,7%* |
| 30-50 | *0,6%* |
| 50-100 | *-0,4%* |
| **0-100** | 0,0% |

**Table 64 Relative fuel consumption variation per speed range and period**

| **Period** | **Total** | **Limiting** | | | ***Overridden*** | | |
|---|---|---|---|---|---|---|---|
| | **Fuel cons.** | **Count** | **Distance** | **Fuel** | **Count** | **Distance** | ***Fuel cons.*** |
| | **(l/00km)** | **(-/100km)** | **(km/100km)** | **(l/100km)** | **(-/100km)** | **(km/100km)** | ***(l/100km)*** |
| 0 | 31,9 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 1 | 32,0 | 0 | 0,0 | 0,0 | 0 | 0,0 | 0,0 |

**Table 65 Distance and fuel consumption in limiting and overridden situations per period**

Conclusion

- 1 principal driver in suburban utilization
- No variation of fuel consumption
- No limitation; no overridden (no impact on fuel consumption)

#### 3.3.2.2.1 Questionnaires

Three drivers answered the items about this system (see Annex 1); items had values between three and ten points.

Driver 2 was the driver with had the best positive perception about Acceleration Limiter: his answers are valued between seven and ten points. This driver provided the highest value (10 points) to the next items:

- I trust the Acceleration Limiter service
- After using Acceleration Limiter I like the service

- More I use the Acceleration Limiter service, I feel less stressed
- I think I have achieved a higher driving comfort using Acceleration Limiter service
- I think The Acceleration Limiter is effective to not exceed the speed limitations
- I accept increase on journey duration as a trade off to decreased fuel consumption

The other two drivers had a more negative perception of the system. They are more critical. The two items with the lowest values for these drivers are:

- I trust the Acceleration Limiter service
- It is simple to identify the functions of the Acceleration service

Additional information about the questionnaires is included in Annex III.

#### 3.3.2.3. Results in Lyon

- L22 / Lyon / STEF / BE-154-BY

AL activated in period 1.

| **DriverID** | ***Period*** | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 1000000111818000 | 34% | 55% | *44%* |
| 1000000021809000 | 20% | 27% | *23%* |
| 1000000022504000 | 27% | 0% | 14% |

**Table 66 Distribution of distance between drivers for each period**

Driver 1000000022504000 is excluded due to the low distances in period 1.

| **Speed range** | ***DriverID*** | | |
|---|---|---|---|
| | **1000000111818000** | **1000000021809000** | ***All drivers*** |
| 0-30 | 2% | 20% | *8%* |
| 30-50 | 6% | 26% | *13%* |
| 50-100 | 92% | 54% | 79% |

**Table 67 Distribution of distance per speed range for each driver**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *0,6%* |
| 30-50 | *-0,1%* |
| 50-100 | *-0,9%* |
| **0-100** | **-0,4%** |

**Table 68 Absolute fuel consumption variation per speed range and period**

| Speed range | *Period* |
|---|---|
| | ***1*** |
| 0-30 | *23,3%* |
| 30-50 | *-1,4%* |
| 50-100 | *-1,0%* |
| 0-100 | -0,4% |

**Table 69 Relative fuel consumption variation per speed range and period**

| Period | Total | Limiting | | | *Overridden* | | |
|---|---|---|---|---|---|---|---|
| | Fuel cons. | Count | Distance | Fuel | Count | Distance | *Fuel cons.* |
| | (l/100km) | (-/100km) | (km/100km) | (l/100km) | (-/100km) | (km/100km) | *(l/100km)* |
| 0 | 33,5 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 1 | 33,8 | 0 | 0,0 | 0,0 | 3 | 0,2 | 0,2 |

**Table 70 Distance and fuel consumption in limiting and overridden situations per period**

Conclusion

- 2 principal drivers; driver 1000000021809000 in suburban utilization and driver 1000000111818000 in haulage utilization
- Small impact on fuel consumption (noise)
- No limitation; few overridden

- L24 / Lyon / STEF / BE-444-FG

AL activated in period 1

| DriverID | *Period* | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 1000000022506000 | 67% | 21% | *46%* |
| 1000000139419000 | 6% | 40% | *22%* |
| 1000000420072000 | 14% | 16% | 15% |

**Table 71 Distribution of distance between drivers for each period**

| Speed range | *DriverID* | | | |
|---|---|---|---|---|
| | **1000000022506000** | **1000000139419000** | **1000000420072000** | ***All drivers*** |
| 0-30 | 10% | 10% | 10% | *10%* |
| 30-50 | 21% | 17% | 18% | *19%* |
| 50-100 | 69% | 73% | 72% | 71% |

**Table 72 Distribution of distance per speed range for each driver**

| **Speed range** | ***Period*** |
|---|---|
| | *1* |
| 0-30 | *0,4%* |
| 30-50 | *-0,6%* |
| 50-100 | *-1,2%* |
| **0-100** | **-1,4%** |

**Table 73 Absolute fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *4,5%* |
| 30-50 | *-3,2%* |
| 50-100 | *-1,7%* |
| **0-100** | **-1,4%** |

**Table 74 Relative fuel consumption variation per speed range and period**

| **Period** | **Total** | **Limiting** | | | ***Overridden*** | | |
|---|---|---|---|---|---|---|---|
| | **Fuel cons.** | **Count** | **Distance** | **Fuel** | **Count** | **Distance** | ***Fuel cons.*** |
| | **(l/100km)** | **(-/100km)** | **(km/100km)** | **(l/100km)** | **(-/100km)** | **(km/100km)** | ***(l/100km)*** |
| 0 | 32,9 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 1 | 32,2 | 0 | 0,0 | 0,0 | 0 | 0,0 | 0,0 |

**Table 75 Distance and fuel consumption in limiting and overridden situations per period**

Conclusion

- 3 principal drivers in suburban utilization
- Small impact on fuel consumption (noise)
- No limitation; few overridden

- L25 / Lyon / STEF / BE-794-BW

AL activated in period 1

| **DriverID** | ***Period*** | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 1000000012987000 | 82% | 44% | 58% |

**Table 76 Distribution of distance between drivers for each period**

| **Speed range** | ***% of distances*** |
|---|---|
| 0-30 | *9%* |
| 30-50 | *21%* |
| 50-100 | 71% |

**Table 77 Distribution of distance per speed range for driver 1000000012987000**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *-0,2%* |
| 30-50 | *-1,1%* |
| 50-100 | *0,2%* |
| **0-100** | **-1,2%** |

**Table 78 Absolute fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *-2,7%* |
| 30-50 | *-5,5%* |
| 50-100 | *0,2%* |
| 0-100 | -1,2% |

**Table 79 Relative fuel consumption variation per speed range and period**

| **Period** | **Total** | **Limiting** | | | ***Overridden*** | | |
|---|---|---|---|---|---|---|---|
| | **Fuel cons.** | **Count** | **Distance** | **Fuel** | **Count** | **Distance** | ***Fuel cons.*** |
| | **(l/100km)** | **(-/100km)** | **(km/100km)** | **(l/100km)** | **(-/100km)** | **(km/100km)** | ***(l/100km)*** |
| 0 | 33,5 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 1 | 32,8 | 0 | 0,0 | 0,0 | 1 | 0,3 | 0,2 |

**Table 80 Distance and fuel consumption in limiting and overridden situations per period**

Conclusion

- 1 principal driver in suburban utilization
- Small impact on fuel consumption (noise)
- No limitation; few overridden

• L27 / Lyon / STEF / BE-829-BY

AL activated in period 1

| **DriverID** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 1000000021806000 | 76% | 94% | 88% | 47% |

**Table 81 Distribution of distance between drivers for each period**

| **Speed range** | ***% of distance*** |
|---|---|
| 0-30 | *18%* |
| 30-50 | *21%* |
| 50-100 | 62% |

**Table 82 Distribution of distance per speed range for driver 1000000021806000**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *0,6%* |
| 30-50 | *0,7%* |
| 50-100 | *-1,1%* |
| **0-100** | **0,3%** |

**Table 83 Absolute fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *3,6%* |
| 30-50 | *3,6%* |
| 50-100 | *-1,8%* |
| **0-100** | **0,3%** |

**Table 84 Relative fuel consumption variation per speed range and period**

| **Period** | **Total** | **Limiting** | | | ***Overridden*** | | |
|---|---|---|---|---|---|---|---|
| | **Fuel cons.** | **Count** | **Distance** | **Fuel** | **Count** | **Distance** | ***Fuel cons.*** |
| | **(l/100km)** | **(-/100km)** | **(km/100km)** | **(l/100km)** | **(-/100km)** | **(km/100km)** | ***(l/100km)*** |
| 0 | 31,0 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 1 | 31,3 | 0 | 0,0 | 0,0 | 0 | 0,0 | 0,0 |

**Table 85 Distance and fuel consumption in limiting and overridden situations per period**

Conclusion

- 1 principal driver in suburban utilization
- Small impact on fuel consumption (noise)
- No limitation; few overridden

- L31 / Lyon / Pomona Saint-Priest / P45409

AL activated in periods 1 and 2

| **DriverID** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 1000000057390000 | 37% | 57% | 49% | 47% |

**Table 86 Distribution of distance between drivers for each period**

| **Speed range** | ***DriverID*** |
|---|---|
| 0-30 | *9%* |
| 30-50 | *15%* |
| 50-100 | 76% |

**Table 87 Distribution of distance per speed range for driver (1000000057390000)**

| **Speed range** | ***Period*** | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | 0,4% | *0,2%* |
| 30-50 | -1,1% | *-0,3%* |
| 50-100 | 1,8% | *0,9%* |
| **0-100** | **1,1%** | **0,9%** |

**Table 88 Absolute fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | 4,5% | *2,6%* |
| 30-50 | -7,2% | *-1,9%* |
| 50-100 | 2,4% | *1,2%* |
| **0-100** | **1,1%** | **0,9%** |

**Table 89 Relative fuel consumption variation per speed range and period**

| **Period** | **Total** | **Limiting** | | | ***Overridden*** | | |
|---|---|---|---|---|---|---|---|
| | **Fuel cons.** | **Count** | **Distance** | **Fuel** | **Count** | **Distance** | ***Fuel cons.*** |
| | **(l/100km)** | **(-/100km)** | **(km/100km)** | **(l/100km)** | **(-/100km)** | **(km/100km)** | ***(l/100km)*** |
| 0 | 29,3 | 0 | 0,0 | 0,0 | 0 | 0,0 | *0,0* |
| 1 | 29,5 | 253 | 1,4 | 0,4 | 0 | 0,0 | *0,0* |
| 2 | 29,5 | 124 | 0,7 | 0,2 | 0 | 0,0 | 0,0 |

**Table 90 Distance and fuel consumption in limiting and overridden situations per period**

Conclusion

- 1 principal driver in urban / suburban utilization
- Small impact on fuel consumption (noise)
- Limitations but on short distances; few overridden

#### 3.3.2.3.1 Questionnaires

Only one driver gave their opinion about AL service (see Annex 3). Therefore, only the items with the low, medium or high values are presented, most of the items had low values (between 2 and 4 points):

- I am confident in my ability to drive the truck safely with the AL service (4 points)
- I trust the AL service (4 points)
- After using AL I like the service (4 points)
- Using the AL service, I decrease capacity of acceleration on float road (4 points)
- More I use the AL service, I feel less stressed (4 points)
- I think I have achieved a higher driving comfort using AL service (4 points)
- More I use the AL service, I feel more apprehensive about it (4 points)
- I believe I have the indispensable knowledge to utilize the AL service (4 points)
- The use of AL service makes urban driving easier (4 points)
- Using the AL service, I consider my driving is more safety (4 points)
- I believe that my work conditions have improved with the use of AL service (4 points)
- I think the AL is effective to not exceed the speed limitations (2 points)

Medium values are for the next items:

- The freight transport image in urban areas is improved with the usage of AL service (6 points)
- I am confident of using AL service (5 points)
- I drive in a more effective way reducing my fuel consumption when using AL service (6 points)

  The items with the more positive scores are the following:

- I believe the AL service works properly (10 points)
- I think that the use of AL service has provided me more efficient and controlled delivery practices (8 points)
- It is simple to identify the functions of the AL service (8 points)
- I consider that I have adopted an eco-friendly style when using AL service (8 points)
- I believe the urban congestion has increase with the usage of the AL service (7 points)
- It is easy to understand how the AL service works (9 points)
- I accept increase on journey duration as a trade off to decreased fuel consumption (7 points)

About fleet operators all the answers are positive (scores are between 5 and 8 points). The items with a score of five are the next:

- Our company believe the AL service is positive for our company
- In general, we think our drivers are confident of using AL service
- Our company believe our company has the indispensable conditions to use the AL service
- According our perception, the AL service improves the environmental image of our company
- We think that using the AL service increases the efficacy of our company work

Items with scores of 8 points are the following:

- We think the safe of our drivers increases with the use of the AL service
- Our company trust the AL service
- The freight transport image in urban areas improves with the usage of AL service

- The image of the city has improved with the use of AL service

Additional information about the questionnaires is included in Annex III.

#### 3.3.2.4. Validation of hypothesis and conclusions

Conclusions of the results of the AL system are presented below.

| City | TruckID | Truck utilization | Fuel consumption reduction | *System limitations* |
|---|---|---|---|---|
| Bilbao | B04 | Long haul | 2% / 2.8% (not significant) | *12 times/100km* |
| Bilbao | B05 | Long haul | -2.2% (not significant) | *13 times/100km* |
| Helmond | H14 | Suburban | 6.4% | *0 times* |
| Helmond | H16 | Suburban | 0% (not significant) | *0 times* |
| Lyon | L22 | Suburban Long haul | -0.4% (not significant) | *0 times* |
| Lyon | L24 | Suburban | -1.4% (not significant) | *0 times* |
| Lyon | L25 | Suburban | -1.2% (not significant) | *0 times* |
| Lyon | L27 | Urban suburban | 0.3% (no significant) | *0 times* |
| Lyon | L31 | Urban suburban | 0.9% - 1.1% (not significant) | 377 times/100 km |

**Table 91 Results of the AL system.**

Most of the results are very small, between -2% and 2% fuel consumption increase. These low results can be linked to small differences in the characteristics of the analyses (different load factors, weather conditions, congestion levels…).

In most of the trucks the AL limited very few times and on short distances so that the impact on fuel consumption wasn't significant.

The system is designed for working in-between specific load factors, remaining deactivated when the truck is above a given weight. In addition, the acceleration limit also depends on the vehicle velocity (at high speeds, the potential of acceleration reduction is low due to low acceleration capacity) and on the driver's behavior (a fuel-eco driver won't activate the function). The consequence is that the AL targets urban and suburban utilizations with many deliveries, where the vehicle started the tour partly loaded and ended it empty and where a significant distance is covered in acceleration. Nevertheless, it may happen that it doesn't occur at the same time (return empty but on highway for example) so that the probability to activate the AL isn't high enough. Combined to the driver's behavior, the system's limitations may be not sufficient to significantly reduce the fuel consumption*.

All cases occurred in the pilot:

- Nanuk: the utilization (long haul) wasn't appropriate; nevertheless, the vehicles were used at low weight so that the load factor could be correct to activate the acceleration limitation; the consequence is a very low rate of limitation observed.

- Van Den Broek: the utilization (suburban) was appropriate; in this case, the only possible explanation is that the truck load factor wasn't above the setting point of the acceleration limiter.

- STEF: the utilization (suburban) was appropriate; nevertheless, previous measurements done on a STEF truck to calibrate the system shown that truck weight was in-between 30 t to 20 t, whereas the calibration was defined at 25 t; in addition, the monitoring of the drivers behavior (acceleration pedal) indicated that the drivers were trained to fuel-eco driving and that the limitations occurrences were very low, which was confirmed during the pilot.

- Pomona: the utilization (urban / suburban) was appropriate and the average load given by the fleet operator was 2,5 t; the acceleration limiter was calibrated for a load of about 1 t, which should result in roughly ¼ to ½ of the distance; if we consider that about ¼ of the distance is done in acceleration, the result is that the acceleration limiter can be activated in 10% to 25% of the distance; Then, the rate of limitation observed can easily be explained by the drivers behaviors.

* An estimation of the limitation distance can be done with the following formula:

- Limitation distance (km/100km) = percentage of distance under the load limit * percentage of distance in acceleration * percentage of distance over the acceleration limit*100

Typical values for distribution application (Pomona-like, extrapolated from the EDS data) will give:

- Limitation distance (km/100 km) = 25%*25%*25%*100 = 1,5 time/100 km

This value has the same order of magnitude that what was observed in Pomona trucks.

Table 93 show the comments to the subjective hypothesis based on the 3 participants from Helmond.

| | Hypothesis | Comment |
|---|---|---|
| ✗ | Using the Acceleration Limiter service, fuel consumption will decrease | There are no significant decrease of the fuel consumption (**Error! Reference source not found.** and **Error! Reference source not found.**) |

**Table 92 The same as Table 22 but for AL.**

| | Hypothesis | Comment |
|---|---|---|
| ✗ | Using the Acceleration Limiter service, the driver will note decreased capacity of acceleration on flat road | Drivers believe that the use of AL service does not decrease the capacity of acceleration on flat road. |
| ✓ | The Acceleration Limiter service is appreciated by drivers | After using AL drivers like the service. |
| ✓ | Drivers will perceive that the Acceleration Limiter service is reliable | Drivers consider the AL service as system moderately reliable. |
| ✓ | Drivers will find the Acceleration Limiter is useful when driving | After using the system the drivers find it useful when driving. |
| ✓ | Drivers will think the Acceleration Limiter is easy to use | Regarding to the question "I think it is easy to understand how the AL service works" the answers of the participants were positive. |
| ✗ | Drivers' stress perception will decrease with the acceleration limiter usage | Drivers' stress perception did not decrease. |
| ✓ | Perceived risk of accidents will decrease with the acceleration limiter usage | Participants believe that the perception risk of accidents decreases after AL usage. |
| ✓ | According to the driver perception the acceleration limiter system will improve of freight transport image in urban areas | The freight transport image in urban areas will improve satisfactorily. |
| ✓ | Drivers will trust the acceleration limiter system | Drivers trust of system is positive |
| ✓ | The drivers will accept increase on journey duration as a trade off to decreased fuel consumption | Drivers are willing to increase their journey duration as a trade off to decreased fuel consumption. |

**Table 93 The same as Table 23 but for AL.**

### 3.3.3. ASL

The methodology followed for analyzing the ASL consumption is exactly the same methodology followed in the AL system, but the analyses are done in each zone separately. The speed profiles within the zones will be also Analysed, providing an idea of the reduction of the overspeeding situations. The graph below shows the speed profile, the percentage of times each speed appears in the database for the selected truck and zone.

A drastic reduction of the overspeeding situations in period 2 (when the ASL was activated) can be observed in the figure above. The overspeed situations of period 0 and period 1 are 20%, while in period 2 there is no overspeeding.

#### 3.3.3.1. Results in Bilbao

- B04 / Bilbao / Nanuk / 8594-GHY

SL activated in period 2

| **Zone** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 0 | 99% | 99% | 99% | *99%* |
| 1131 | 0% | 0% | 0% | *0%* |
| 1132 | 0% | 0% | 0% | *0%* |
| 1151 | 0% | 0% | 0% | *0%* |
| 1152 | 0% | 0% | 0% | *0%* |
| 1181 | 0% | 0% | 0% | *0%* |
| 1182 | 1% | 1% | 1% | 1% |

**Table 94 Distribution of distance between zones for each period for all drivers**

It can be observed that most of the time the truck is circulating outside of the zones. Any fuel reduction obtained within the zones applies to the 1% of the total distance, having very low effects in the total fuel consumption. The benefits of the ASL are more related to safety issues than to economic or environmental ones. This issue will affect the overspeeding analyze, since the sample for obtaining the speed profile may be very small for applying statistical analysis.

Zone 1182 analyze

| **Speed range** | ***Period*** |
|---|---|
| | ***2*** |
| 0-30 | *1%* |
| 30-50 | *8%* |
| 50-100 | *91%* |
| 0-100 | 100% |

**Table 95 Distribution of distance per speed range and period**

| Speed range | *Period* | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | -0,1% | *0,2%* |
| 30-50 | 0,5% | *-0,2%* |
| 50-100 | 4,8% | *2,7%* |
| **0-100** | **5,1%** | **2,8%** |

**Table 96 Relative fuel consumption variation per speed range and period**

| Speed range | *Period* | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | -7,4% | *22,6%* |
| 30-50 | 16,0% | *-7,2%* |
| 50-100 | 5,0% | *2,8%* |
| **0-100** | **5,1%** | **2,8%** |

**Table 97 Absolute fuel consumption variation per speed range and period**

| Zone | Period | Distance (km) | Speed (km/h) | Count (-/100km) | | Fuel (l/100km) | | *Inside distance (% total)* | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Limiting | Overridden | Limiting | Inside | Active | *Limiting* |
| 1131 | 2 | 40 | 27,4 | 118 | 3 | 0,4 | 54,7 | 2,2% | *1,2%* |
| 1152 | 2 | 18 | 5,2 | 39 | 0 | 0,7 | 62,6 | 7,8% | *0,9%* |
| 1181 | 2 | 11 | 72,5 | 0 | 0 | 0,0 | 24,8 | 0,0% | *0,0%* |
| 1182 | 2 | 287 | 79,2 | 0 | 0 | 0,0 | 28,5 | 0,0% | 0,0% |

**Table 98 Distance and fuel consumption in limiting and overridden situations per zone**

Overspeeding analyze

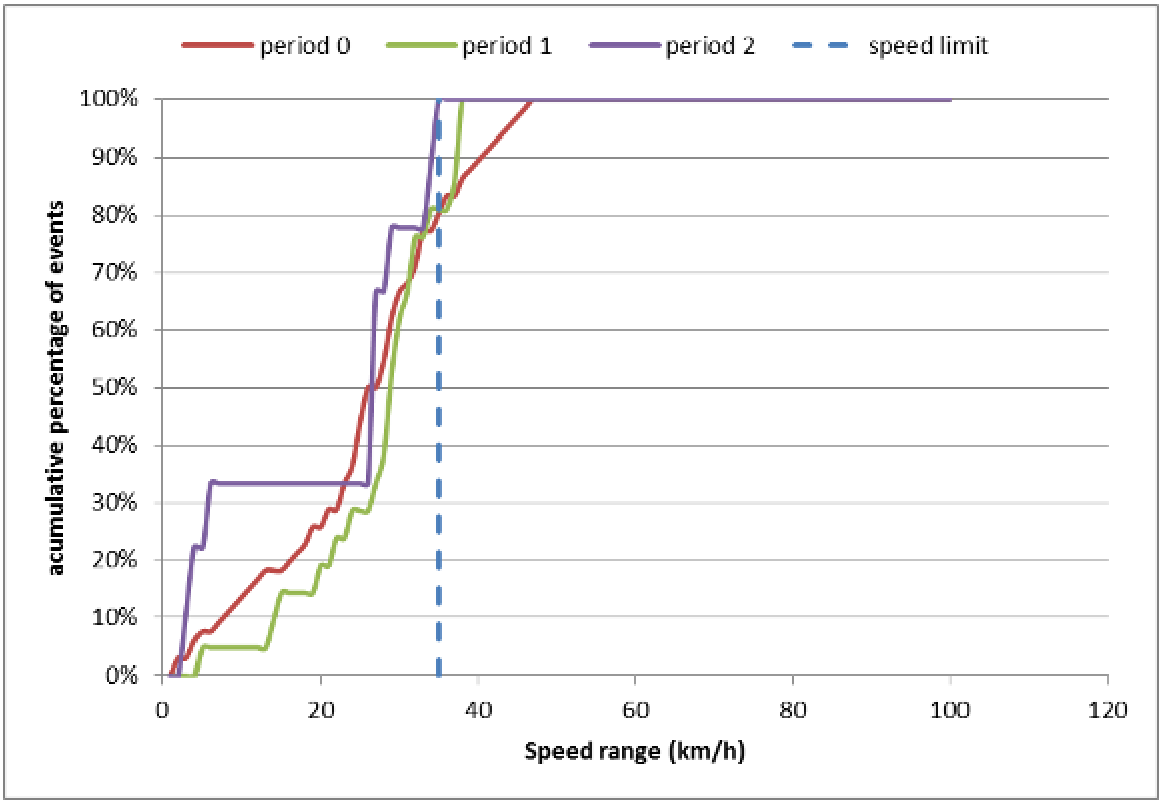



**Figure 65 Speed profile in zone 1131.**

In this case a reduction of 20% is observed. Basically, there is no ovespedding when the ASL is activated.

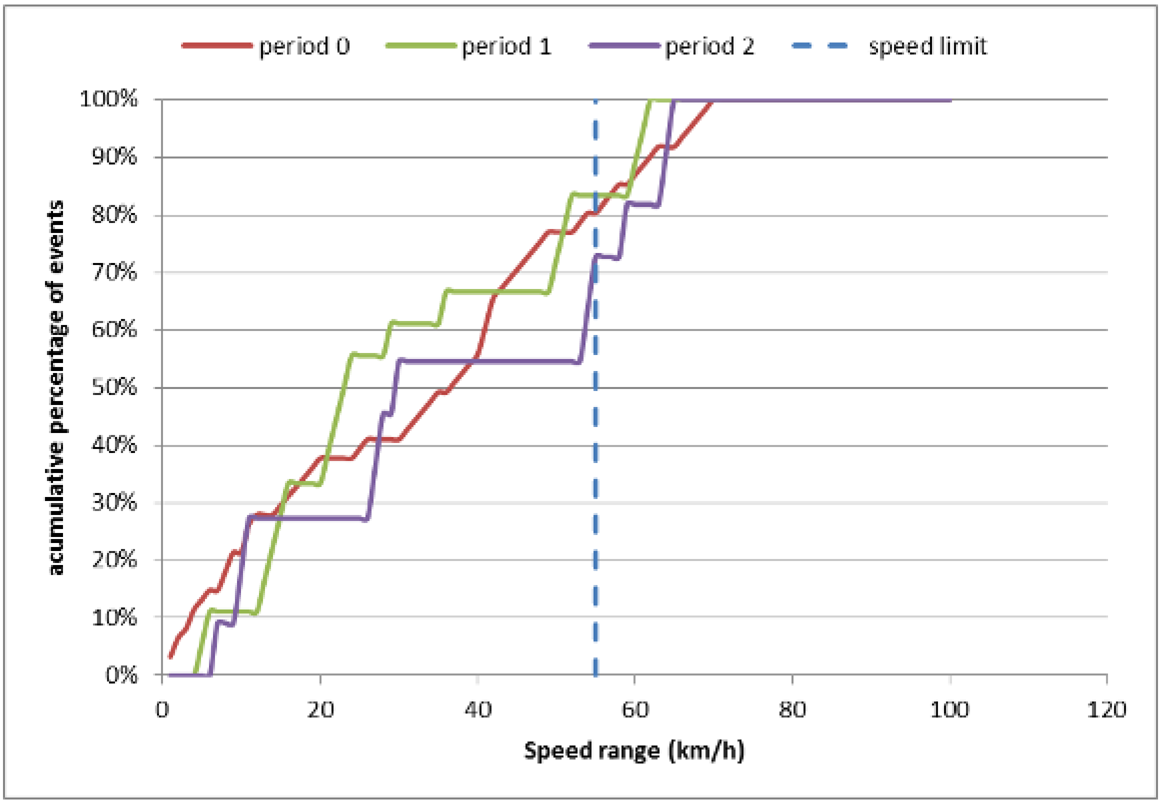



**Figure 66 Speed profile in zone 1152.**

In this case there is no reduction of overspeeding situations.

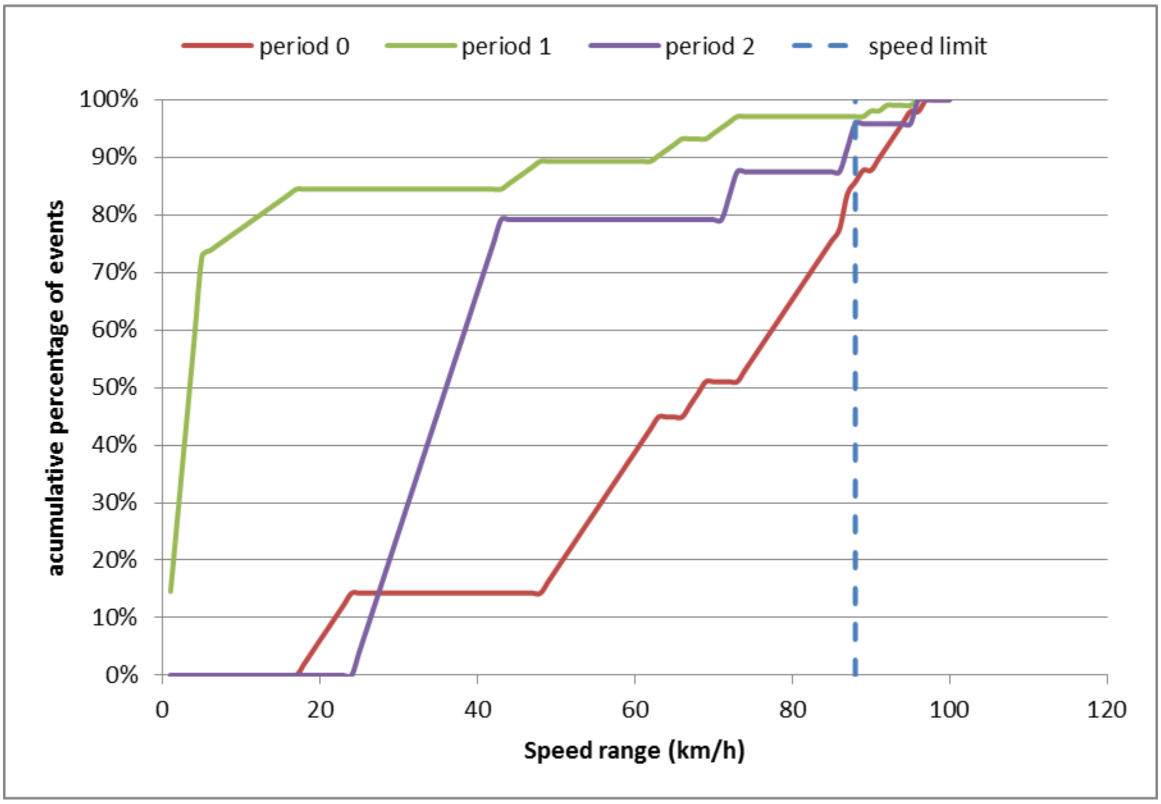



**Figure 67 Speed profile in zone 1181.**

In this case a reduction of 10% is observed. The same reduction is observed in period 1, where only the EDS was activated. The shape of the curves (straight lines between a few set of points) indicates that the data sample is very small and no conclusion can be drawn.

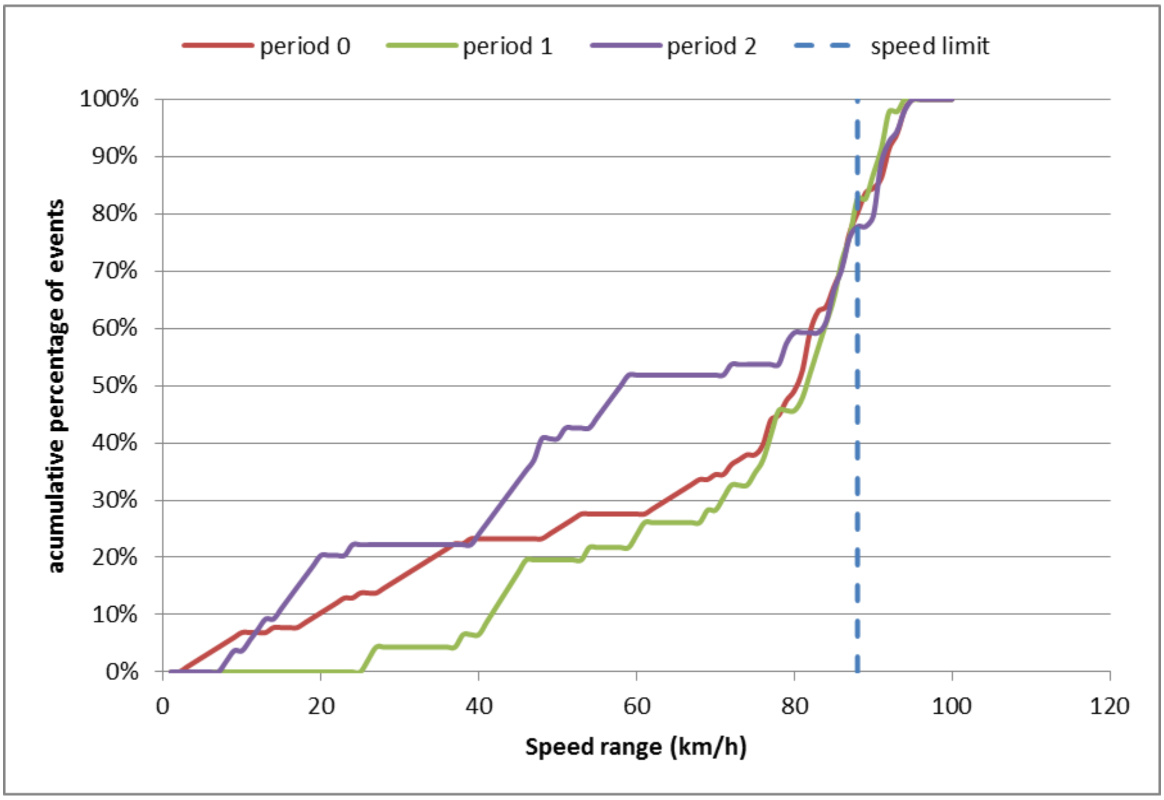



**Figure 68 Speed profile in zone 1182.**

In this case there is no reduction of overspeeding situations, but the speed profile is higher in period 2 than in the other periods, which means that average speeds are smaller.

Conclusion:

- Very low percentage of distance in zones (long haulage utilization) ); main zone is 1182
- Increase of fuel consumption in zone 1182 (noise)
- Limitations in zones 1131 and 1151; almost no overridden

• B06 / Bilbao / Nanuk / 8970-GHY

SL activated in period 1.

| **Zone** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 0 | 99% | 99% | 99% | *99%* |
| 1131 | 0% | 0% | 0% | *0%* |
| 1132 | 0% | 0% | 0% | *0%* |
| 1151 | 0% | 0% | 0% | *0%* |
| 1152 | 0% | 0% | 0% | *0%* |
| 1181 | 0% | 0% | 0% | *0%* |
| 1182 | 1% | 1% | 1% | 1% |

**Table 99 Distribution of distance between zones for each period for all drivers**

The same pattern can be observed for this truck, most of the time the truck is circulating outside the zones.

Zone 1182 analyze

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *1%* |
| 30-50 | *2%* |
| 50-100 | *97%* |
| **0-100** | **100%** |

**Table 100 Distribution of distance per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | 1 | *2* |
| 0-30 | -0,4% | *-0,2%* |
| 30-50 | 0,2% | *0,0%* |
| 50-100 | 0,6% | *0,2%* |
| **0-100** | **0,5%** | **0,0%** |

**Table 101 Relative fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | -39,7% | *-17,4%* |
| 30-50 | 10,5% | *-0,7%* |
| 50-100 | 0,6% | *0,2%* |
| **0-100** | **0,5%** | **0,0%** |

**Table 102 Absolute fuel consumption variation per speed range and period**

| **Zone** | **Period** | **Distance (km)** | **Speed (km/h)** | **Count (-/100km)** | | **Fuel (litre/100km)** | | ***Inside distance (% total)*** | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Limiting** | **Overridden** | **Limiting** | **Inside** | **Active** | ***Limiting*** |
| 1131 | 1 | 57 | 29,5 | 78 | 0 | 0,2 | 53,8 | 1,7% | *0,7%* |
| 1152 | 1 | 8 | 11,0 | 905 | 0 | 12,5 | 62,2 | 182,8 % | *17,2%* |
| 1181 | 1 | 30 | 73,8 | 0 | 0 | 0,0 | 26,3 | 0,0% | *0,0%* |
| 1182 | 1 | 435 | 83,1 | 27 | 0 | 0,5 | 27,7 | 2,5% | 1,9% |

**Table 103 Distance and fuel consumption in limiting and overridden situations per zone**

Overspeeding analyze

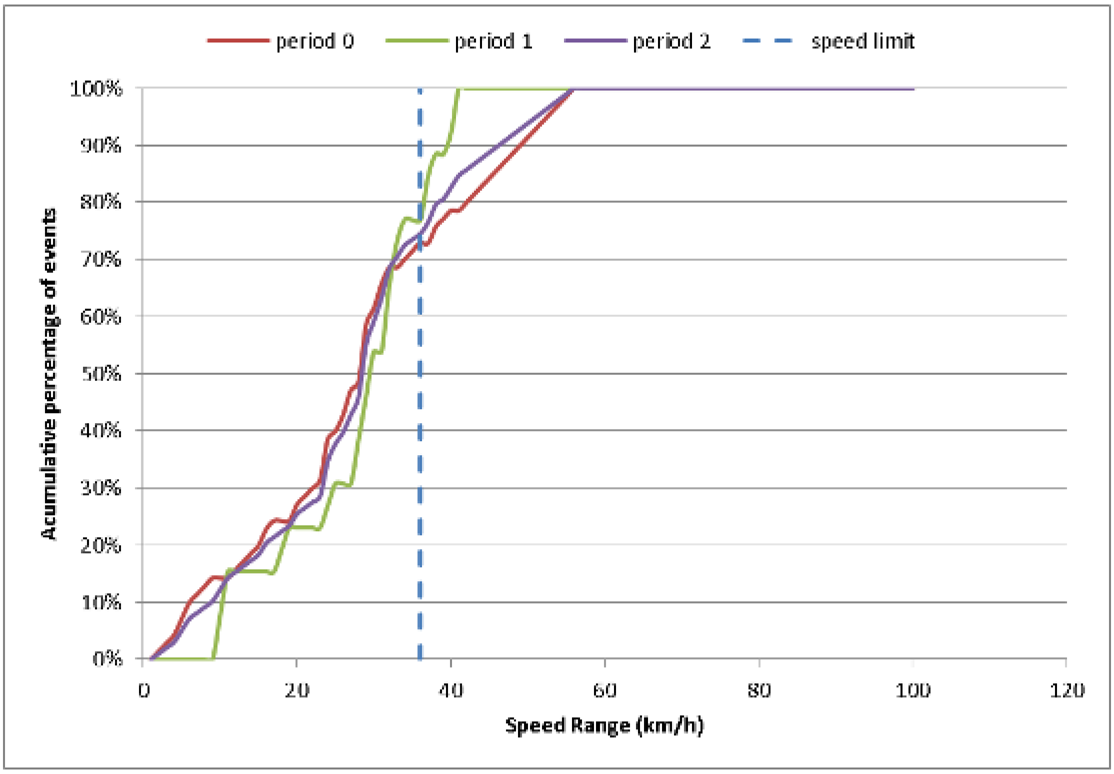



**Figure 69 Speed profile in zone 1131**

The profile of period 1 is different to the profile in period 0. The profile of period 2 is very similar to the one observed in period 1, indicating that there is no learning effects in the driving behavior of the drivers in this zone. The important fact is that there is no speed higher than 40 in period 0, while in period 0 and period 2 this speed is overpassed in 20% of the cases.

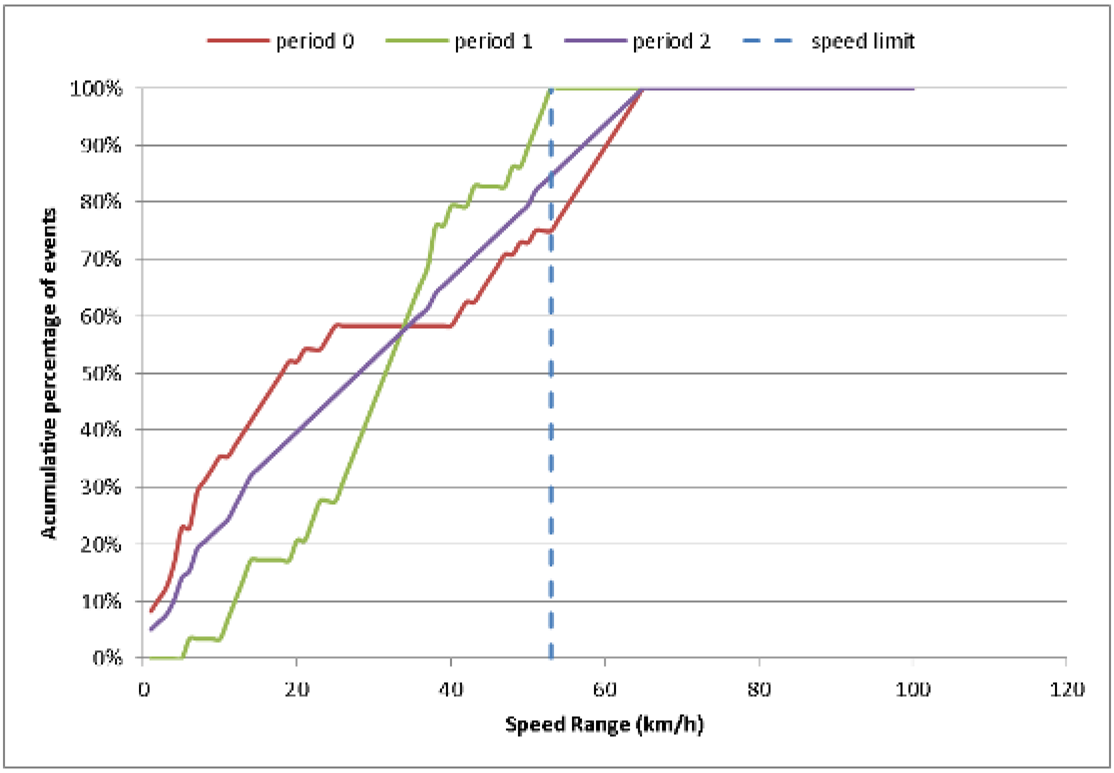



**Figure 70 Speed profile in zone 1152.**

In this case there is small change in the driving behavior after using the system. In period 1 the reduction of overspeeding is 25% (there is no overspeeding), while in period 2 there is a 15% of cases where the driver was overspeeding.

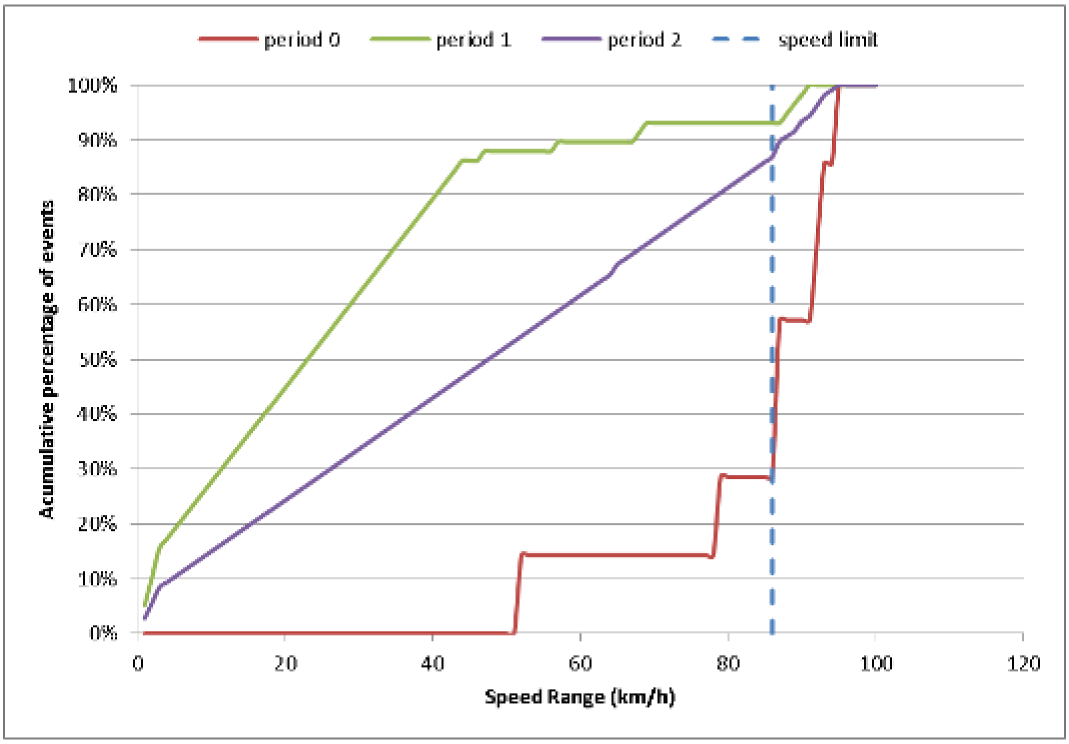



**Figure 71 Speed profile in zone 1181.**

The quantity of data in this zone is very small for obtaining conclusions, but there is a tendency of reducing the overspeeding.

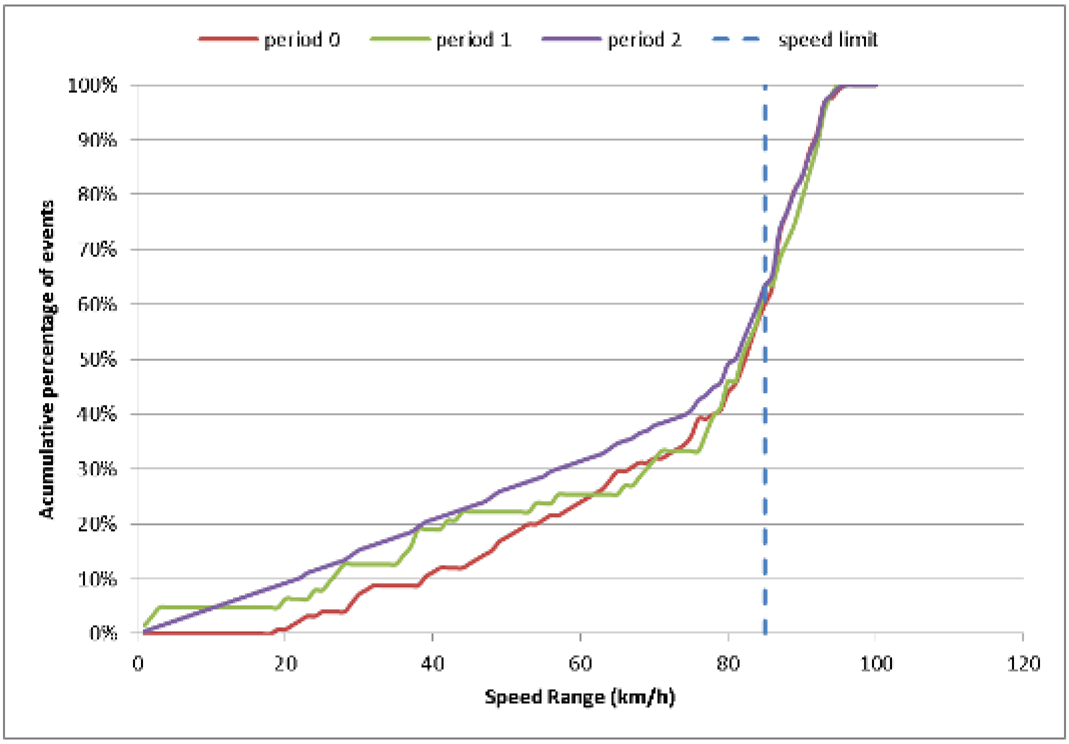



**Figure 72 Speed profile in zone 1182.**

No significant change in this zone.

Conclusion

- Very low percentage of distance in zones (long haulage utilization); main zone is 1182
- No variation of fuel consumption in zone 1182
- Few limitation in zone 1131, 1152 and 1182; no overridden

#### 3.3.3.2. Results in Helmond

- H15 / Helmond / Van Den Broek / BT-BX-25

SL activated in period 1.

| **Zone** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 0 | 96% | 97% | 96% | *96%* |
| 4131 | 0% | 0% | 0% | *0%* |
| 4151 | 3% | 3% | 3% | *3%* |
| 4171 | 0% | 0% | 0% | *0%* |
| 4181 | 0% | 0% | 0% | 0% |

**Table 104 Distribution of distance between zones for each period for all drivers**

The same pattern can be observed for this truck, most of the time the truck is circulating outside the zones.

Zone 4151 analyze

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *48%* |
| 30-50 | *42%* |
| 50-100 | *10%* |
| **0-100** | **100%** |

**Table 105 Distribution of distance per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | 3,3% | *4,3%* |
| 30-50 | 1,3% | *1,7%* |
| 50-100 | -0,2% | *-1,1%* |
| **0-100** | **4,5%** | **5,0%** |

**Table 106 Relative fuel consumption variation per speed range and period**

| Speed range | *Period* | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | 7,0% | *9,1%* |
| 30-50 | 3,2% | *4,2%* |
| 50-100 | -2,1% | *-10,8%* |
| **0-100** | **4,5%** | **5,0%** |

**Table 107 Absolute fuel consumption variation per speed range and period**

| Zone | Period | Distance (km) | Speed (km/h) | Count (-/100km) | | Fuel (litre/100km) | | *Inside distance (% total)* | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Limiting | Overridden | Limiting | Inside | Active | *Limiting* |
| 4131 | 1 | 1 | 34,2 | 2143 | 0 | 3,6 | 28,6 | 39,3 % | *33,9%* |
| 4151 | 1 | 179 | 18,9 | 35 | 0 | 0,3 | 49,0 | 3,2% | *1,1%* |
| 4171 | 1 | 32 | 56,9 | 53 | 0 | 0,6 | 30,7 | 2,6% | *2,2%* |
| 4181 | 1 | 41 | 67,3 | 61 | 0 | 0,7 | 29,8 | 5,6% | 2,8% |

**Table 108 Distance and fuel consumption in limiting and overridden situations per zone**

Overspeeding analyze

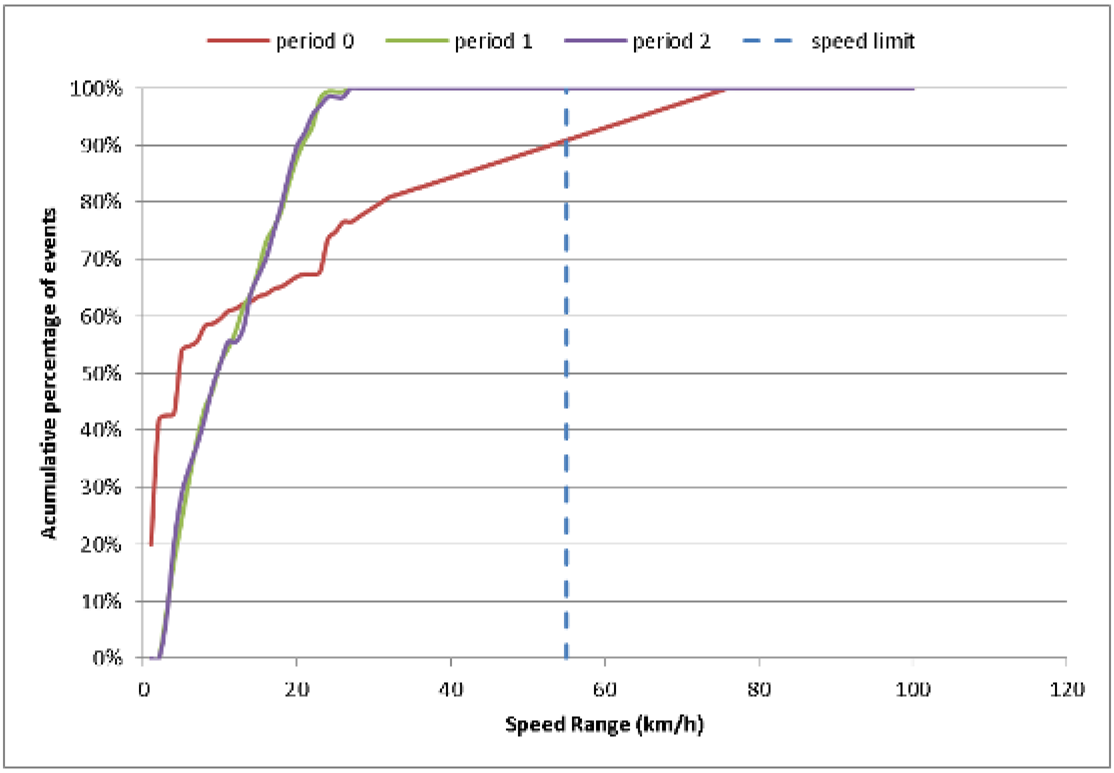



**Figure 73 Speed profile in zone 4151.**

Significant reduction of the speed profile, maximum speed in period 1 and period 2 of 25 km/h, while in period 0 20% of the cases presented higher speed. Period 1 and period 2 present very similar results. There is an important change in the driver's behaviour.

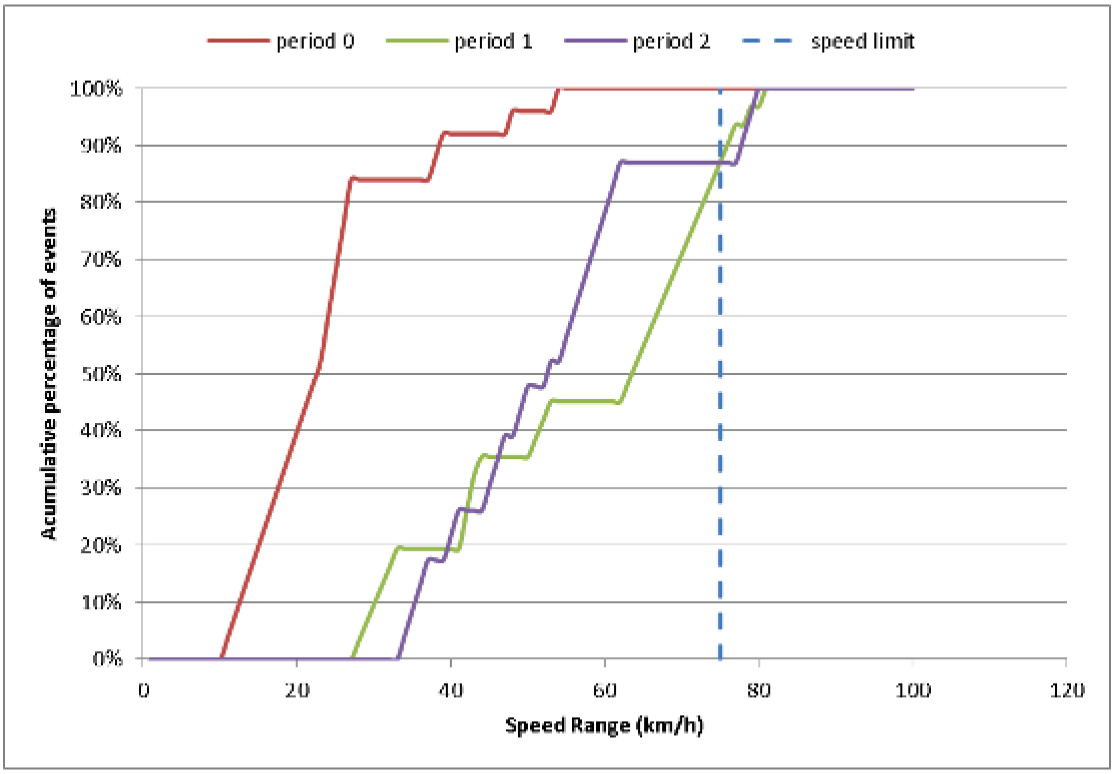



**Figure 74 Speed profile in zone 4171.**

Not enough quantity for concluding.

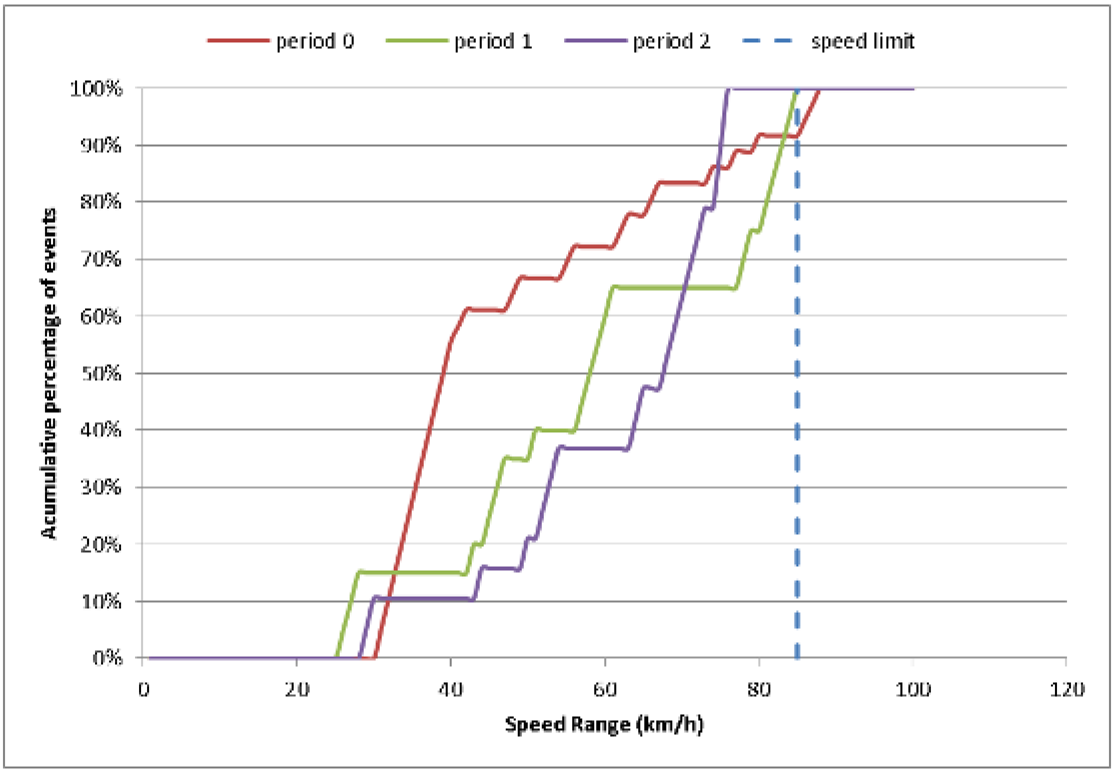



**Figure 75 Speed profile in zone 4181.**

Not enough quantity for concluding.

Conclusion

- Very low percentage of distance in zones; main zone was 4151
- Increase of fuel consumption in zone 4151 but decrease in the speed range 50-100 km/h
- Some limitations in zones 4151, 4171 and 4181; no overridden

- H16 / Helmond / Van Den Broek / BT-DB-24

SL activated in period 1

| **Zone** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 0 | 98% | 96% | 97% | *0%* |
| 4151 | 2% | 3% | 3% | *0%* |
| 4171 | 0% | 0% | 0% | *8%* |
| 4181 | 0% | 0% | 0% | 1% |

**Table 109 Distribution of distance between zones for each period for all the drivers**

The same pattern can be observed for this truck, most of the time the truck is circulating outside the zones.

Zone 4151 analyze

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *54%* |
| 30-50 | *42%* |
| 50-100 | *5%* |
| **0-100** | **100%** |

**Table 110 Distribution of distance per speed range and period**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *1,6%* |
| 30-50 | *-2,5%* |
| 50-100 | *0,4%* |
| **0-100** | **-0,5%** |

**Table 111 Relative fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** |
|---|---|
| | *1* |
| 0-30 | *3,1%* |
| 30-50 | *-6,0%* |
| 50-100 | *8,5%* |
| **0-100** | **-0,5%** |

**Table 112 Absolute fuel consumption variation per speed range and period**

| Zone | Period | Distance (km) | Speed (km/h) | Count (-/100km) | | Fuel (l/100km) | | *Inside distance (% total)* | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Limiting | Overridden | Limiting | Inside | Active | *Limiting* |
| 4131 | 1 | 1 | 17,0 | 0 | 0 | 0,0 | 31,0 | 0,0% | *0,0%* |
| 4151 | 1 | 611 | 24,7 | 93 | 0 | 0,5 | 44,3 | 4,8% | *1,2%* |
| 4171 | 1 | 51 | 44,6 | 429 | 0 | 3,1 | 34,1 | 52,2 % | *9,4%* |
| 4181 | 1 | 76 | 56,4 | 0 | 0 | 0,0 | 31,1 | 2,4% | 0,0% |

**Table 113 Distance and fuel consumption in limiting and overridden situations per zone**

Overspeeding analyze

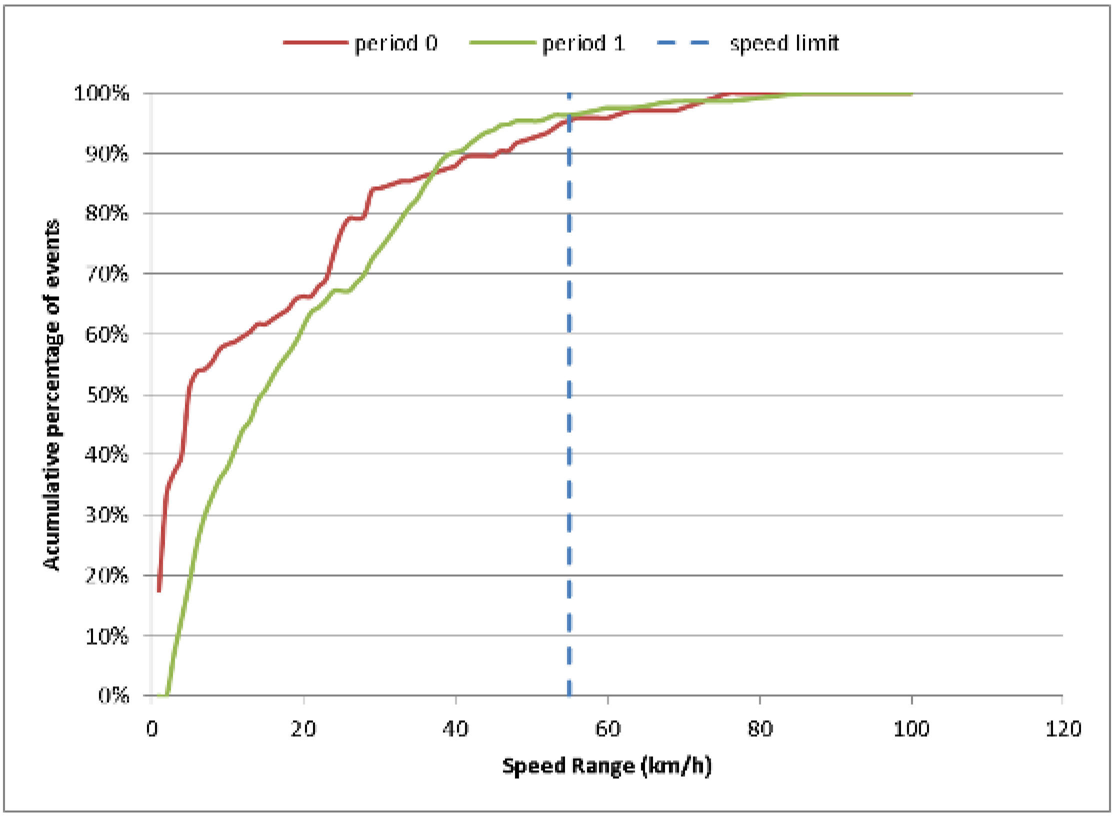



**Figure 76 Speed profile in zone 4151.**

The speed profiles in both cases are very similar, no changes.

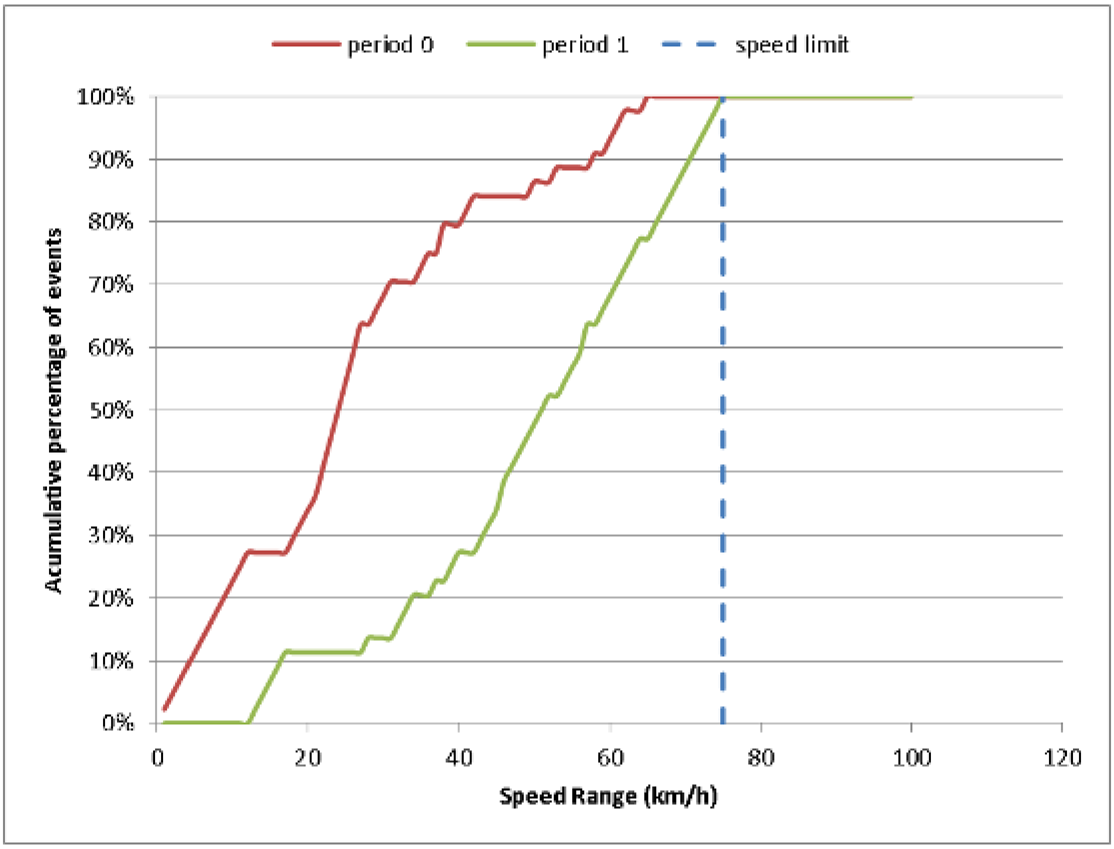



**Figure 77 Speed profile in zone 4171.**

Not enough quantity for concluding, but there is the tendency of higher speed when using the system.

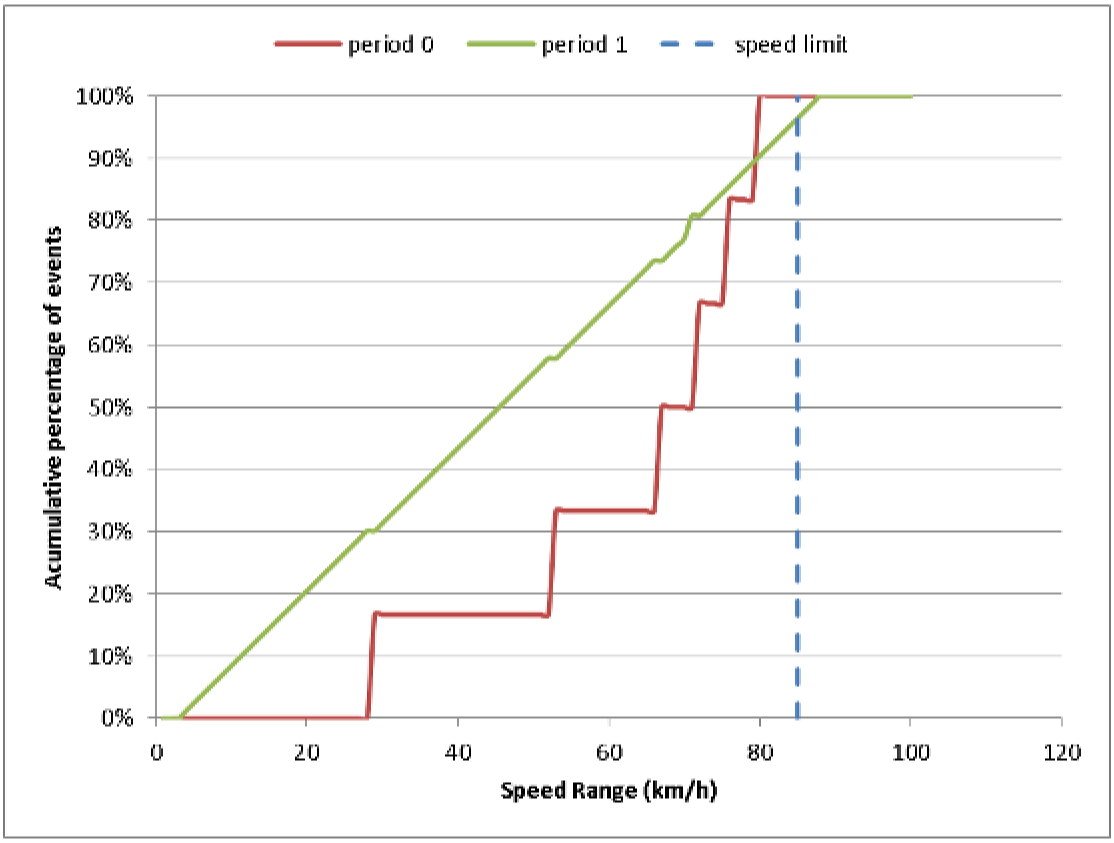



**Figure 78 Speed profile in zone 4181.**

Not enough quantity for concluding.

Conclusion

- Very low percentage of distance in zones; main zone was 4151
- Slight decrease of fuel consumption in zone 4151 but increase in the speed range 50-100 km/h (noise)
- Some limitations in zones 4151 and 4171; no overridden

#### 3.3.3.2.1 Questionnaires

Five drivers hold an opinion about Speed Limiter service (see Annex 1). In most of the items drivers gave a positive opinion. Next, the items with highest values are presented:

- I think the Speed Limiter is effective to not exceed the speed limitations
- I am confident of using Speed Limiter service
- It is easy to understand how the Speed Limiter service works
- I drive in a more effective way reducing my fuel consumption when using Speed Limiter service
- I trust the Speed Limiter service
- I am confident in my ability to drive the truck safely with the Speed Limiter service

The others items had medium value except the item "I believe the urban congestion has increased with the usage of the Speed Limiter service" but it means that Speed Limiter service is positive because the urban congestion had decreased.

In regards to fleet operators the items had values over 6 points except the item: ""We believe the urban congestion has increased with the usage of the Speed Limiter service" but to have a low score in this item has a positive sense. Items with the highest values (9 points) are the next:

- We think the Speed Limiter is effective to not exceed the speed limitations
- The freight transport image in urban areas is improved with the usage of Speed Limiter service
- We think that using the Speed Limiter service increases the efficacy of our company work
- The image of the city has improved with the use of Speed Limiter service
- We believe the Speed Limiter service works properly

Additional information about the questionnaires is included in Annex III.

### 3.3.3.3. Results in Lyon

- L28 / Lyon / Pomona Saint-Priest / P45406

SL activated in period 1.

| Zone | *Period* | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 0 | 91% | 88% | 90% | *90%* |
| 3130 | 0% | 0% | 0% | *0%* |
| 3150 | 0% | 1% | 0% | *0%* |
| 3170 | 7% | 10% | 9% | *8%* |
| 3190 | 1% | 1% | 1% | 1% |

**Table 114 Distribution of distance between zones for each period for all the drivers**

In this case the quantity of data in zone 3170 is quite significant.

Zone 3170 analyze

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *1%* |
| 30-50 | *5%* |
| 50-100 | *93%* |
| **0-100** | **100%** |

**Table 115 Distribution of distance per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | 1 | *2* |
| 0-30 | -0,1% | *0,0%* |
| 30-50 | 0,3% | *0,1%* |
| 50-100 | 0,1% | *0,0%* |
| **0-100** | **0,2%** | **0,1%** |

**Table 116 Relative fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | 1 | *2* |
| 0-30 | -7,8% | *-0,8%* |
| 30-50 | 5,8% | *2,2%* |
| 50-100 | 0,1% | *0,0%* |
| **0-100** | **0,2%** | **0,1%** |

**Table 117 Absolute fuel consumption variation per speed range and period**

| **Zone** | **Period** | **Distance (km)** | **Speed (km/h)** | **Count (-/100km)** | | **Fuel (l/100km)** | | ***Inside distance (% total)*** | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Limiting** | **Overridden** | **Limiting** | **Inside** | **Active** | ***Limiting*** |
| 3150 | 1 | 75 | 17,1 | 23 | 0 | 0,1 | 40,7 | 5,3% | *0,4%* |
| 3170 | 1 | 1076 | 75,7 | 15 | 0 | 0,4 | 25,5 | 0,7% | *1,9%* |
| 3190 | 1 | 108 | 69,3 | 0 | 0 | 0,0 | 25,7 | 9,3% | 0,0% |

**Table 118 Distance and fuel consumption in limiting and overridden situations per zone**

Overspeeding analyze

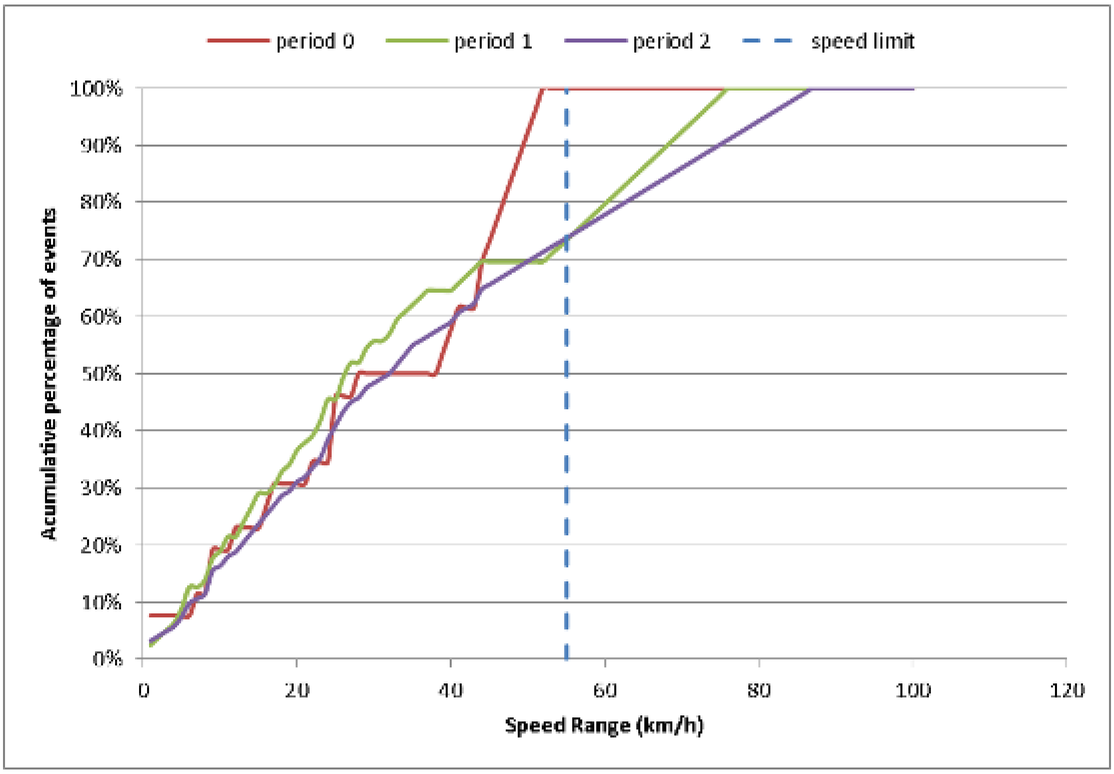



**Figure 79 Speed profile in zone 3150.**

Increase in the speed profile in both periods 1 and 2.

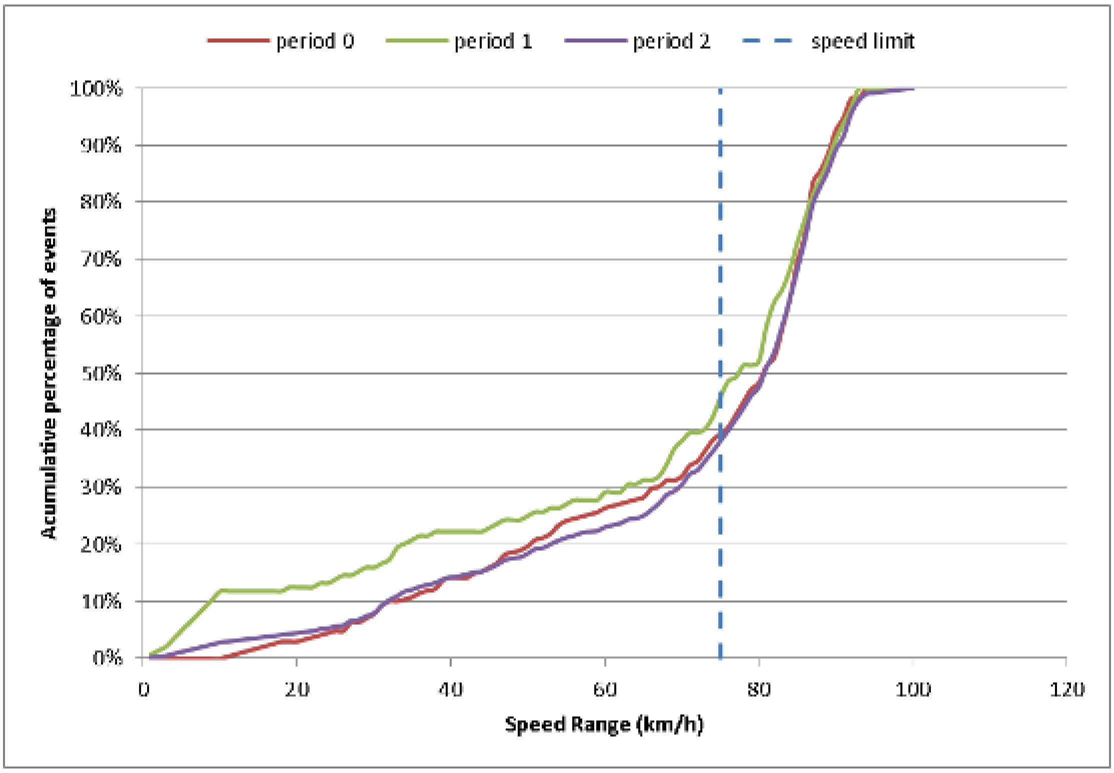



**Figure 80 Speed profile in zone 3170.**

No significant changes in the speed profile, small reduction of the speed profile in period 1.

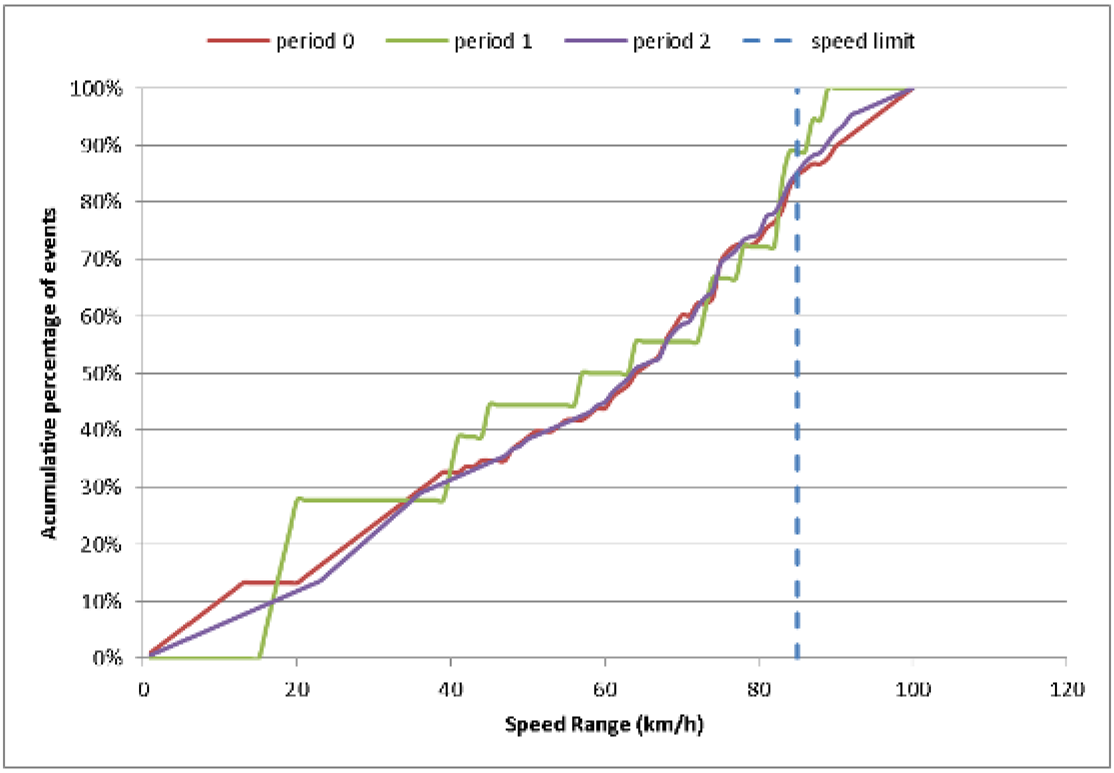



**Figure 81 Speed profile in zone 3190.**

No significant changes in the speed profile, small reduction of the speed profile in period 1.

Conclusion

- Very low percentage of distance in zones apart zone 3170
- No variation of fuel consumption in zone 3170
- Very few limitations in zones 3150 and 3170; no overridden

- L29 / Lyon / Pomona Saint-Priest / P45407

SL activated in period 2

| Zone | *Period* | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | *Total* |
| 0 | 89% | 90% | 90% | *91%* |
| 3130 | 0% | 0% | 0% | *0%* |
| 3150 | 0% | 0% | 0% | *1%* |
| 3170 | 7% | 6% | 7% | *6%* |
| 3190 | 3% | 3% | 3% | 2% |

**Table 119 Distribution of distance between zones for each period for all the drivers**

Zone 3170 analyze

Fuel consumption not Analysed due to lack of periodic data in baseline period.

| Zone | Period | Distance (km) | Speed (km/h) | Count (-/100km) | | Fuel (l/100km) | | *Inside distance (% total)* | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Limiting | Overridden | Limiting | Inside | Active | *Limiting* |
| 3150 | 2 | 24 | 18,1 | 0 | 0 | 0,0 | 41,2 | 0,0% | *0,0%* |
| 3170 | 2 | 531 | 69,8 | 273 | 3 | 5,8 | 25,5 | 16,7% | *28,9%* |
| 3190 | 2 | 350 | 61,9 | 8 | 0 | 0,1 | 24,9 | 11,7% | 0,3% |

**Table 120 Distance and fuel consumption in limiting and overridden situations per zone**

Conclusion

- Very low percentage of distance in zones apart zone 3170
- Limitations in zones 3170 and few in zone 3190; almost no overridden

- L30 / Lyon / Pomona Saint-Priest / P45408

SL activated in period 2.

| Zone | *Period* | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | *Total* |
| 0 | 92% | 90% | 91% | *91%* |
| 3130 | 0% | 0% | 0% | *0%* |
| 3150 | 0% | 2% | 1% | *1%* |
| 3170 | 6% | 7% | 6% | *6%* |
| 3190 | 2% | 2% | 2% | 2% |

**Table 121 Distribution of distance between zones for each period for all the drivers**

In this case the quantity of data in zone 3170 is quite significant.

Zone 3170 analyze

| Speed range | *Period* |
|---|---|
| | *2* |
| 0-30 | *2%* |
| 30-50 | *10%* |
| 50-100 | *89%* |
| **0-100** | **100%** |

**Table 122 Distribution of distance per speed range and period**

| Speed range | *Period* | |
|---|---|---|
| | 1 | *2* |
| 0-30 | 0,2% | *-0,3%* |
| 30-50 | -0,3% | *-0,4%* |
| 50-100 | 3,2% | *0,2%* |
| **0-100** | **3,1%** | **-0,6%** |

**Table 123 Relative fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | 1 | *2* |
| 0-30 | 11,7% | *-20,6%* |
| 30-50 | -3,3% | *-4,4%* |
| 50-100 | 3,6% | *0,2%* |
| **0-100** | **3,1%** | **-0,6%** |

**Table 124 Absolute fuel consumption variation per speed range and period**

| **Zone** | **Period** | **Distanc e (km)** | **Spee d (km/ h)** | **Count (-/100km)** | | **Fuel (litre/100km)** | | ***Inside distance (% total)*** | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Limiting | Overridde n | Limiting | Inside | Active | *Limiting* |
| 3150 | 2 | 211 | 11,0 | 21 | 0 | 0,1 | 45,5 | 5,7% | *0,3%* |
| 3170 | 2 | 1271 | 71,9 | 13 | 0 | 0,2 | 25,9 | 0,7% | *1,3%* |
| 3190 | 2 | 452 | 65,5 | 25 | 1 | 0,3 | 26,0 | 8,7% | 1,3% |

**Table 125 Distance and fuel consumption in limiting and overridden situations per zone**

Overspeeding analyze

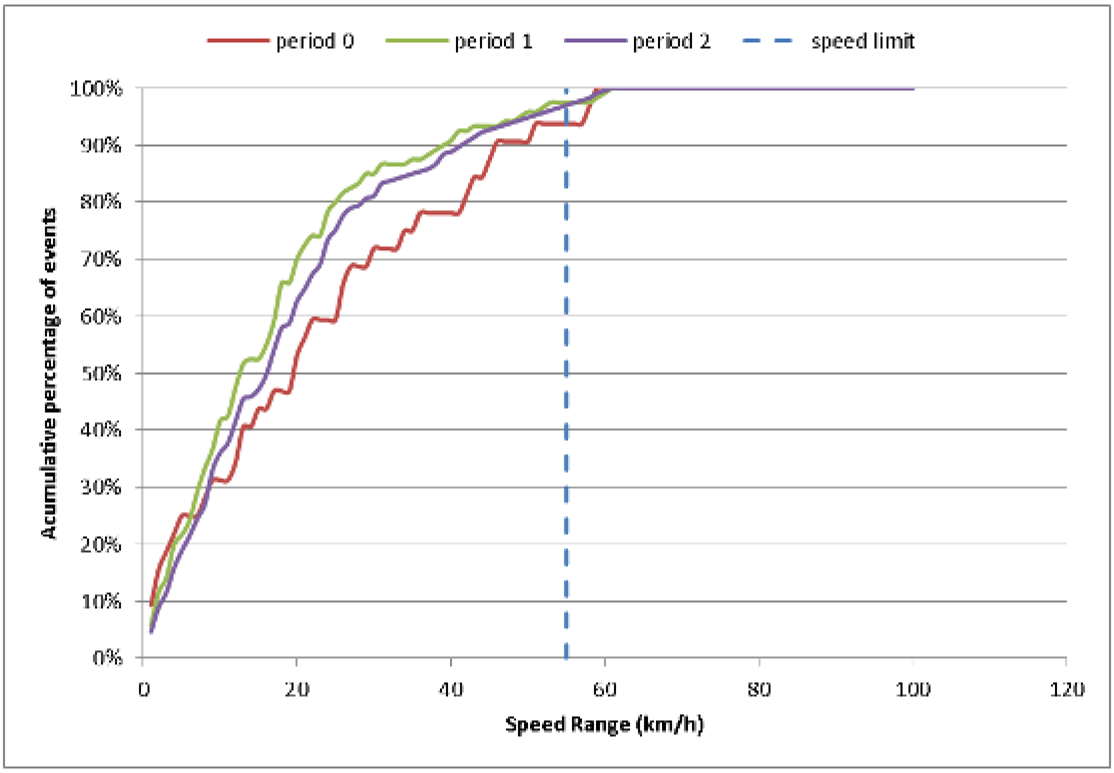



**Figure 82 Speed profile in zone 3150**

General reduction of the speed profile, decrease from 10% to 5% of overspeeding.

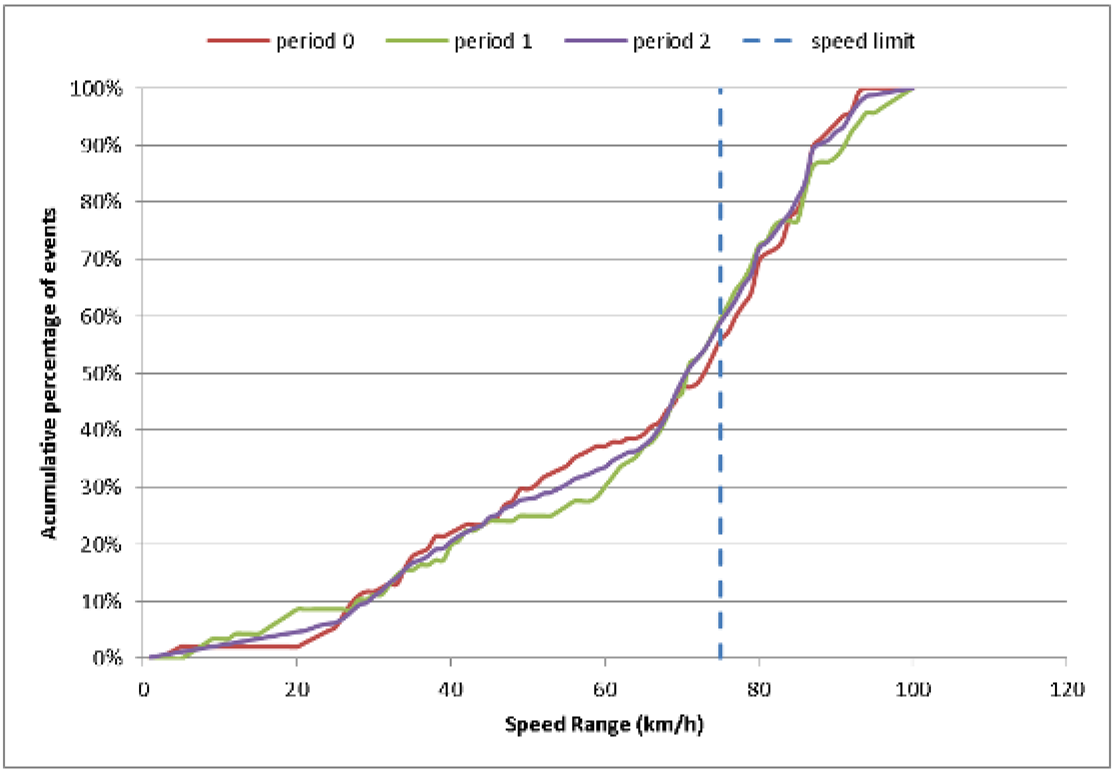



**Figure 83 Speed profile in zone 3170.**

No significant changes in the speed profile.

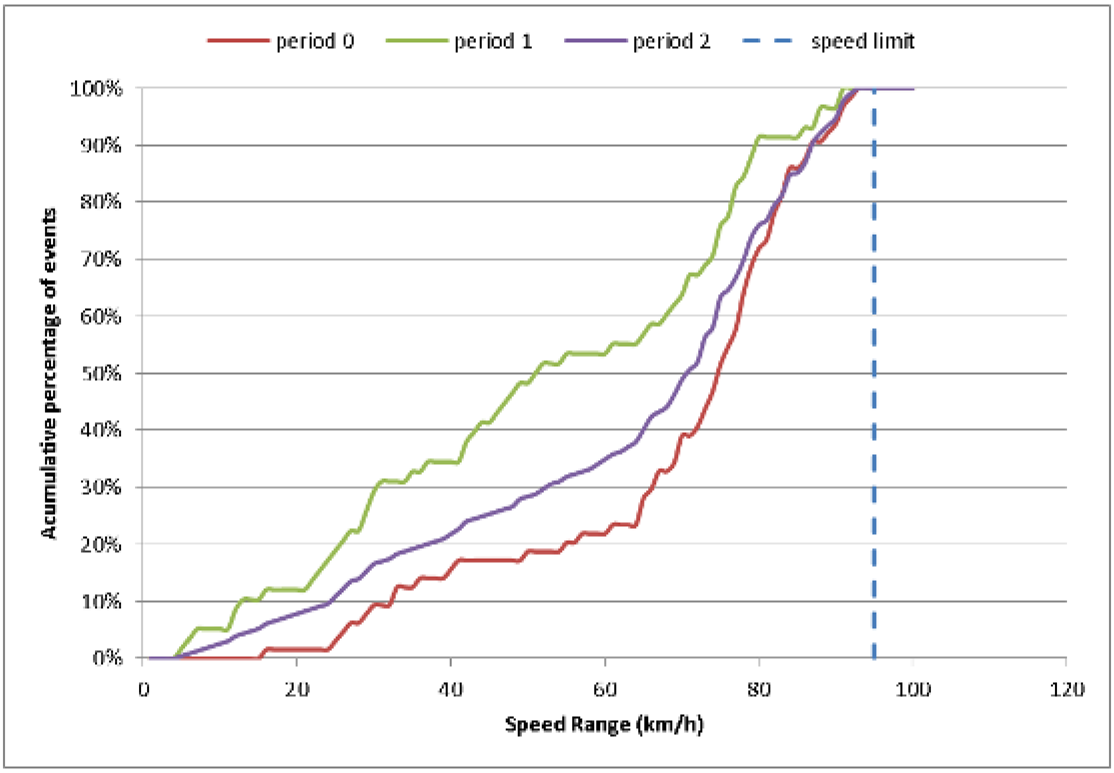



**Figure 84 Speed profile in zone 3190**

No changes in overpseeding, but reduction of the speed profile when using the ASL. Small increase of the speed profile when deactivating the system.

Conclusion

- Very low percentage of distance in zones apart zone 3170
- No significant variation of fuel consumption in zone 3170
- Very few limitations in any zones; almost no overridden

• L31 / Lyon / Pomona Saint-Priest / P45409

SL activated in period 2.

| **Zone** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 0 | 90% | 89% | 89% | *89%* |
| 3130 | 0% | 0% | 0% | *0%* |
| 3150 | 0% | 0% | 0% | *0%* |
| 3170 | 9% | 10% | 10% | *10%* |
| 3190 | 1% | 1% | 1% | 1% |

**Table 126 Distribution of distance between zones for each period for all the drivers**

In this case the quantity of data in zone 3170 is quite significant.

Zone 3170 analyze

| **Speed range** | ***Period*** |
|---|---|
| | ***2*** |
| 0-30 | *2%* |
| 30-50 | *5%* |
| 50-100 | *93%* |
| **0-100** | **100%** |

**Table 127 Distribution of distance per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | 0,1% | *0,0%* |
| 30-50 | 0,1% | *0,2%* |
| 50-100 | 2,2% | *0,9%* |
| **0-100** | **2,4%** | **1,1%** |

**Table 128 Absolute fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | 1 | *2* |
| 0-30 | 5,2% | *1,9%* |
| 30-50 | 2,8% | *3,5%* |
| 50-100 | 2,3% | *1,0%* |
| **0-100** | **2,4%** | **1,1%** |

**Table 129 Absolute fuel consumption variation per speed range and period**

| Zone | Period | Distance (km) | Speed (km/h) | Count (-/100km) | | Fuel (litre/100km) | | *Inside distance (% total)* | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Limiting | Overridden | Limiting | Inside | Active | *Limiting* |
| 3170 | 2 | 1240 | 78,9 | 23 | 0 | 0,3 | 25,3 | 1,2% | *1,2%* |
| 3190 | 2 | 36 | 73,9 | 258 | 6 | 3,6 | 25,5 | 25,9 % | 18,6% |

**Table 130 Distance and fuel consumption in limiting and overridden situations per zone**

Overspeeding analyze

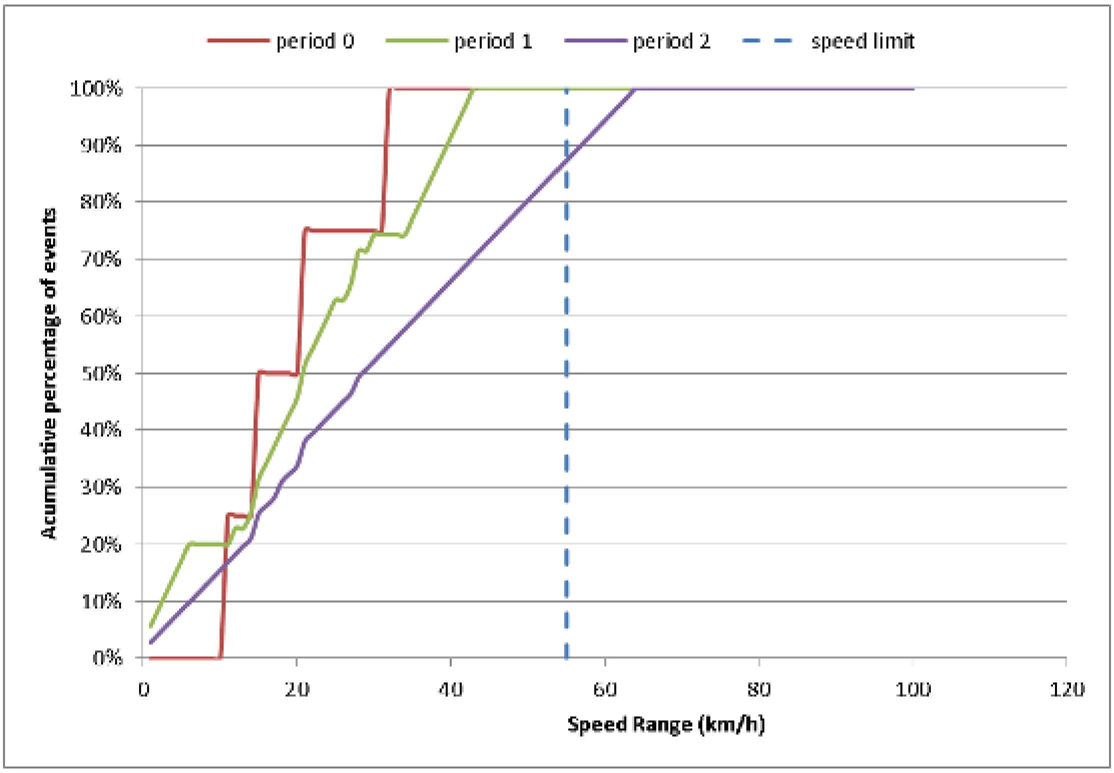



**Figure 85 Speed profile in zone 3150.**

Not enough quantity for concluding.

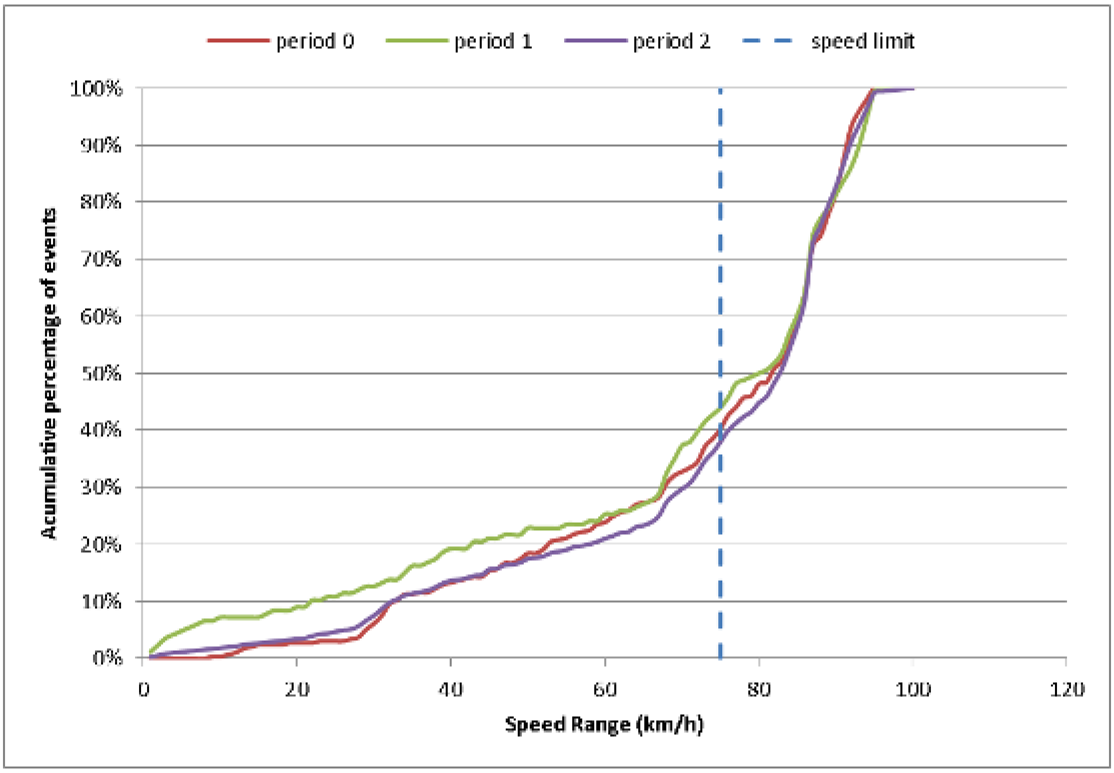



**Figure 86 Speed profile in zone 3170.**

No significant changes in the speed profile.

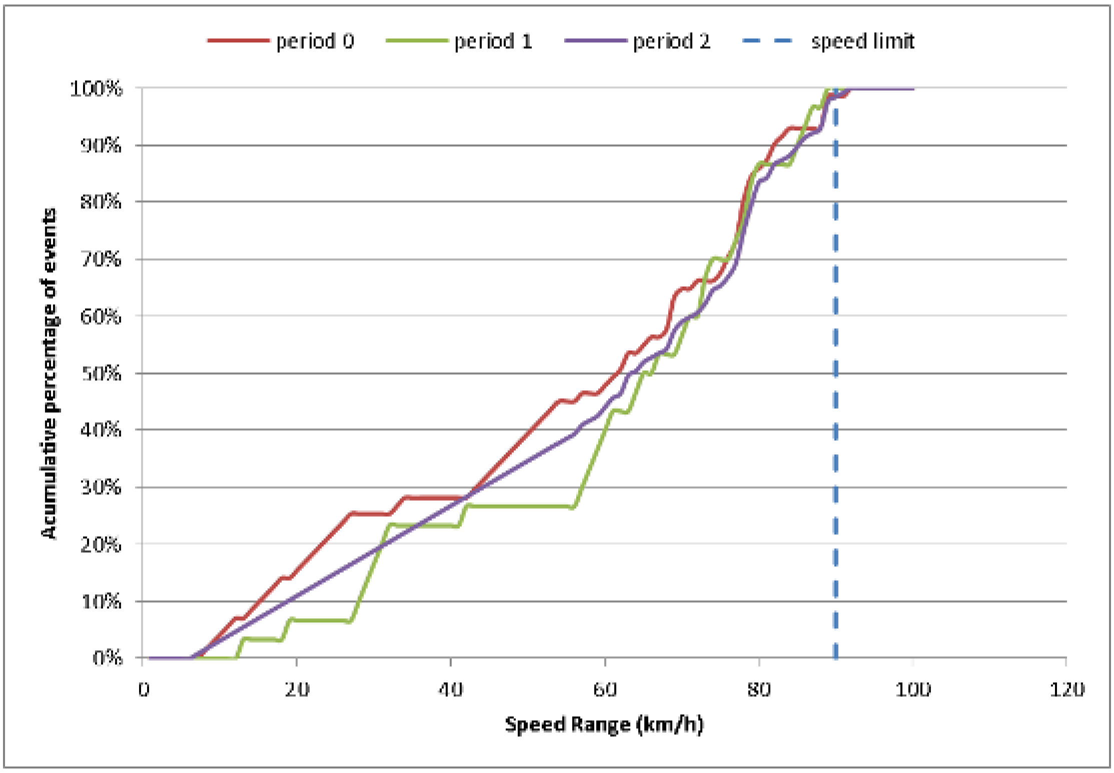



**Figure 87 Speed profile in zone 3190.**

No significant changes in the speed profile.

Conclusion

- Very low percentage of distance in zones; main zone was 3170
- Increase of fuel consumption in zone 3170 (noise)
- Very few limitations in any zones; almost no overridden

#### 3.3.3.3.1 Questionnaires

Only one driver answers the questionnaire in Lyon (see Annex 3). Some of the items have a negative value:

- I think I have achieved a higher driving comfort using Speed Limiter (4 points)
- I think that using the Speed Limiter Service increases the efficacy of my work (2 points)
- I believe that my work conditions have improved with the use of the Speed Limiter service (4 points)
- I drive in a more effective way reducing my fuel consumption when using Speed Limiter service (4 points)
- Using the Speed Limiter service, I consider my driving is more safety (4 points)
- I am confident in my ability to drive the truck safely with the Speed Limiter service (4 points)
- The use of the Speed Limiter service helps me in the driving task (4 points)
- After using Speed Limiter I like the service (4 points)

Although there were some items with negative scores the sense is positive to evaluate the answer:

- Speed Limiter services disturbs me when I drive (2 points)
- More I use the Speed Limiter service, I feel more apprehensive about it (4 points)
- I believe the urban congestion has increased with the usage of the Speed Limiter service (2 points)

With medium values we have the next items:

- The use of Speed Limiter services makes urban driving easier (5 points)
- I am confident of using Speed Limiter service (5 points)
- I think that the use of the Speed Limiter service has provided me more efficient and controlled delivery practices (5 points)
- I consider that I have adopted an eco-friendly style when using Eco-driving support service (6 points)

The results with the fleet operators are:

- The use of Speed Limiter services makes urban driving easier
- We think that using the ASL services increases the efficacy of our company work
- The image of the city has improved with the use of Speed Limiter service
- We believe the Speed Limiter service works properly
- We believe the urban congestion has increased with the usage of the Speed Limiter service

The other items had a score of 8 points:

- We think the Speed Limiter is effective to not exceed the speed limitations
- The freight transport image in urban areas is improved with the usage of ASL service
- According our perception, the ASL service improves the environmental image of our company
- Our company trust the ASL service

- Using the ASL service, our company consider safer the driving of our drivers
- After using ASL our company like the service
- Our company accept increase on journey duration as a trade off to decreased fuel consumption

Additional information about the questionnaires is included in Annex III.

#### 3.3.3.4. Validation of hypothesis and conclusions

Conclusions of the results of the ASL system are presented below.

| City | TruckID | Fuel consumption variation | Limitations (main zone) | *Overspeeding reduction* |
|---|---|---|---|---|
| Bilbao | B04 | 2.8% | 0 times/100 km | Yes (zone 30 km/h) |
| Bilbao | B06 | 0.5% (not significant) | 27 times/100 km | Yes (zones 30 and 50 km/h) |
| Helmond | H15 | 4.5% | 35 times/100 km | No |
| Helmond | H16 | -0.5% (not significant) | 93 times/100 km | No |
| Lyon | L28 | 0.2 % (not significant) | 15 times/100 km | No |
| Lyon | L29 | No periodic data in baseline | 273 times/100 km | -- |
| Lyon | L30 | -0.6% (not significant) | 13 times/100 km | No |
| Lyon | L31 | 1.1% (not significant) | 23 times/100 km | No |

**Table 131 Results of the ASL system.**

In terms of fuel consumption there is reduction, but this was expected since lower speed doesn't mean lower consumption. The relation "instantaneous speed-fuel consumption" is a second grade curve with a minimum value in medium speeds. When limiting speed to less than the speed related to the minimum consumption we are increasing the fuel consumption.

At the same time the system works only within defined zones, that represented less than 1% of the total fuel consumption of most of the trucks in the pilot, therefore any fuel consumption reduction would apply to this 1% and would be insignificant.

The scope of this limiter is more safety-related than economic related. The driver has a fundamental role in the success of this system since he can accept or reject the limitation, Data Analysed above shows that most of the times the drivers were rejecting the limitation.

Finally, the table with the results regarding the hypotheses proposed is included below.

| | Hypothesis | Comment |
|---|---|---|
| ✗ | Using the Speed Limiter service reduces fuel consumption | There are no a clear decrease of the fuel consumption (Table 96 and Table 97). |
| ✓ | Average speed of the truck will decrease with the usage of the speed limiter | There are a almost general reduction of the speed profile (Figure 65- Figure 87) |

| | Hypothesis | Comment |
|---|---|---|
| ✓ | Using the Speed Limiter service, the driver will accept/acknowledge speed limit recommendations from the system | The Speed Limiter recommendations have been evaluated positively by the drivers. |
| ✓ | Using the Speed Limiter service, the driver will be not be disturbed in his driving task | The use of the SL service helps the drivers in their driving task. |
| ✓ | The Speed Limiter service is appreciated by drivers | After using the system, the drivers like the service. |
| ✓ | Drivers will perceive that speed limiter service is reliable | Drivers perceive that speed limiter service is very reliable. |
| ✓ | Drivers will find the speed limiter is useful when driving | Participants believe the system is useful. |
| ✓ | Drivers will think the speed limiter is easy to use | Driver do not have difficulties to understand the speed limiter. |
| ✗ | Drivers' stress perception will decrease with the speed limiter usage | Participants do not believe the speed limiter was a system that helps to reduce their stress perception |
| ✓ | Perceived risk of accidents will decrease with the speed limiter usage | Drivers considered the perception of risk of accidents decrease with the SL usage. |
| ✗ | According to the driver perception, the speed limiter system will improve the freight transport image in urban areas | The freight transport image in urban areas does not change, according to the driver perception. |
| ✓ | Drivers will trust the speed limiter system | Drivers are safe while they are using the system. |

### 3.3.4. EDS

The methodology followed for analyzing the EDS consumption is similar to the one used for the AL system but using the score of drivers in order to compare the fuel consumption reduction to the use of the system (better score means better following of the advices). The event used in this case is the EDS cycle duration.

- Analysis of the trucks for all periods: number of events, distance, moving fuel consumption, moving time
- Identification of the principal drivers and the truck utilization for the selected drivers
    - Percentage of distance covered by each drivers per period: the aim of this analysis is to select the principal drivers that have significantly used the system, i.e. with a percentage of total distance over 10%
    - Number of events, distance, average moving fuel consumption, average speed, average scores per day
    - Distribution of distance in each speed range: this analysis permits to understand the use of the truck (urban, suburban or long haul). This speed profile is very important for

the presented analysis since the fuel consumption depends on the speed. In order to have comparable data, the speed profiles should be similar, reducing in this way the uncertainty of the fuel consumption due to the difference of distance repartition. Two distributions of speed ranges are used in the deliverable: from 0 to 100 km/h with 10 km/h steps (all events which speed is comprised between S and S+10 km/h); from 0 to 100 km/h in three steps, 0-30 km/h (urban), 30-50 km/h (suburban) and 50-100 km/h (interurban). This last speed profile is used for the Business Models.

  - Number of events, distance, average moving fuel consumption, average speed, average scores per day: the aim of this analysis is to understand the truck utilization and to control how regular it is during the whole pilot. It should be noticed that the average speed and fuel consumption parameters include stops.

- Comparison of the number of events, distance, moving fuel consumption, moving time between periods per speed range for the selected drivers: the aim of this comparison as in the AL methodology is to check if there are any deviations between periods, which could mean that the truck have been used differently with consequences on the evaluation (all periods must be consistent during the pilot).
- Comparison of scores distributions between periods for the selected drivers: in the case of the EDS, the way the system performs can be depicted by the evolution of the scores during the pilot. Each score can be Analysed to understand the driver's behavior but for the purpose of the evaluation, a total score is defined
  - For trucks with manual transmission: average of all scores
  - For trucks with automated transmission: average of acceleration pedal and hard brake scores

  The graphs show the distribution of scores, representing the percentage of the time a score is present in the database. Comparing the same plot for the different periods it can be easily concluded if there was an improvement in the scores of the driver or not.
- Analysis of the moving fuel consumption per 100 kilometers and total score in each speed range: it is used to determine the evolution of fuel consumption per 100 km and total scores by speed range and to check the consistency of each parameter (an increase of total score should result in a decrease of fuel consumption per 100 km and vice versa). It should notice that the link between both parameters isn't direct because fuel consumption per 100 km depends on unknown parameters like truck load or traffic which impacts are supposed to be negligible on a long period. The assumption may be not correct when the number of event used is low or when the vehicle utilization has changed significantly during the pilot.
- Results: for the selected drivers
  - Evolution of moving fuel consumption per 100 km and total score per speed range
  - Evolution of moving fuel consumption and total score per speed range; the distribution of distance that is taken as reference is calculated over the total period and for all selected drivers so that a comparison can be done between periods and between drivers (as in the AL case).
  - Evolution of moving fuel consumption per speed range: to present the results in a leaner way, the speed range that is taken is that of the Business Model.

An example of the above methodology is detailed in Annex III. It is applied to all trucks in order to have different results depending on the use of the truck. General results are presented below, while detailed results for each truck are presented in Annex III.

#### 3.3.4.1. Results in Bilbao

- Total scores per driver in period 0

| DriverID | Speed range | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0-10 | 10-20 | 20-30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 | 80-90 | *90-100* |
| E03095687W000010 | 100 | 98 | 87 | 81 | 80 | 78 | 80 | 80 | 82 | *96* |
| E03110308H000000 | 100 | 98 | 88 | 87 | 86 | 87 | 80 | 84 | 81 | *76* |
| E03076129V000000 | 100 | 98 | 93 | 86 | 81 | 81 | 81 | 82 | 81 | *88* |
| E03104242R000000 | 100 | 98 | 90 | 83 | 86 | 82 | 86 | 80 | 81 | *81* |
| Driver behaviors: Green = best; orange = average; red = lowest; white = undetermined | | | | | | | | | | |

**Table 132 Total score per driver and speed range (period 0)**

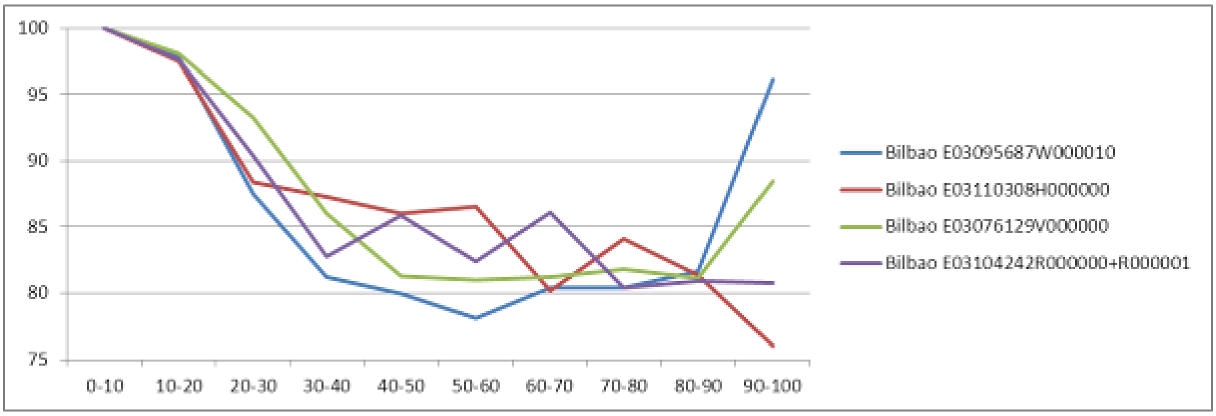



**Figure 88 Total score per driver and speed range (period 0)**

In Bilbao, an initial classification of the drivers cannot be done because their ranks depend on speed ranges. The large difference of total score in the 90-100 km/h can be attributed to the small number of events.

- B04 / Nanuk / 8594-GHY

EDS activated in period 1 and 2.

| DriverID | Period | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | *Total* |
| E03095687W000010 | 42% | 46% | 30% | *40%* |
| E03110308H000000 | 18% | 46% | 17% | *24%* |
| E08995819J000000 | 22% | 2% | 0% | 13% |

**Table 133 Distance distribution per driver and period**

Driver E08995819J000000 is excluded due to the low distances in periods 1 and 2.

| Speed range | DriverID | | |
|---|---|---|---|
| | E03095687W000010 | E03110308H000000 | *Total* |
| 0-30 | 1% | 1% | *1%* |
| 30-5 | 2% | 3% | *2%* |
| 50-100 | 97% | 96% | 97% |

**Table 134 Distance distribution per driver and speed range**

| Speed range | *DriverID and period* |
|---|---|

| | E03095687W000010 | | *E03110308H000000* | |
|---|---|---|---|---|
| | **1** | **2** | **1** | ***2*** |
| 0-30 | 0,0% | 0,0% | 0,0% | *0,0%* |
| 30-50 | 0,0% | 0,0% | 0,0% | *0,0%* |
| 50-100 | 1,0% | 3,4% | 3,1% | *1,0%* |
| **0-100** | **1,0%** | **3,4%** | **3,2%** | **1,0%** |

**Table 135 Relative fuel consumption variation per speed range and period**

| Speed range | *DriverID and period* | | | |
|---|---|---|---|---|
| | E03095687W000010 | | *E03110308H000000* | |
| | 1 | 2 | 1 | *2* |
| 0-30 | 5,4% | 2,9% | 2,8% | *-2,9%* |
| 30-50 | 2,4% | -4,4% | 1,6% | *-3,2%* |
| 50-100 | 1,0% | 3,5% | 3,2% | *1,0%* |
| **0-100** | **1,0%** | **3,4%** | **3,2%** | **1,0%** |

**Table 136 Absolute fuel consumption variation per speed range and period**

Conclusion

- 2 principal drivers in long haul utilization
- Both drivers have failed to reduce their fuel consumptions but both have reduced it in period 2 in the 0-50 km/h speed range (but high incertitude due to low distance in this speed range)
  - Total scores have increased in the speed range 50-100 km/h, which doesn't reflect the fuel reduction in the speed range; this trend confirms the hypothesis proposed in AL analysis (changes in operating conditions that haven't been identified).
- B05 / Nanuk / 8602-GHY

EDS activated in period 2. Second selected driver changed of driverID during the pilot; driverID corresponds to E03104242R000000 + E03104242R000001

| DriverID | *Period* | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | *Total* |
| E03076129V000000 | 46% | 47% | 46% | *46%* |
| E03104242R000000 | 38% | 49% | 41% | 41% |

**Table 137 Distance distribution per driver and period**

| Speed range | DriverID | | |
|---|---|---|---|
| | E03076129V000000 | E03104242R000000 | *Total* |
| 0-30 | 1% | 1% | *1%* |
| 30-5 | 1% | 1% | *1%* |
| 50-100 | 98% | 98% | 98% |

**Table 138 Distance distribution per driver and speed range**

| Speed range | *DriverID and period* |
|---|---|

| | E03076129V000000 | | *E03104242R000000* | |
|---|---|---|---|---|
| | 1 | 2 | 1 | *2* |
| 0-30 | 0,0% | 0,0% | 0,0% | *0,0%* |
| 30-50 | 0,0% | 0,0% | 0,0% | *0,0%* |
| 50-100 | 1,1% | 0,7% | 7,1% | *2,5%* |
| **0-100** | **1,0%** | **0,7%** | **7,1%** | **2,5%** |

**Table 139 Relative fuel consumption variationper speed range and period**

| Speed range | *DriverID and period* | | | |
|---|---|---|---|---|
| | E03076129V000000 | | *E03104242R000000* | |
| | 1 | 2 | 1 | *2* |
| 0-30 | -0,1% | 0,4% | 5,1% | *2,1%* |
| 30-50 | -4,8% | -3,3% | -2,9% | *0,5%* |
| 50-100 | 1,1% | 0,7% | 7,2% | *2,6%* |
| **0-100** | **1,0%** | **0,7%** | **7,1%** | **2,5%** |

**Table 140 Absolute fuel consumption variation per speed range and period**

Conclusions

- 2 principal drivers in long haul utilization
- Both drivers have failed to reduce their total fuel consumptions; nevertheless, in period 2 the variations have been reduced; results in speed range 0-50 km/h may be considered as noise due to the low distance covered
- The variations of the total scores don't correctly reflect the variations of fuel consumption which confirms the hypothesis proposed in the AL analysis ( change in the operating conditions that haven't been identified)

#### 3.3.4.2. Results in Helmond

- Total scores per driver in period 0

**Table 141-Score per driver and speed range (period 0).**

| DriverID | *Speed range* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0-10 | 10-20 | 20-30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 | 80-90 | *90-100* |
| 239336000000 | 100 | 93 | 78 | 66 | 62 | 59 | 61 | 61 | 63 | *100* |
| 69683000000 | 100 | 98 | 88 | 80 | 75 | 72 | 67 | 73 | 82 | |
| 224753000000 | 100 | 98 | 90 | 86 | 83 | 81 | 79 | 79 | 80 | |
| Driver behaviors: Green = best; orange = average; red = lowest; white = undetermined | | | | | | | | | | |

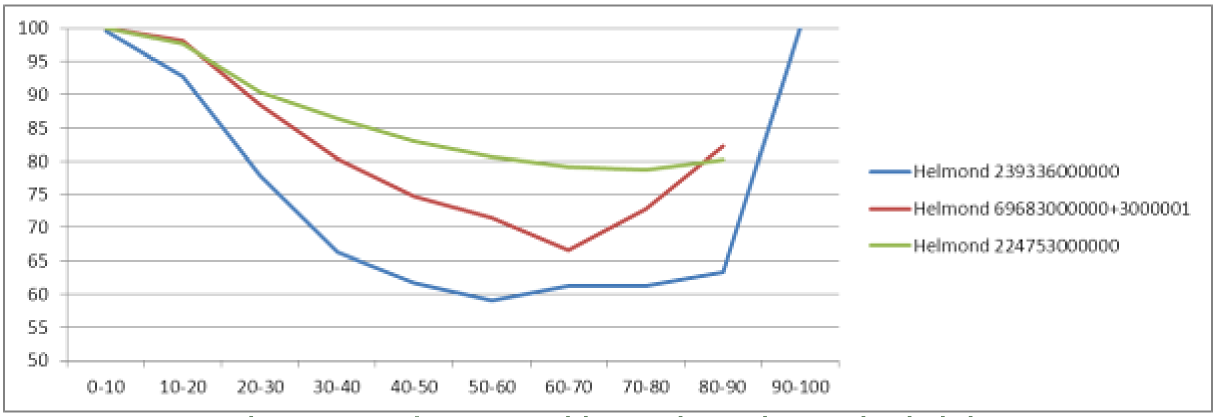



**Figure 89 Total score per driver and speed range (period 0).**

In Helmond, the drivers can be clearly classified because the ranks don't depend on the speed ranges.

- H16 / Van Den Broek / BT-DB-24

EDS activated in period 1

| **DriverID** | ***Period*** | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 239336000000 | 78% | 21% | 39% |

**Table 142 Distance distribution per driver and period.**

| **Speed range** | ***% of distance*** |
|---|---|
| 0-30 | *4%* |
| 30-50 | *11%* |
| 50-100 | 85% |

**Table 143 Distance distribution per speed range for the driverID 239336000000.**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *0,0%* |
| 30-50 | *-0,1%* |
| 50-100 | *0,2%* |
| **0-100** | **0,1%** |

**Table 144 Relative fuel consumption variation per speed range and period**

| Speed range | *Period* |
|---|---|
| | *1* |
| 0-30 | *-0,8%* |
| 30-50 | *-0,8%* |
| 50-100 | *0,3%* |
| **0-100** | **0,1%** |

**Table 145 Absolute fuel consumption variation per speed range and period**

Conclusions

- 1 principal driver in suburban utilization with lowest initial scores
- No variation in fuel consumption
- Variations of total scores don't fully reflect the variations of fuel consumption over the whole speed range; it is consistent with the hypothesis made in the AL analysis (change in the operating conditions that haven't been identified); nevertheless, values are low and can be considered as noise.

- H17 / Van Den Broek / BT-NZ-86

EDS activated in period 1

| DriverID | *Period* | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 69683000000 | 67% | 57% | 60% |

**Table 146 Distance distribution per driver and period.**

| Speed range | *% of distance* |
|---|---|
| 0-30 | *1%* |
| 30-50 | *2%* |
| 50-100 | 97% |

**Table 147 Distance distribution per driver and speed range for the driverID 69683000000.**

| Speed range | *Period* |
|---|---|
| | *1* |
| 0-30 | *-0,1%* |
| 30-50 | *-0,2%* |
| 50-100 | *-2,4%* |
| **0-100** | **-2,7%** |

**Table 148 Relative fuel consumption variation per speed range and period**

| Speed range | *Period* |
|---|---|
| | *1* |
| 0-30 | *-7,5%* |
| 30-50 | *-8,1%* |
| 50-100 | *-2,5%* |
| **0-100** | **-2,7%** |

**Table 149 Absolute fuel consumption variation per speed range and period**

Conclusion

- 1 principal driver in long haul utilization with average initial scores
- Significant reduction of fuel consumption in all speed ranges; in absolute, the reduction is high in the 0-50 km/h speed range but the incertitude is high due to the low distance covered.
- Increase of total scores increases in all speed ranges, which confirms the fuel reduction trends over the whole speed range.

- H18 / Van Den Broek / BT-NZ-87

EDS activated in period 1

| DriverID | *Period* | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 224753000000 | 99% | 12% | 33% |

**Table 150 Distance distribution per driver and period**

| Speed range | *% of distance* |
|---|---|
| 0-30 | *2%* |
| 30-50 | *6%* |
| 50-100 | 92% |

**Table 151 Distance distribution per speed range for the driverID (224753000000)**

| Speed range | *Period* |
|---|---|
| | *1* |
| 0-30 | *0,1%* |
| 30-50 | *0,1%* |
| 50-100 | *3,2%* |
| **0-100** | **3,3%** |

**Table 152 Relative fuel consumption variation per speed range and period**

| Speed range | *Period* |
| --- | --- |
| | ***1*** |
| 0-30 | *2,6%* |
| 30-50 | *1,2%* |
| 50-100 | *3,5%* |
| **0-100** | **3,3%** |

**Table 153 Absolute fuel consumption variation per speed range and period**

Conclusion

- 1 principal driver in long haul utilization with best initial scores
- Increase of fuel consumption in all speed ranges
- Decrease of total scores in the 50-100 km/h speed range which confirms the high fuel increase in the speed range

#### 3.3.4.2.1 Questionnaires

The driver 3 have higher scores than the other two drivers (see Annex 1). The items with lowest values are the next:

- I believe the Eco-driving support service works properly
- It is simple to identify the functions of the Eco-driving support

The items with highest values are: “After using Eco-driving support I like the service”, “I think the Eco-driving support improves the freight transport image in urban areas taking into account that it use reduces the $CO_2$ emissions and other pollutants”, “I think the Eco-driving is effective to reduce the fuel consumption and the pollutants”, “The freight transport image in urban areas is improved with the usage of Eco-driving support” and “I am confident of using Eco-driving support”.

Additional information about the questionnaires is included in Annex III.

### 3.3.4.3. Results in Krakow

- Total scores per driver in period 0

| DriverID | Speed range | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0-10 | 10-20 | 20-30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 | 80-90 | *90-100* |
| 580524001320000+20001 | 100 | 97 | 96 | 95 | 95 | 95 | 96 | 95 | 95 | *93* |
| 680103009580000+80001 | 99 | 94 | 91 | 92 | 91 | 92 | 92 | 94 | 92 | *85* |
| 570125040190000+90001 | 100 | 99 | 97 | 97 | 97 | 97 | 98 | 98 | 97 | *100* |
| 600907040750000+50001 | 100 | 98 | 94 | 95 | 96 | 95 | 96 | 96 | 95 | *92* |
| 840321051710000 | 100 | 99 | 98 | 97 | 98 | 97 | 96 | 95 | 94 | *91* |
| 701224043360000+60001 | 100 | 98 | 96 | 95 | 95 | 94 | 96 | 95 | 94 | *92* |
| 840321051710000 | 100 | 99 | 98 | 97 | 98 | 97 | 96 | 95 | 94 | *91* |
| Driver behaviors: Green = best; orange = average; red = lowest; white = undetermined | | | | | | | | | | |

**Table 154 Score per driver and speed range (period 0)**

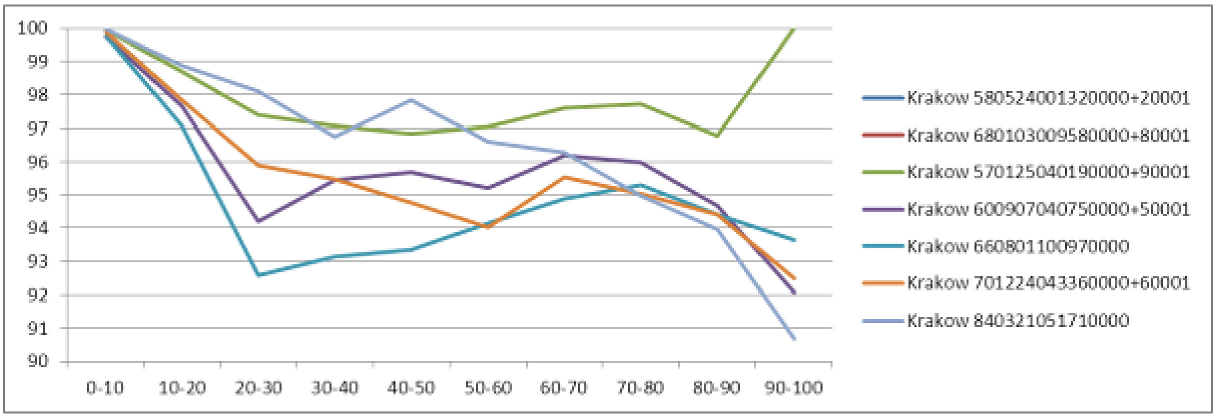



**Figure 90 Total score per driver and speed range (period 0)**

In Krakow, a classification of the drivers can be proposed. A driver has highest scores and two others have lowest scores. Total scores in the speed range 90-100 km/h have large incertitudes due to the low number of events.

- K01 / Krakow / Temperi / KR-763-CY

EDS activated in period 1. Selected driver changed of driverID during the pilot; driverID corresponds to 580524001320000 + 580524001320001.

| DriveID | *Period* | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 580524001320000 | 100% | 90% | 92% |

**Table 155 Distance distribution per driver and period.**

| **Speed range** | ***% of distance*** |
|---|---|
| 0-30 | *1%* |
| 30-50 | *2%* |
| 50-100 | 97% |

**Table 156 Distance distribution per driver and speed range for the driverID 580524001320000.**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *0,1%* |
| 30-50 | *0,1%* |
| 50-100 | *10,2%* |
| **0-100** | **10,3%** |

**Table 157 Relative fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** |
|---|---|
| | ***1*** |
| 0-30 | *7,3%* |
| 30-50 | *4,7%* |
| 50-100 | *10,4%* |
| **0-100** | **10,3%** |

**Table 158 Absolute fuel consumption variation per speed range and period**

Conclusions

- 1 principal driver in long haul utilization
- High increase of fuel consumption in the whole speed range
- Total scores didn't change between periods; the large variation of fuel consumption can only be attributed to variations of utilization of the truck

- K02 / Krakow / Temperi / KR-655-EA

EDS activated in period 1.

| **Driveid** | ***Period*** | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 680103009580000 | 100% | 100% | 100% |

**Table 159 Distance distribution per driver and period**

Selected driver changed of driverID during the pilot; driverID corresponds to 680103009580000 + 680103009580001

| Speed range | *DriverID* |
|---|---|
| 0-30 | *1%* |
| 30-50 | *2%* |
| 50-100 | 97% |

**Table 160 Distance distribution per driver and speed range fro the driverID 680103009580000.**

| Speed range | *Period* |
|---|---|
| | *1* |
| 0-30 | *0,0%* |
| 30-50 | *0,0%* |
| 50-100 | *6,3%* |
| **0-100** | **6,4%** |

**Table 161 Relative fuel consumption variation per speed range and period**

| Speed range | *Period* |
|---|---|
| | ***1*** |
| 0-30 | *4,3%* |
| 30-50 | *1,8%* |
| 50-100 | *6,5%* |
| **0-100** | **6,4%** |

**Table 162 Absolute fuel consumption variation per speed range and period**

Conclusion

- 1 principal driver in long haul utilization
- High increase of fuel consumption in the whole speed range
- Total scores didn't change between periods; the large variation of fuel consumption can only be attributed to variations of utilization of the truck

- K03 / Krakow / Temperi / KR-864-CR

EDS activated in period 1

| Driveid | *Period* | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 570125040190000 | 100% | 64% | 73% |

**Table 163 Distance distribution per driver and period**

| Speed range | *% of distance* |
|---|---|
| 0-30 | *1%* |
| 30-50 | *2%* |
| 50-100 | 97% |

**Table 164 Distance distribution per driver and speed range for the driverID 570125040190000 .**

| **Speed range** | ***Period*** |
|---|---|
| | *1* |
| 0-30 | *0,0%* |
| 30-50 | *-0,2%* |
| 50-100 | *0,4%* |
| **0-100** | **0,2%** |

**Table 165 Relative fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** |
|---|---|
| | *1* |
| 0-30 | *0,8%* |
| 30-50 | *-11,4%* |
| 50-100 | *0,4%* |
| **0-100** | **0,2%** |

**Table 166 Absolute fuel consumption variation per speed range and period**

Conclusions

- 1 principal driver in long haul utilization with highest initial scores
- No significant variation of fuel consumption (apart in the 0-50 km/h speed range but with high incertitude due to low distance covered)
- No significant variation of total scores that confirms the trend in fuel consumption

- K06 / Krakow / Temperi / KR-785-CR

EDS activated in period 1.

| **DriverID** | ***Period*** | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 600907040750000 | 61% | 48% | *51%* |
| 660801100970000 | 39% | 43% | 42% |

**Table 167 Distance distribution per driver and period**

First selected driver changed of driverID during the pilot; driverID corresponds to 600907040750000+60090704050001

| **Speed range** | ***DriverID*** | | |
|---|---|---|---|
| | **600907040750000** | **660801100970000** | ***Total*** |
| 0-30 | 1% | 1% | *1%* |
| 30-50 | 2% | 2% | *2%* |
| 50-100 | 98% | 97% | 97% |

**Table 168 Distance distribution per driver and speed range**

| Speed range | *DriverID and period* | |
|---|---|---|
| | **600907040750000** | ***660801100970000*** |
| | **1** | ***1*** |
| 0-30 | -0,1% | *-0,1%* |
| 30-50 | 0,0% | *-0,2%* |
| 50-100 | -1,8% | *-6,0%* |
| **0-100** | **-1,9%** | **-6,3%** |

**Table 169 Relative fuel consumption variation per speed range and period**

| Speed range | *DriverID and period* | |
|---|---|---|
| | **600907040750000** | ***660801100970000*** |
| | **1** | ***1*** |
| 0-30 | -11,1%% | *-10,8%* |
| 30-50 | -0,9% | *-11,9%* |
| 50-100 | -1,8% | *-6,2%* |
| **0-100** | **-1,9%** | **-6,3%** |

**Table 170 Absolute fuel consumption variation per speed range and period**

Conclusion

- 2 principal drivers in long haul utilization; first driver has lowest initial scores
- Both drivers have succeeded in reducing their fuel consumptions
- Both drivers increased their total scores all over the speed range; the driver with average initial scores had the highest increase of total scores

• K07 / Krakow / Temperi / KR-195-EA

EDS activated in period 1.

| DriverID | *Period* | | |
|---|---|---|---|
| | **0** | **1** | ***Total*** |
| 701224043360000 | 50% | 51% | *51%* |
| 840321051710000 | 49% | 49% | 49% |

**Table 171 Distance distribution per driver and period.**

First selected driver changed of driverID during the pilot; driverID corresponds to 701224043360000+701224043360001

| Speed range | *DriverID* | | |
|---|---|---|---|
| | **840321051710000** | **701224043360000** | ***Total*** |
| 0-30 | 1% | 0% | *1%* |
| 30-50 | 1% | 1% | *1%* |
| 50-100 | 98% | 98% | 98% |

**Table 172 Distance distribution per driver and speed range.**

| Speed range | *DriverID and period* | |
|---|---|---|
| | **840321051710000** | ***701224043360000*** |
| | **1** | ***1*** |
| 0-30 | 0,0% | *0,0%* |
| 30-50 | 0,2% | *0,1%* |
| 50-100 | 1,2% | *9,5%* |
| **0-100** | **1,4%** | **9,6%** |

**Table 173 Relative fuel consumption variation per speed range and period**

| Speed range | *DriverID and period* | |
|---|---|---|
| | **840321051710000** | ***701224043360000*** |
| | **1** | ***1*** |
| 0-30 | 4,9% | *-0,9%* |
| 30-50 | 13,2% | *6,7%* |
| 50-100 | 1,2% | *9,7%* |
| **0-100** | **1,4%** | **9,6%** |

**Table 174 Absolute fuel consumption variation per speed range and period**

Conclusions

- 2 principal drivers in long haul utilization; first driver has lowest initial scores
- Both drivers haven't succeeded in reducing their fuel consumptions
- Total scores didn't change between periods; the variation of fuel consumption can only be attributed to variations of utilization of the truck

#### 3.3.4.4. Results in Lyon

- Total scores per driver in period 0

| | **DriverID** | ***Speed range*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **0-10** | **10-20** | **20-30** | **30-40** | **40-50** | **50-60** | **60-70** | **70-80** | **80-90** | ***90-100*** |
| Dijon | 1000000324345000 | 100 | 98 | 92 | 87 | 85 | 83 | 83 | 82 | 82 | *69* |
| | 1000000167984000 | 100 | 95 | 89 | 79 | 81 | 68 | 74 | 72 | 76 | |
| | 1000000164724000 | 100 | 96 | 92 | 89 | 87 | 86 | 82 | 81 | 79 | *50* |
| | 1000000361029000 | 99 | 85 | 75 | 73 | 69 | 68 | 66 | 67 | 67 | |
| | 1000000220190000 | 98 | 88 | 83 | 82 | 81 | 82 | 79 | 77 | 76 | *50* |
| Saint-Priest | 1000000491948000 | 99 | 91 | 84 | 81 | 77 | 75 | 75 | 71 | 75 | |
| Annecy | 1000000183457000 | 99 | 91 | 84 | 81 | 80 | 80 | 79 | 82 | 81 | *75* |
| | 1000000182294000 | 100 | 96 | 91 | 87 | 84 | 81 | 83 | 84 | 84 | |
| Valence | 1000000324774000 | 98 | 79 | 72 | 65 | 62 | 62 | 65 | 62 | 67 | |
| | 1000000088576000 | 100 | 96 | 89 | 83 | 78 | 75 | 73 | 66 | 65 | *75* |
| | 1000000024677000 | 99 | 94 | 86 | 83 | 80 | 78 | 75 | 76 | 71 | |
| | 1000000099605000 | 99 | 82 | 76 | 72 | 68 | 66 | 66 | 64 | 65 | *75* |
| Driver behaviors: Green = best; orange = average; red = lowest; white = undetermined | | | | | | | | | | | |

**Table 175 Score per driver and speed range (period 0).**

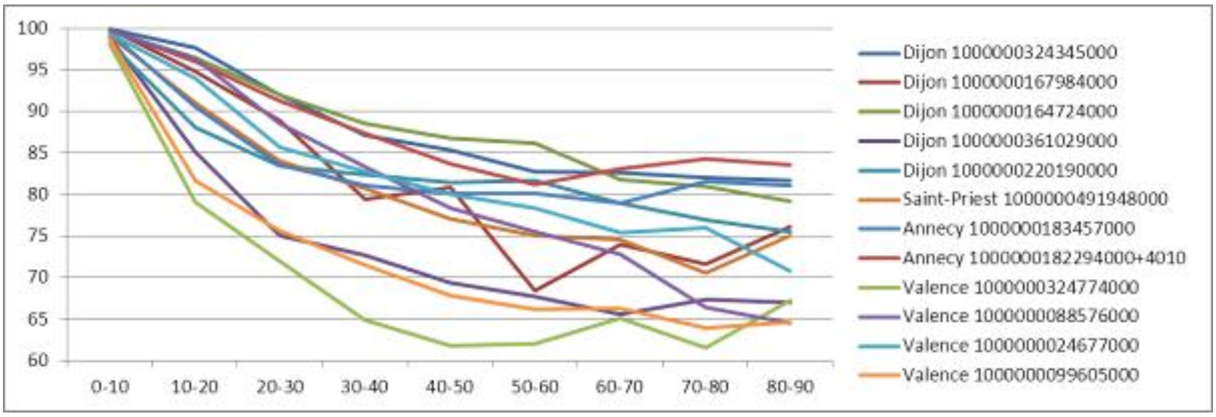



**Figure 91 Total score per driver and speed range (period 0).**

In Lyon, there are large variations of initial scores and a classification of the drivers can be proposed.

- L16 / Lyon / Pomona Dijon / 829-XP-21

EDS activated in period 1 and 2

| **DriverID** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 1000000324345000 | 61% | 63% | 18% | *48%* |
| 1000000167984000 | 7% | 8% | 16% | 11% |

**Table 176 Distance distribution per driver and period.**

| **Speed range** | ***DriverID*** | | |
|---|---|---|---|
| | **1000000324345000** | **1000000167984000** | ***Total*** |
| 0-30 | 4% | 1% | *4%* |
| 30-50 | 12% | 3% | *11%* |
| 50-100 | 84% | 95% | 86% |

**Table 177 Distance distribution per driver and speed range.**

| **Speed range** | ***DriverID and period*** | | | |
|---|---|---|---|---|
| | **1000000324345000** | | ***1000000167984000*** | |
| | **1** | **2** | **1** | ***2*** |
| 0-30 | 0,1% | 0,2% | 0,7% | *0,2%* |
| 30-50 | -0,4% | 0,4% | 4,3% | *1,0%* |
| 50-100 | -0,8% | 2,1% | 2,7% | *-0,6%* |
| **0-100** | **-1,1%** | **2,6%** | **7,6%** | **0,6%** |

**Table 178 Relative fuel consumption variation per speed range and period**

| Speed range | *DriverID and period* | | | |
|---|---|---|---|---|
| | **1000000324345000** | | ***1000000167984000*** | |
| | **1** | **2** | **1** | ***2*** |
| 0-30 | 1,4% | 4,9% | 17,9% | *6,5%* |
| 30-50 | -3,6% | 3,4% | 40,3% | *9,2%* |
| 50-100 | -0,9% | 2,4% | 3,1% | *-0,7%* |
| **0-100** | **-1,1%** | **2,6%** | **7,6%** | **0,6%** |

**Table 179 Absolute fuel consumption variation per speed range and period**

Conclusion

- 2 principal drivers; first driver (DriverID 1000000324345000) in suburban utilization with high initial scores; second driver (DriverID 1000000167984000) in long haul utilization with no classification
- Driver 1000000324345000: total fuel consumption decreases in period 1 and increases in period 2; total scores confirm the trends with an increase in period 1 and a decrease in period 2
- Driver 1000000167984000: total fuel consumption increases in period 1 and no variation (noise) in period 2; total scores confirm the trends with a decrease in period 1 and no variation in period 2; incertitude at low and medium speed ranges due to the distances covered

- L18/ Lyon / Pomona Dijon / 9220-XH-21

EDS activated period 1 and 2

| DriverID | *Period* | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | *Total* |
| 1000000361029000 | 36% | 70% | 58% | *58%* |
| 1000000164724000 | 26% | 3% | 9% | 10% |

**Table 180 Distance distribution per driver and period**

| Speed range | *DriverID* | | |
|---|---|---|---|
| | 1000000164724000 | 1000000361029000 | *Total* |
| 0-30 | 0 | 0 | *3%* |
| 30-50 | 12% | 10% | *12%* |
| 50-100 | 85% | 87% | 85% |

**Table 181 Distance distribution per driver and speed range**

| Speed range | *DriverID and period* | | | |
|---|---|---|---|---|
| | **1000000361029000** | | ***1000000164724000*** | |
| | **1** | **2** | **1** | ***2*** |
| 0-30 | -0,1% | -0,4% | 0,0% | *-0,3%* |
| 30-50 | 0,3% | -0,6% | 1,4% | *-2,0%* |
| 50-100 | 1,0% | -1,6% | -2,7% | *-0,9%* |
| **0-100** | **1,2%** | **-2,6%** | **-1,3%** | **-3,2%** |

**Table 182 Relative fuel consumption variation per speed range and period**

| Speed range | *DriverID and period* | | | |
|---|---|---|---|---|
| | **1000000361029000** | | ***1000000164724000*** | |
| | **1** | **2** | **1** | ***2*** |
| 0-30 | -4,8% | -13,6% | -1,1% | *-10,7%* |
| 30-50 | 2,6% | -4,7% | 11,8% | *-16,5%* |
| 50-100 | 1,2% | -1,9% | -3,2% | *-1,1%* |
| **0-100** | **1,2%** | **-2,6%** | **-1,3%** | **-3,2%** |

**Table 183 Absolute fuel consumption variation per speed range and period**

Conclusion

- 2 principal drivers: both in suburban utilization; first driver (DriverID 1000000164724000) with high initial scores; second driver (DriverID 1000000361029000) with lowest initial scores
- Driver 1000000361029000: decrease of fuel consumptions only in period 2; total scores confirm the observed trends
- Driver 1000000164724000: decrease of total fuel consumptions in both periods but highest performance in period 2 with a decrease in all speed ranges; nevertheless, total scores didn't clearly reflect these trends (high incertitude due to short distances covered in period 1 and 2)

- L19 / Lyon / Pomona Dijon / 9222-XH-21

EDS activated period 1 and 2.

| DriverID | *Period* | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 1000000220190000 | 76% | 61% | 70% | 67% |

**Table 184 Distance distribution per driver and period.**

Selected driver changed of driverID during the pilot; driverID corresponds to 1000000220190000 + 1000000220190010.

| Speed range | *DriverID* |
|---|---|
| | ***1000000220190000*** |
| 0-30 | *2%* |
| 30-50 | *8%* |
| 50-100 | 90% |

**Table 185 Distance distribution per driver and speed range.**

| Speed range | *Period* | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | 0,2% | *0,3%* |
| 30-50 | 0,4% | *0,6%* |
| 50-100 | 3,1% | *6,0%* |
| **0-100** | **3,7%** | **6,8%** |

**Table 186 Relative fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | **1** | ***2*** |
| **0-30** | **6,7%** | ***11,0%*** |
| **30-50** | **4,8%** | ***6,9%*** |
| **50-100** | **3,5%** | ***6,7%*** |
| **0-100** | **3,7%** | **6,8%** |

**Table 187 Absolute fuel consumption variation per speed range and period**

Conclusion:

- 1 principal driver in suburban utilization with average initial scores
- Increase of fuel consumptions in both periods and at all speed ranges; total scores confirm the observed trends at all speed ranges

* L32 / Lyon / Pomona Saint-Priest / P45411

EDS activated period 1 and 2. Driver 1000000663961000 is excluded due to no baseline period.

| **DriverID** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 1000000491948000 | 30% | 42% | 44% | *41%* |
| 1000000663961000 | 0% | 22% | 17% | 16% |

**Table 188 Distance distribution per driver and period**

| **Speed range** | ***DriverID*** |
|---|---|
| | ***1000000491948000*** |
| 0-30 | *9%* |
| 30-50 | *28%* |
| 50-100 | 63% |

**Table 189 Distance distribution per speed range.**

| **Speed range** | ***Period*** | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | -0,5% | *-0,5%* |
| 30-50 | -2,3% | *-2,6%* |
| 50-100 | -2,9% | *-3,5%* |
| **0-100** | **-5,7%** | **-6,6%** |

**Table 190 Relative fuel consumption variation per speed range and period**

| **Speed range** | ***Period*** | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | -5,6% | *-5,0%* |
| 30-50 | -8,2% | *-9,3%* |
| 50-100 | -4,6% | *-5,6%* |
| **0-100** | **-5,7%** | **-6,6%** |

**Table 191 Absolute fuel consumption variation per speed range and period**

Conclusion:

- 1 principal driver in urban / suburban utilization with average initial scores
- High reduction of fuel consumptions in both periods and at all speed ranges; total scores confirm the observed trends in all speed ranges

- L33 / Lyon / Pomona Annecy / P45412

EDS activated in period 1 and 2

| **DriverID** | ***Period*** | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 1000000183457000 | 55% | 76% | 78% | 71% |

**Table 192 Distance distribution per driver and period.**

| **Speed range** | ***DriverID*** |
|---|---|
| | ***1000000183457000*** |
| 0-30 | *6%* |
| 30-50 | *30%* |
| 50-100 | 63% |

**Table 193 Distance distribution per speed range.**

| **Speed range** | ***Period*** | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | 0,3% | *0,3%* |
| 30-50 | 2,9% | *5,4%* |
| 50-100 | 5,0% | *5,1%* |
| **0-100** | **8,1%** | **10,8%** |

**Table 194 Relative fuel consumption variation per speed range and period**

| Speed range | *Period* | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | 4,3% | *4,0%* |
| 30-50 | 9,5% | *17,9%* |
| 50-100 | 7,9% | *8,0%* |
| **0-100** | **8,1%** | **10,8%** |

**Table 195 Absolute fuel consumption variation per speed range and period**

Conclusion

- 1 principal driver in urban / suburban utilization with high initial scores.
- High increase of fuel consumption in both periods and at all speed ranges; total scores confirm the trends

- L34 / Lyon / Pomona Annecy / P45413

EDS activated in period 1 and 2. Selected driver changed of driverID during the pilot; driverID corresponds to 1000000182294000 + 1000000182294010.

| DriverID | *Period* | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 1000000182294000 | 72% | 86% | 74% | 76% |

**Table 196 Distance distribution per driver and period.**

| Speed range | ***DriverID*** |
|---|---|
| | *1000000182294000* |
| 0-30 | *13%* |
| 30-50 | *25%* |
| 50-100 | 62% |

**Table 197 Distance distribution per driver and speed range.**

| Speed range | *Period* | |
|---|---|---|
| | **1** | ***2*** |
| 0-30 | 0,1% | *0,1%* |
| 30-50 | 0,7% | *-0,9%* |
| 50-100 | 2,7% | *1,4%* |
| **0-100** | **3,4%** | **0,5%** |

**Table 198 Relative fuel consumption variation per speed range and period**

| Speed range | *Period* | |
|---|---|---|
| | 1 | *2* |
| 0-30 | 0,9% | *1,1%* |
| 30-50 | 2,3% | *-3,0%* |
| 50-100 | 4,2% | *2,1%* |
| **0-100** | **3,4%** | **0,5%** |

**Table 199 Absolute fuel consumption variation per speed range and period**

Conclusion:

- 1 principal driver in urban / suburban utilization; no classification of initial scores
- Increase of fuel consumption in period 1 and no change (noise) in period 2; total scores confirm the observed trends

- L35 / Lyon / Pomona Valence / P45414

EDS activated in period 1 and 2

| DriverID | *Period* | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 1000000324774000 | 68% | 34% | 0% | *42%* |
| 1000000088576000 | 13% | 37% | 68% | 33% |

**Table 200 Distance distribution per driver and period.**

| Speed range | **DriverID** | | |
|---|---|---|---|
| | **1000000324774000** | **1000000088576000** | ***Total*** |
| 0-30 | 3% | 5% | *4%* |
| 30-50 | 11% | 18% | *14%* |
| 50-100 | 86% | 77% | 82% |

**Table 201 Distance distribution per driver and speed range.**

| | ***DriverID and period*** | | | |
|---|---|---|---|---|
| **Speed range** | **1000000324774000** | | ***1000000088576000*** | |
| | **1** | **2** | **1** | **2** |
| 0-30 | -0,2% | - | 0,4% | *0,2%* |
| 30-50 | -1,0% | - | -0,1% | *0,2%* |
| 50-100 | -2,5% | - | 3,9% | *2,0%* |
| **0-100** | **-3,8%** | **-** | **4,2%** | **2,3%** |

**Table 202 Relative fuel consumption variation per speed range and period**

| Speed range | 1000000324774000 | | *1000000088576000* | |
|---|---|---|---|---|
| | 1 | 2 | 1 | *2* |
| 0-30 | -5,6% | - | 9,8% | *3,9%* |
| 30-50 | -7,4% | - | -0,7% | *1,1%* |
| 50-100 | -3,1% | - | 4,7% | *2,4%* |
| **0-100** | **-3,8%** | **-** | **4,2%** | **2,3%** |

**Table 203 Absolute fuel consumption variation per speed range and period**

Conclusion

- 2 principal drivers in urban / suburban utilization; driver 1000000324774000 with low initial scores and no period 2; driver 1000000088576000 with no classification of initial scores
- Driver 1000000324774000: reduction of fuel consumption at all speed ranges; total scores confirm the trends
- Driver 1000000088576000: increase of total fuel consumption in both periods; total scores confirm the trends
    - L36 / Lyon / Pomona Annecy / P45415

| DriverID | *Period* | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | ***Total*** |
| 1000000099605000 | 63% | 58% | 78% | *66%* |
| 1000000024677000 | 9% | 25% | 12% | 14% |

**Table 204 Distance distribution per driver and period.**

| Speed range | *DriverID* | | |
|---|---|---|---|
| | **1000000099605000** | **1000000024677000** | ***Total*** |
| 0-30 | 7% | 4% | *4%* |
| 30-50 | 26% | 13% | *15%* |
| 50-100 | 67% | 83% | 80% |

**Table 205 Distance distribution per driver and speed range.**

| Speed range | *DriverID and period* | | | |
|---|---|---|---|---|
| | **1000000099605000** | | ***1000000024677000*** | |
| | **1** | **2** | **1** | ***2*** |
| 0-30 | -0,2% | 0,0% | -0,2% | *-0,2%* |
| 30-50 | -0,4% | -0,8% | 0,3% | *0,8%* |
| 50-100 | -1,8% | 2,2% | -6,1% | *1,0%* |
| **0-100** | **-2,4%** | **1,4%** | **-6,0%** | **1,6%** |

**Table 206 Relative fuel consumption variation per speed range and period**

| Speed range | *DriverID and period* | | | |
|---|---|---|---|---|
| | 1000000099605000 | | *1000000024677000* | |
| | 1 | 2 | 1 | *2* |
| 0-30 | -3,7% | -0,5% | -5,4% | *-4,2%* |
| 30-50 | -2,8% | -4,9% | 2,1% | *5,1%* |
| 50-100 | -2,2% | 2,7% | -7,6% | *1,2%* |
| **0-100** | **-2,4%** | **1,4%** | **-6,0%** | **1,6%** |

**Table 207 Absolute fuel consumption variation per speed range and period**

Conclusion:

- 2 principal drivers in urban / suburban utilization (driver 1000000099605000 in more urban conditions than driver 1000000024677000 and with highest distance); driver 1000000099605000 with average initial scores and driver 1000000099605000 with low initial scores
- Driver 1000000099605000: reduction of fuel consumption in period 1 but increase in period 2; total scores confirm the trends (increased of scores in period 1 and decreased of scores in period 2)
- Driver 1000000024677000: reduction of fuel consumption in period 1 but increase in period 2; total scores confirm the trends in period 1 but are less correlated in period 2 (incertitude due to low distance covered in period 0 and 2)

##### 3.3.4.4.1 Questionnaires

In reference to Eco-driving support, only one driver answers the questionnaires (see Annex 3). Only four items had low scores

- I think that the use of the Eco-driving support has provided me more efficient and controlled delivery practices (4 points)
- I believe I have the indispensable knowledge to utilize the Eco-driving support service (4 points)
- I believe that my work conditions have improved with the use of the Eco-driving support (4 points)
- I believe that the advices provided by the Eco-driving support are adequate (2 points)

Except the item “I believe the Eco-driving support service works properly” which had a value of 6 points the other items had a positive value with scores between 7 and 9 points.

Regarding to fleet operators there are two items with low values (3 points):

- ○ We believe our company drivers have the indispensable knowledge to utilize the Eco-driving support service
- ○ We believe that the advices provide by the Eco-driving support are adequate

Items with medium values are the following:

- After using Eco-driving support we like the service
- The image of the city has improved with the use of Eco-driving support
- We think the Eco-driving support improves the freight transport image in urban areas taking into account that its use reduces the $CO_2$ emissions and other pollutants
- The use of Eco-driving support services makes urban driving easier
- Our company is confident of using Eco-driving support
- Our company trust the Eco-driving support service
- We think that using the Eco-driving support service increases the efficacy of our company work

- More we use the Eco-driving support service, we feel more apprehensive about it
- According our perception, the Eco-driving support service improves the environmental image of our company
- It is easy to understand how the Eco-driving support works
- We believe the Eco-driving support service works properly

The highest values are for the next items:

- We think the Eco-driving is effective to reduce the fuel consumption and the pollutants (8 points)
- The freight transport image in urban areas is improved with the usage of Eco-driving support (8 points)
- Using the Eco-driving support service, our company consider the driving of our drivers is more safety (8 points)
- Our company accepts increase on journey duration as a trade off to decreased fuel consumption (10 points).

Additional information about the questionnaires is included in Annex III.

#### 3.3.4.5. Validation of hypothesis and conclusions

Conclusions of the results of the EDS system are presented below.

| City | Truck ID | Driver ID | Truck utilization | Fuel consumption variation | | | |
|---|---|---|---|---|---|---|---|
| | | | | 0-100 km/h | | 0-50 km/h | |
| Bilbao | B04 | E03095687W000010 | long haul | 1,0% | 3,4% | 3,6% | -1,4% |
| | | E03110308H000000 | long haul | 3,2% | 1,0% | 2,1% | -3,1% |
| | B05 | E03076129V000000 | long haul | 1,0% | 0,7% | -3,0% | -1,8% |
| | | E03104242R000000 | long haul | 7,1% | 2,5% | 0,2% | 1,1% |
| Helmond | H16 | 239336000000 | suburban | 0,1% | - | -0,8% | - |
| | H17 | 69683000000 | long haul | -2,7% | - | -7,9% | - |
| | H18 | 224753000000 | long haul | 3,3% | - | 1,6% | |
| Krakow | K01 | 580524001320000 | long haul | 10,3% | - | 10,7% | - |
| | K02 | 680103009580000 | long haul | 6,4% | - | 4,4% | - |
| | K03 | 570125040190000 | long haul | 0,2% | - | 2,5% | - |
| | K06 | 600907040750000 | long haul | -1,9% | - | 2,5% | - |
| | | 840321051710000 | long haul | -6,3% | - | -3,9% | - |
| | K07 | 701224043360000 | long haul | 1,4% | - | -11,6% | - |
| | | 840321051710000 | long haul | 9,6% | - | -7,6% | - |
| Lyon | L16 | 1000000324345000 | suburban | -1,1% | 2,6% | -2,3% | 3,8% |
| | | 1000000167984000 | long haul | 7,6% | 0,6% | 34,5% | 8,5% |
| | L18 | 1000000164724000 | suburban | 1,2% | -2,6% | 9,2% | -15,3% |
| | | 1000000361029000 | suburban | -1,3% | -3,2% | 1,1% | -6,6% |
| | L19 | 1000000220190000 | suburban | 3,7% | 6,8% | 5,2% | 7,9% |
| | L32 | 1000000491948000 | urban/suburban | -5,7% | -6,6% | -7,5% | -8,2% |
| | L33 | 1000000183457000 | urban/suburban | 8,1% | 10,8% | 8,6% | 15,5% |
| | L34 | 1000000182294000 | urban/suburban | 3,4% | 0,5% | 2,1% | -2,3% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | L35 | 1000000324774000 | urban/suburba n | -3,8% | - | -7,0% | 0,0% |
| | | 1000000088576000 | urban/suburba n | 4,2% | 2,3% | 1,7% | 1,7% |
| | L36 | 1000000024677000 | suburban | -2,4% | 1,4% | 0,5% | 3,1% |
| | | 1000000099605000 | suburban | -6,0% | 1,6% | -3,0% | -3,9% |

**Table 208 Results of the EDS system.**

The results are presented per truck and driver, because the variation of fuel consumption reduction depends very much on the driver willingness to follow the advices given by the EDS. Thus, the starting score of the drivers is crucial for estimating the fuel reduction consumption. Already fuel eco drivers will have low benefits from the system, while non-fuel eco drivers will have enormous benefits when following the advices.

Another criterion that must be taken into account is the truck utilization, because the EDS has been developed for distribution applications that are used in urban and suburban areas. The results are split in two speed ranges that represent the urban driving conditions (0-50 km/h, FREILOT view) and the overall driving conditions (0-100 km/h, fleet owner view). For long haul utilization, the results in the urban speed range may be not significant due to the low distance covered in these areas.

In urban / suburban utilization, the maximum fuel reduction achieved was -6,6% in the 0-100 km/h speed range and -15,3% in the 0-50 km/h speed range.

In long haul utilization, the maximum fuel reduction achieved was -6,3% in the 0-100 km/h speed range and -11,6% in the 0-50 km/h speed range (but this result may be not significant as previously explained).

Fuel increases were observed, the maximum being achieved by a driver with high initial scores, which shows that the starting point and those “good” drivers can reduce their fuel consumption quite a lot if they don’t pay attention to their behaviour.

Below, the table indicating the result of each hypothesis test is included:

| | Hypothesis | Comment |
|---|---|---|
| ✓ | Following the advice from the Eco-Driving Support service will lead to decreased fuel consumption | There is a significant reduction of fuel consumption (**Error! Reference source not found.** and **Error! Reference source not found.**). |

**Table 209 The same as Table 22 but for EDS.**

| | Hypothesis | Comment |
|---|---|---|
| ✓ | In stressful situations drivers will have difficulties to follow the instructions | In stressful situations drivers have some difficulties to follow the instructions. |
| ✓ | Eco-Driving Support service is appreciated by drivers | After using Eco-Driving Support drivers like the service. |
| ✓ | Drivers will perceive that Eco driving support is reliable | Participants answered with a positive score. |
| ✓ | Drivers will find the Eco driving support useful when driving | Eco-Driving Support is moderately useful to the drivers when driving. |
| ✗ | Drivers will think the Eco driving support is easy to use | Drivers believe that the Eco-Driving Support support is complicated to use. |

| | | |
|---|---|---|
| ✗ | Drivers' stress perception will increase with the Eco driving support usage | Drivers perceived less stressed when they use the service. |
| ✗ | Perceived risk of accidents will decrease with the Eco driving support usage | Using the Eco-Driving Support, the driving of the participants is not all safety. |
| ✓ | According to the driver perception the Eco driving support system will improve of freight transport image in urban areas | The freight transport image in urban areas improves satisfactorily. |
| ✓ | Drivers will trust the Eco driving support system to give good advice | Drivers are confident of using Eco-Driving Support. |

**Table 210 The same as Table 23 but for EDS.**

# 4. General Conclusions

During the last three years the FREILOT project has been under development aiming to demonstrate in four different locations in real operation conditions the potential positive effects in fuel consumption and emissions of five applications:

- Energy Efficiency Intersection Control
- Delivery Space Booking
- Acceleration Limiter
- Adaptative Speed Limiter
- Eco Driving Support

It has been a challenge from the beginning to carry out these tests and to collect all the data needed for the final evaluation. Different problems arise during the project (e.g. technical problems, participants' recruitment, legal issues, etc…) and for almost all a solution was achieved in order to carry out the pilot. The solution of some of them implied in some cases a compromise between the technical implementation and evaluation partners, guaranteeing the quality of a minimum set of data to perform the evaluation of the services.

Added to this fact, as the pilot started, in some locations (e.g. Bilbao) the impact of the project was so high, that the number of participants increased during the duration of the operational phase. This effect contributes in the achievement of one of the main objectives of the FREILOT pilot: to include additional fleet operators and/or trucks (Objective 3). This is also important for achieving sustainable after-project life (Objective 2), where some of the services, e.g. Delivery Space Booking are dependent on a broad user base (large number of fleet operators and/or trucks). In these specific cases, the evaluation plan had to be adapted trying to guarantee always a successful evaluation of the systems.

Through this document, the detailed results achieved for the services in the different locations were presented. Regarding the impact on energy efficiency, it is clear the effect of the EEIC in the different locations: -13% of decrease in Helmond, -8% of decrease in Lyon and a general positive effect is observed in Krakow. From the in-vehicle systems, the one with a most positive impact in energy efficiency is EDS, achieving in the range of speeds 0-50 km/h (urban environment) about -15,3% of fuel reduction. For all these services with positive impact on fuel consumption, the impact achieved in the CO2 emissions reduction was similar, due the direct relation between fuel consumption and CO2 emissions. For the EEIC was also analysed the effects on NOx obtaining reductions of -14% in Helmond.

The main impact of DSB is not in terms of fuel efficiency (no significant differences were achieved) but it is relevant to mention the positive effect in illegal parking conditions in the street, leading to avoid dangerous situations in the road (safety) and achieving a more fluent traffic (positive impact on traffic efficiency). Regarding the acceptation of the drivers, most of the drivers thought that this service improved the freight image in urban areas, they like the service and they find it is easy to use. Moreover, drivers believe DSB increases the efficiency of their work, it facilitates their delivery operations and it increases the delivery efficiency. Regarding fleet operators, they consider that when their companies unload the goods using DSB, the delivery load is safer. Also, they believe the freight transport image in urban area is improved with the use of DSB. Furthermore, this service facilitates their tasks because they do not need to look for free spaces, therefore DSB service does not disturb their driving task.

In the case of AL system the results found under the experiment conditions, in terms of fuel consumption are not so significant, being between -2% and 2% fuel consumption increase. In the case of ASL there is reduction, but not so big. The scope of the SL is more safety-related than economic related. Added to this, the driver has a fundamental role in the success of this system since he can accept or reject the limitation. The data Analysed shows that most of the times the drivers were rejecting the limitation.

Finally, the results in terms of fuel consumption are summarized below:

- EEIC Helmond: -13% of fuel reduction measured.
- EEIC Lyon: -8 % of fuel reduction measured.
- EEIC Krakow: positive impact in fuel consumption (data not enough to give a global value).
- AL (all sites): fuel consumption reduction measured between -2% and 2%.
- ASL (all sites): no significant reduction in fuel consumption measured.
- EDS (all sites): maximum fuel reduction measured between -6,6% in the 0-100 km/h and -15,3% in the 0-50 km/h.
- DSB Lyon: no significant reduction in fuel consumption measured.
- DSB Bilbao: no significant reduction in fuel consumption measured. The main impact was in traffic conditions.

## *4.1. Lessons learned*

From FREILOT partners' side, the lessons learned during the evolution of this project are also considered relevant results of it. FREILOT was one of the first pilots, but, today, different initiatives are already on course or starting. All the experiences achieved within this project can be well used in other projects, so, trying to not extend too much the document at this point, below, the main experiences from the point of view of evaluation are included:

- Methodology

  When the methodology definition started, no methodology specially defined for pilots was available. In this case, and for similitude with a Field Operation Test, FESTA was adopted as reference methodology for FREILOT. From this project, the use of this reference methodology is suggested as it fits really well with the different phases of the pilot. Added to this, it is really important in the different steps of the definition (identification of research questions, hypothesis, indicators and measurements) to collaborate with the partners in charge of business models. In this case, it is interesting to take into account to the analyses of the potential benefits defined for the services and contribute with the real data collected to analyse the business cases in terms of benefits obtained form the pilot for each site.

- Data measurement

  From the evaluation point of view is really important to provide the list of measures to be collected during the pilot and the requirements of this data collection to the implementation WP as soon as possible. In this way all the requirements regarding data collection can be taken into account during the implementation of the services and, in case any problem appears, it will be possible to look for a solution in order to get similar data or data that can help in order to perform the analyses of the services.

- Pre-piloting before pilot

  Before starting the pilot phase, it is really important to do some weeks of pre-piloting. In this was all the chain (activation of the system, data collection, procedures, etc..) can be tested in order to assure that all the process is working well and avoid some unnecessary failures during the pilot.

- Communication among WPs

  In a project like FREILOT the communication with between the evaluation WP and the other WPs is really important, as much, as the communication with the pilot sites leaders. During the implementation is really important to take into account the needs from the point of view of data measurement, because, if not, later it is not possible to obtain the results expected. The communication with the partners in charge of the business models is really important in order to provide to them useful results for the business cases preparation, helping in this way to the future deployment. And finally, during the operation a good communication with the Operation WP is crucial. The pilot itself and its naturalistic aspect introduce a lot of variables (variation of drivers, technical/mechanical problems, variation of routes, etc…) in the tests, affecting this to the data collection. Operation partners register this 'events' during the operation. This information is later useful during the data analyses process in order to understand the results.

Finally, after the summary of the main lessons learn in terms of preparation and execution of the pilot from the point of view of evaluation, a specific lesson learnt in relation with the evaluation of fuel consumption for these kinds of systems is included below.

The fuel consumption depends on the truck utilization and driver behavior. The target of ADAS systems is to fill the gap between usual drivers and skilled drivers. As a consequence, the ability of fuel eco drivers to reduce their fuel consumption is less than that of non-fuel eco drivers.

The EDS helps in illustrating this fact.

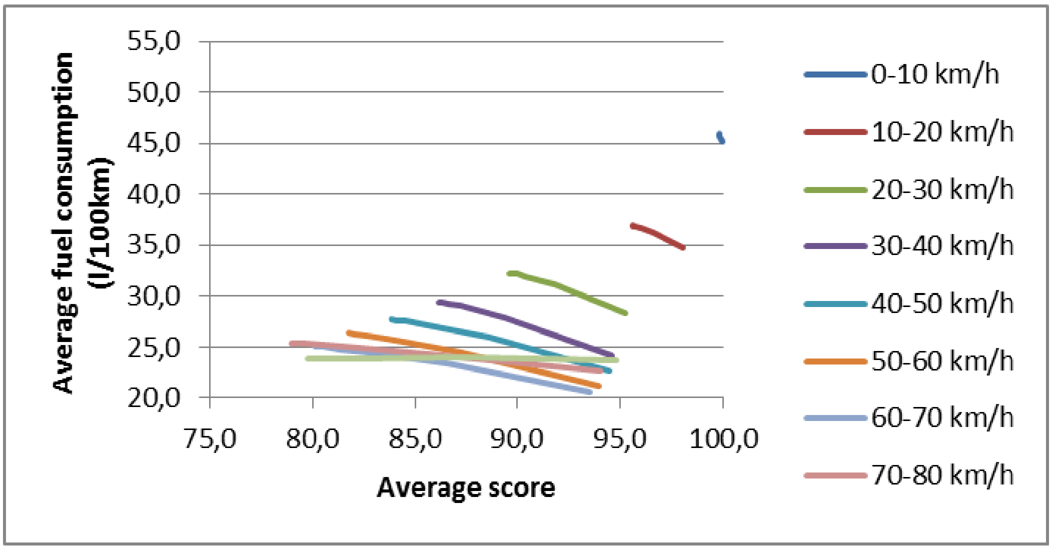
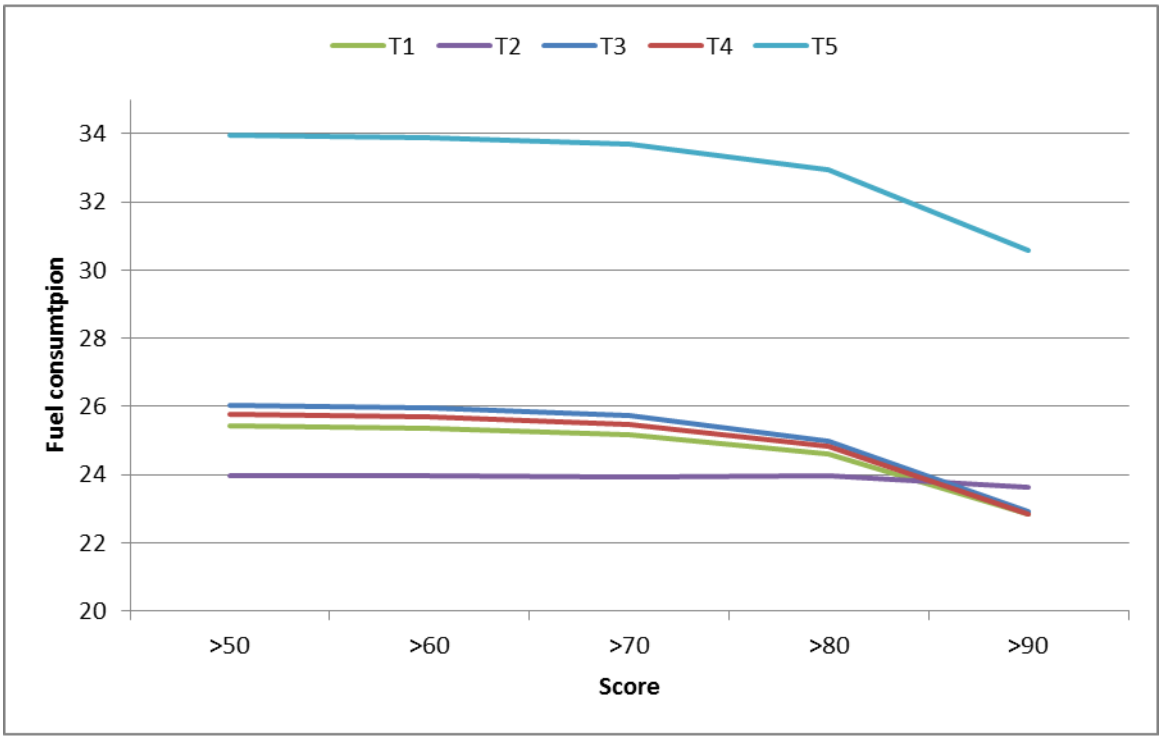



**Figure 92 Fuel consumption per speed range and score range**

The graph above shows the reduction of fuel consumption related to a better score for each speed range. It can be observed that better score means lower fuel consumption for the same speed range. These results are interesting, since it links the fuel consumption to the score, therefore the driver behavior is crucial in the fuel consumption reduction.

It is also important to highlight in this point the importance of the starting score of the driver. If the starting score (without the system) is high, the possibilities of reducing fuel consumption are less, and oppositely, a driver with low starting score has more possibilities of reducing the fuel consumption.

The above comment is illustrated in the figure below (obtained from the data analysis):




The figure above shows the fuel consumption per type of truck and score. The type of truck is related to the use of the truck (urban, suburban or interurban). It can be observed that the fuel consumption reduction is extremely related to the starting score of the driver, without the advices of the system. The same score improvement of a driver with a high starting score or a driver with a low starting score will have different effects.

For an urban truck (T5), a driver with a high starting score (>80) will reduce fuel consumption in 7% when improving the score to >90. For the same truck, a driver with a medium starting score (>70) will reduce fuel consumption in 2.1% when improving the score to >80.

For a suburban truck (T1, T3 and T4), a driver with a high starting score (>80) will reduce fuel consumption in 8% when improving the score to >90. For the same truck, a driver with a medium starting score (>70) will reduce fuel consumption in 2.6% when improving the score to >80.

For an interurban truck (T2), due to the longer driving cycles with most of the distance running at high speed, there is small possibility of reduction (1% in the best case).

## Bibliography

Pluvinet P., Gonzalez-Feliu J., Ambrosini C., GPS data analysis for understanding urban goods movements, in City Logistics VII, 7th international conference on City Logistics, Mallorca, Espagne, 7-9 juin 2011, Institute for City Logistics, Elsevier.

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