TRUCK SILHOUETTES ANALYSIS WITH WIM DATA ON A63 MOTORWAY

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ABSTRACT

Beyond enforcement of commercial truck weight regulations, weigh in motion (WIM) devices provide detailed data very useful to analyse road freight traffic characteristics. This item presents results on silhouette analysis on motorway. Detailed but anonymised data coming from A63 motorway WIM devices were provided by Cerema to Atlandes.

1. CONTEXT

A63 runs through the “Landes” district, between Bordeaux and Bayonne, as an extension of A10 (Paris – Bordeaux) and link west of Iberic peninsula to the north and west of Europe. It is used both direction by approx. 10 000 trucks per day. WIM devices have been set in each direction on the right lane, the most used by trucks. Data used in this item cover periods extending on several months over years 2016 to 2020. Continuity is not complete because WIM have been unavailable during certain period, partly due to roadworks and partly to WIM data collection problems. Meanwhile, more than 5,5 million truck passing records could be used.

As concessionaire of A63, Atlandes is directly interested in gathering information on traffic, especially when it can be linked with road safety or incident detection. On the A63, most of incidents concerning trucks occurring are flat tires (61%), due to tires wear and tear. This led Atlandes to decide to investigate the use of lifting axles among trucks using A63. For this, detailed data describing axle position on trucks were needed. The only available and accurate data source on A63 was the two WIM devices set between Castets and Lesperon. WIM devices automatically determine from length and axle positions a truck class among 63 classes in France. But of course, a lifted axle is not detected. To go further, other mathematical analysis were needed. This analysis was entrusted to the Société de Calcul Mathématique (SCM) who used the non-hierarchical classification method for mobile centers (k-means).

2. TRUCK SILHOUETTE ANALYSIS: FINDING LIFTED AXLE

The spreading use of lifted axle is aiming at reducing fuel consumption by reducing friction forces, and saving tires by reducing their individual mileage.

The purpose of this item is therefore to attempt to reconstruct the real silhouette of certain trucks, notably semi-trailers known as T2S2 or T2S3 for a 2 axle trailer with a semi-trailer with 2 or 3 axles (tandem or tridem), including the case where one axle is lifted; and consequently to detect lifted axles. It focuses on 3 or 4 running axles trucks, therefore with 4 or 5 axles over which 1 or 2 is lifted, and more specifically on trailers with semi-trailers, which represent more than 80% of trucks on motorway in France, from which approx. 75% are T2S3. When an axle is lifted on a T2S3, it is identified as a T2S2 or as a 3 axles truck (photo 1).

Photo 1: Truck with a lifted axle

To identify these vehicles, we started from detailed data, axle positions and overall length, and used with SCM a statistical classification method that groups together vehicles with similar silhouettes. It partitions the data relative to their distances from these centers and iterates to minimize the sum of the intra-class variances.

To identify silhouette with lifted axle, the method compares silhouettes differing by their number of axle but having same length and same axle positions for the axles in common.

First use case compares silhouettes with 4 and 5 axles, to identify semi-trailer “T2S3” with a lifted axle (fig 1a and b). 4 axles trucks divided by the method into 6 classes (fig 1a) and 5 axles truck into 5 classes (fig 1b). Silhouettes shown in fig 1 (a and b) describes the centers of those classes, defined by relative axle positions. Fig 1c shows classes from 4 and 5 axles silhouettes that can be grouped because of their similarities. Classes 3 (4 axles) and 2 and 3 (5 axles) shows great similarity, axles from ranks 1,2,4 and 5 from 5 axles vehicles being aligned with 4 axles of the other group. The same applies to classes 2 and 1 of vehicles with 4 and 5 axles respectively.

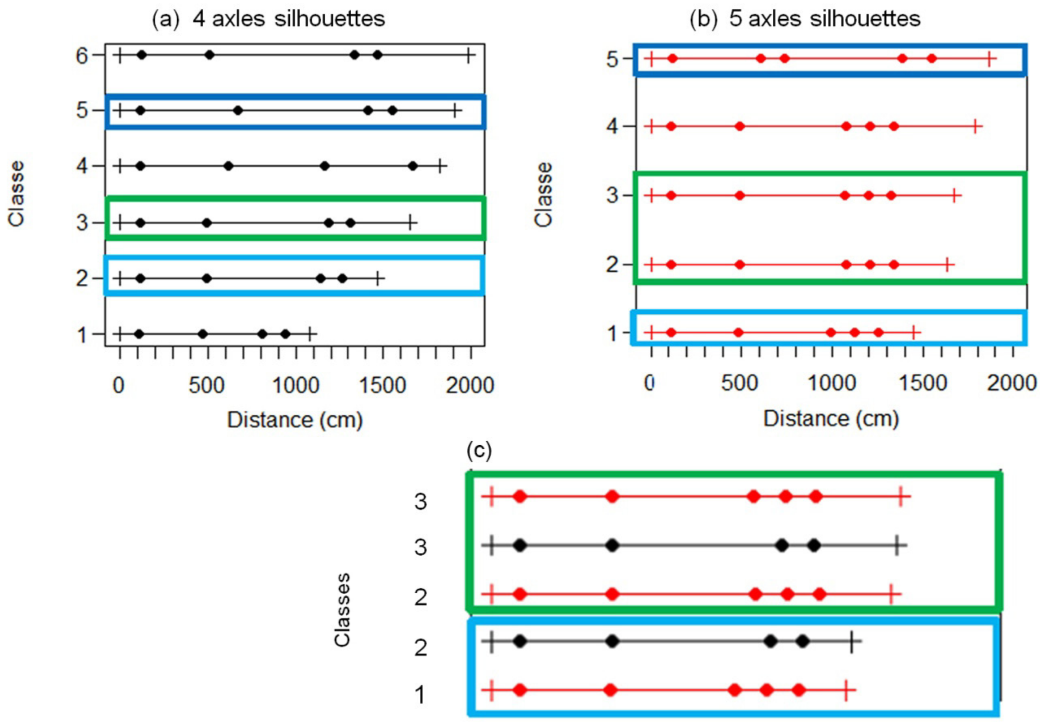

Figure 1: 4 and 5 axles silhouettes classification with k-means method

It thus appears that classes 2 and 3 of 4 axles correspond to T2S3 of differing overall length (class 2 being approximately 2m shorter), with third axle lifted.

3. TRUCK USE OF LIFTED AXLE

On the basis of this analysis, the study compared the average weights of heavy vehicles with lifted axles to the reference population, then the changes in the use of lifted axles over time, by comparing situations by direction. We first observe the evolution through time of the share of semi-trailers with lifted axle out of the total number of semi-trailers (T2S3), then we study the average weights of each silhouette and their evolution over time.

Figure 2 shows the average weights of T2S3 trucks with and without lifted axle, by year and by direction of travel. Figure shows very steady curves through time. Trucks with lifted axle are on average 10t lighter, which confirm they are empty or lightly loaded (in mass). Trucks are slightly more loaded (+5 to 10%) northbound, coming from the Iberian Peninsula, than in southbound, indicating a slight asymmetry in freight flows.

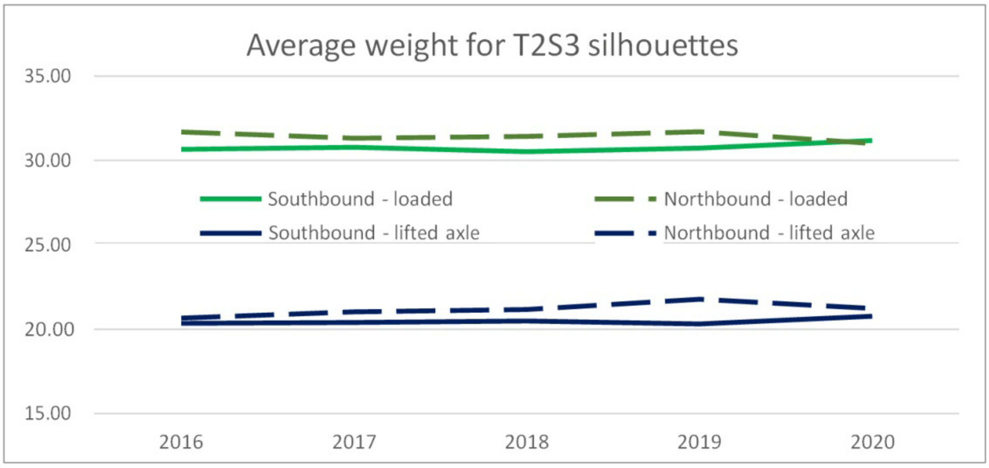

Figure 2: Average T2S3 truck weight with or without lifted axle by year and direction (A63)

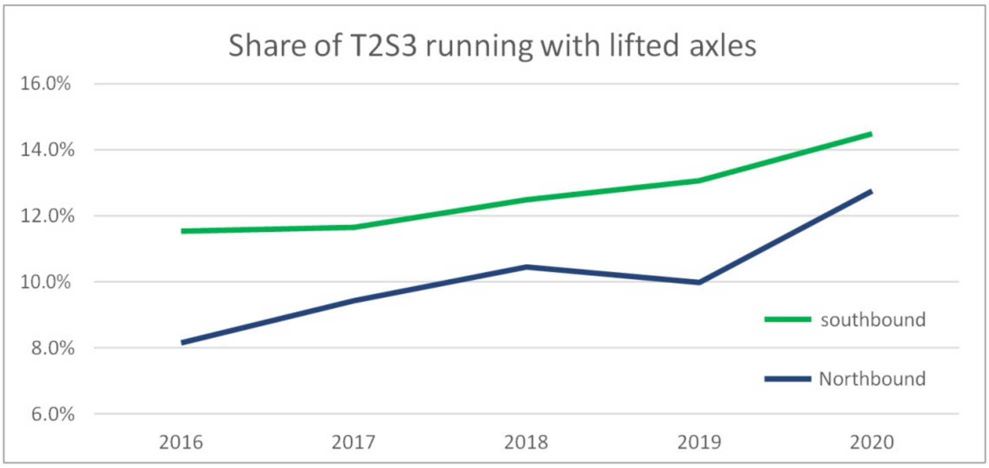

Figure 3: Evolution through time of lifted axle rate among T2S3 by direction (A63)

Figure 3 gives the evolution over time of the T2S3 share with a lifted axle. We first note the discrepancy (1% to 1.5%) between directions which confirms that there are more vehicles returning empty southward than northward (flow asymmetry). We then observe a steady growth in the use of lifted axles from 2016 on, of 4 points southward and 5 points northward (or nearly 50% increase). The gap between directions appears to be narrowing slightly, indicating that carriers are striving to seek reversible flow of goods to optimize their journeys.

4. CONCLUSIONS

Thanks to the implementation of a non-hierarchical statistical classification method known as mobile centers (k-means), an identification which seems quite reliable of the lifted axles of heavy goods vehicles with T2S3 semi-trailers has been possible. It will be possible to confirm this by truck photo analysis. Vehicle with lifted axle rate is growing from 2016 up to now, from around 10% to close to 14% on A63 (both direction). Moreover, the analysis identifies the position of the lifted axle, most often the front axle of the tridem (third axle of the truck), followed by the last axle (rear). Finally, these analysis also confirmed the asymmetry of the freight flows on the A63, with more loaded vehicles going north, from the Iberian Peninsula.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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