Integrated Evaluation of and Vision on Truck Parking in Flanders, Belgium

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Abstract. The Flemish government launched two related projects in Belgium between 2020 and 2023. First, they rolled out an Intelligent Truck Parking Service (ITPS) along a part of the E17 motorway. Then we supported them to develop a vision on truck parking. The ITPS consisted of an app for the truck drivers, combined with information on variable message signs. We evaluated the ITPS so as to provide answers to the following research questions: (i) which technology best measures parking occupancy? (ii) what is the impact of providing parking occupancy information to the truck driver? (iii) how do users deal with the information (user experience)? In order to evaluate the ITPS, we performed a technical analysis, an impact analysis, a user acceptance analysis, and performed interviews with stakeholders regarding the ecosystem. In addition, the analysis of GPS measurements provided insights into used parking locations and occupancies for developing the vision.

Keywords: Intelligent traffic and mobility management, User behaviour and acceptance.

1 Background and research questions

The Flemish government launched two related projects in Belgium between 2020 and 2023. First, they rolled out an Intelligent Truck Parking Service (ITPS) testing ground along the E17 motorway corridor between the community of Kalken and the French border (see also Figure 1). Then we supported them to develop a vision on truck parking. After some quality improvements, the ITPS was commissioned with the launch of an app, a dynamic DATEX II flow, a web interface, and the visualisation on VMS boards. The goal of the evaluation of the ITPS was to provide answers to the following three research questions:

- RQ1: What is the best technology to measure parking occupancy?
- RQ2: What is the impact of providing information to the truck driver on the occupancy of the parking?
- RQ3: How do users deal with the information (user experience)?

During our evaluation, we performed a technical analysis, an impact analysis, a user acceptance analysis, and performed interviews with stakeholders regarding the ecosystem. Finally, we analysed GPS measurements to obtain insights into used parking

locations and occupancies for developing a vision on truck parking. We will provide details on each of these aspects in the following sections.

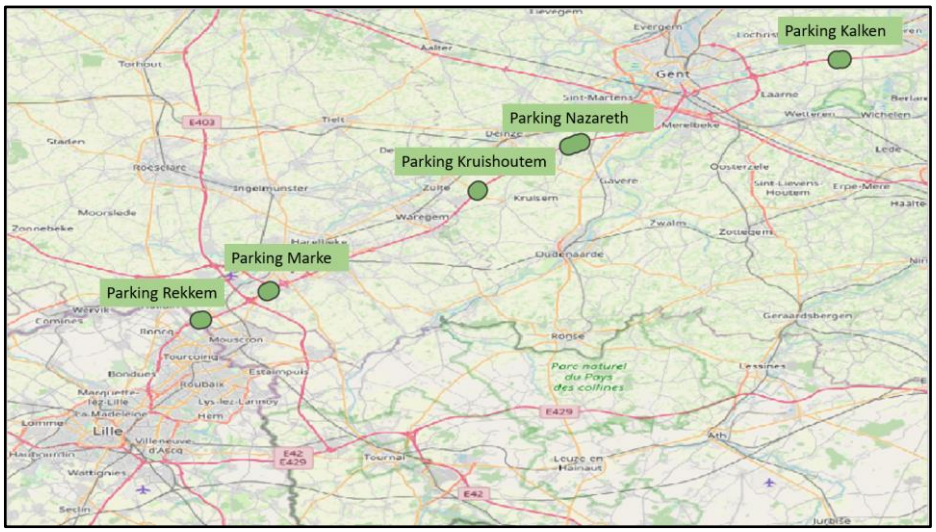

Fig. 1. Geographical overview of the truck parkings along the E17 motorway within the pilot project.

2 Analyses

2.1 Technical evaluation

A number of detection methods (not the same everywhere) have been made available at the various rest areas and service zones, including (i) loop detectors, (ii) barriers and ticket system, (iii) parking sensors, (iv) DSRC readers, (v) traffic sensors, and (vi) truck OBU data. In order to assess the accuracy of the measurement systems, manual counts were performed (which were also initially used to (re)calibrate the systems). During the baseline measurement, one measurement was performed per car park every day, at a specific time, for two weeks between September 15, 2020 and September 28, 2020. This means that a total of 14 measurements were performed per car park over the measurement period. Four measurement moments are possible per day: morning (between 6 am and 12 pm), afternoon (between 12 pm and 6 pm), evening (between 6 pm and midnight) and night (between midnight and 6 am). For each manual count, we determined the absolute and the percentage error, and the mean absolute percent error (MAPE) in relation to the different measurement methods (in the morning when there are fewer trucks, the absolute error is decisive, at night the percentage error is decisive, and in the afternoon both are important). For each type of count, we also looked at the statistical distribution of the errors, and whether outliers occur.

2.2 Impact analysis

To measure the impact of the different incentives on the occupancy rate, we organised three successive phases:

- Phase 1: this is the baseline measurement (there is no app and the VMS boards are not active)
- Phase 2: an app is available to the truck drivers (Truckmeister, on Android and iOS)
- Phase 3: the app is available and the VMS boards are active

		W38	W39	W40	W41	W42	W43	W44	W45	W46	W47
Fase	**Info**	**14/sep**	**21/sep**	**28/sep**	**5/okt**	**12/okt**	**19/okt**	**26/okt**	**2/nov**	**9/nov**	**16/nov**
Fase 1	Nulmeting										
Fase 2	App										
Fase 3	App+VMS										
				(1/10)			*(22/10)*				

For each of these phases, we performed an analysis of the parking occupancies, the impact of the VMS, and the results from the OBU data.

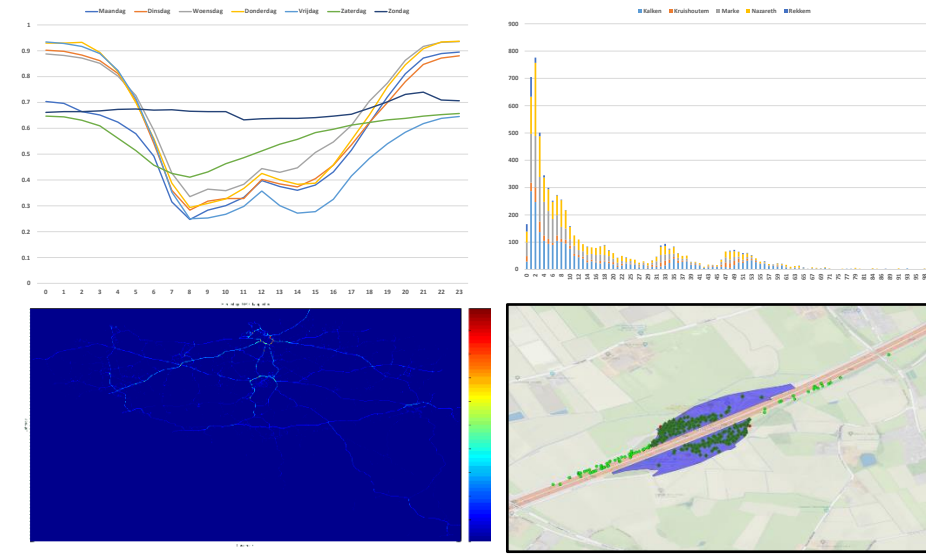

Fig. 2. Example data sources used for the analysis of the research questions: parking occupancies per day of the week (*upper-left*), distribution of parking durations in minutes (*upper-right*), truck OBU data from trucks (*bottom-left*), truck OBU data matched on motorway parking terrains (*bottom-right*).

2.3 Analysis of user acceptance

2.3.1 Surveying truck drivers

We rolled out a survey after the end of phase 3, containing an extensive questionnaire. The survey could not be conducted in the car parks themselves due to the COVID-19 pandemic and the associated measures. As such, we created it digitally. Because the truck drivers had to be reached on the route, the concession holders of the car parks were approached for this, advertisements were posted in specific Facebook groups of truck drivers (both those of the government and others), via LinkedIn posts, and finally it was also distributed among the truck drivers of a specific local distribution company. In addition, QR codes were also made available, which referred to the survey. The survey was available in Dutch, French, English, and German. The survey was closely monitored week after week, with appropriate actions taken to receive statistically significant feedback and a high response rate. In total we had 256 complete (42 %) and 349 (58 %) incomplete answers for a total of 605 together.

2.3.2 Interviews with stakeholders

As a final step in our evaluation, we held interviews with nine relevant stakeholders from the ecosystem: transport sector organisations, private concession holders, public stakeholders, service providers, and stakeholders from policy. Through the interview we wanted to gauge the use, the possibilities, and the findings about services that provide information about the occupancy rate. Each interview included the following three main parts that were surveyed from all stakeholders:

- In the first part, we asked about more general aspects of service zones and the extent to which the interviewee or the organisation has knowledge about the services to communicate occupancy rates to truck drivers or others.
- In the second part, we mainly asked how the organisation feels about this service.
- In a final part, we discussed the specific aspects of this service: to what extent is it effective? What impact can it have on the organisation? How do you see the costs and benefits? Etc.

3 Conclusions

3.1 Research question 1: Which technology best measures parking occupancy?

After analysing parking occupancy measurements, the answer to this question appears to be nuanced, whereby the traffic sensors appear to score less well, barriers score quite well, as do parking sensors (if there is no overcrowding). This answer is based on a detailed technical evaluation of measuring methods for the dynamic occupancy rates of truck parkings.

3.2 Research question 2: What is the impact of providing parking occupancy information to the truck driver?

To measure the impact of the different incentives on the occupancy rate, we organised three successive phases: a baseline measurement, an app made available to the truck drivers, and both an app and active VMS boards. Compared to the baseline measurement in phase 1, making the app available in phase 2 had a negligible to nonexistent effect on the parking behaviour of truck drivers (due to the very low penetration rate). It was not possible to uncover a direct link between the messages on the VMS and the parking occupancy.

3.3 Research question 3: How do users deal with the information (user experience)?

We rolled out our own survey after phase 3, which contained an extensive questionnaire. Almost all respondents (239 of 256, 93 %) drove on the A10 / E17 towards France, which gave relevant results. There were 164 respondents (69 %) who used the information from the VMS. Almost all (89 %) found the information offered useful to very useful. Most of the respondents (76 %) thought that the information on the VMS was usually correct, and if this was not the case, it turned out that there was no space left while the signs indicated the opposite (just like with the app). In the future, a large proportion of truck drivers (80 %) would find an app useful to very useful, and a smaller proportion (20 %) rather useless.

4 Some caveats and recommendations

It is not clear whether VMS or the app can guarantee a better service: VMS appears to be necessary if one gets closer to the car parks. An app allows for more options and can, if necessary, be more complete. The reluctance to an app is more about the use of a mobile phone and road safety. If this service is integrated into the truck itself, the reluctance is less. Providing the service is mainly placed in the hands of the government by some stakeholders, one expects that the government will outline the guidelines and assume responsibility for both the detection facilities and the provision of data.

The first study had a very broad approach, in which a number of aspects were highlighted in great detail. To answer the three research questions, various analyses were performed, experiments were set up, and groups of users were questioned. There are consequently a number of comments with regard to the implementation of the study and the interpretation of the results. Before such a study like this can be started, the technical systems to be considered must already be operating under good conditions. This was not always the case, which meant that certain analyses had to be repeated several times. Various problems occurred during the study, including detection methods that were set over time

with different parameters, problems with technical installations, missing measurements, manual counts that were partly incorrect, etc. Further research could be useful, given that a significant number of manual counts are available. This would then make it possible to determine whether data is best fused or not, or recalibrated regularly, and to what extent raw data is suitable for achieving a good fusion. A larger amount of data and a greater mutual comparability of the various locations are strong pluses.

Another caveat to the impact analyses is that more data would in any case lead to more stable results.

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References

1. Maerivoet, S., Ons, B., Vlassenroot, S., Berghmans, R., and Bourgeois, D. (2021). Milestone 11 'Pilot Evaluation Report' of Activity 6 'Truck Parking: Project Evaluation' of the CEF project 'Safe and Secure Infrastructure in Flanders'.
2. Vlassenroot, S., Vankaauwen, G., Maerivoet, S., and Ons, B. (2023). Final report 'Developing a vision for truck parking in Flanders', Department of Mobility and Public Works.