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A comparison of reward systems for truck drivers based on telematics data and driving behavior assessments

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Abstract: This paper investigates the impact of different driving behavior evaluation systems on the distribution of monetary rewards for economic driving. It starts with an introduction into truck telematics systems as the most prominent data source for the assessment metrics. Two specific systems are presented in more detail, focusing on the way driver evaluation is performed in each of them. Data that has been collected from the two systems in a real case is used to analyze if the drivers had a fair chance to get the same bonus independently of the system that was built in their truck.

Key words: Telematics, driving behavior, incentives, award systems

1 Introduction

Using data analytics on big amounts of data in order to improve the competitive position of many businesses has become major trend. The logistics and transportation sectors do not represent exceptions in this shift to the digital economy. Exploiting big data techniques can help to improve operational efficiency, to provide better customer experience or to design completely new business models (DHL 2013).

While the scientific literature on how big data will impact the logistics sector is still scarce (Waller and Fawcett 2013), a number of applications have already made their way into daily business and private life. A prevalent example is the navigation feature in Google Maps, which exploits the tracking of the location data sent by millions of mobile phones in order to determine the fluidity of traffic flows in large parts of the world.

In this paper we present the case of a trucking company that has equipped its fleet with telematics systems that report various technical and non-technical data about the vehicle and the driver activities in near real time to the central office. The company uses this data among others to assess a driver's performance regarding their more or less economic handling of the vehicle. The goal is to award an economic driving style by an additional premium thus setting an incentive for a win-win situation for the driver and the company.

To be able to do so the company relies on assessment metrics that are built in the telematics systems. In practice, many fleets are composed by trucks of different vendors equipped usually with different telematics technologies. As there is no standard way to assess the economic driving behavior, the used metrics are also differing. A central question that this contribution aims to answer is if there is a fair treatment of drivers independently of the truck model they are assigned to.

The structure of the paper is as follows. Section 2 gives an overview on modern telematics systems and their components. In the sequel, Section 3 details the parameters that are used to establish driving behavior assessments and explains the implemented metrics for two widespread systems. Data from a real world case is presented and the question about the fairness of the granted primes is discussed. The correlation of economic driving and external operational factors are highlighted in Section 4. Section 5 summarizes and concludes the paper.

2 Telematics systems

The term “telematics” has been coined by the French authors Simon Nora and Alain Minc for settings emerging from the integration of computer science (“informatique”) and telecommunication technology (Nora and Minc 1978). Telematics systems comprise data storage and processing machines as well as (usually partly wireless) network technology to exchange

information between them. Applications can be found in diverse industries (e.g. medicine, education, traffic), but we focus on the use for road freight transportation, more specifically to link the mobile vehicle via a telematics system to a remote user in the central office.

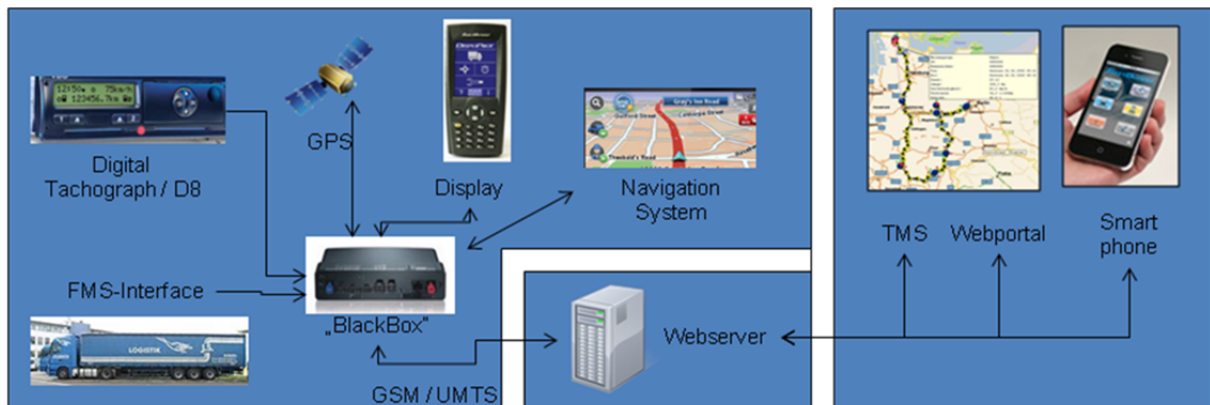


Figure 1: Possible components of a telematics system in road freight transportation

A telematics system for trucks with typical components is shown in Figure 1. The central processing unit (black box or On Board Unit - OBU) is able to determine the location of the vehicle using a satellite positioning system (usually the American Global Positioning System - GPS). It is linked to other components. Via the industry standard interface FMS (Fleet Management System 2015) it gets technical data about the vehicle (like speed, position of the accelerator pedal, total fuel consumption and many others). The digital tachograph records the activities of the driver ("driving", "break or rest", "availability", "other work") and can be linked to the black box through a so called D8 interface. Finally the telematics unit itself can be equipped with a display that allows for interaction like the exchange of text messages with the central office or the use of navigation software.

The collected data is then transferred using mobile network communication to a server that provides the information to the end user devices, which can be dedicated client software, a web browser or a cell phone app. The information can also be integrated via web services into existing software solutions like transport management systems (TMS). Based on a survey on the German market, a classification of telematics systems depending on their scope of functionalities and degree of integration has been proposed by Dudek (2013). The class with the smallest range of functionalities provide mere localization and tracking features. On the other side, advanced systems allow the business process oriented integration of data captured by components illustrated in Figure 2 and potentially other information like identification data from connected hand scanners or the cooling temperature in the trailer.

The group of functionalities concerning the driver includes the management of its (remaining) driving time (for scheduling and fleet management purposes) as well as the assessment of

its driving style. The latter and the way how it is used for setting up incentives for economic driving will be discussed in the next section.

3 Assessment of driving behavior and incentive systems

There are a number of relevant parameters for the assessment of economic driving: fuel consumption per distance, break usage, uniform speed profile, accelerator pedal movement, number of stops and others. How these parameters are used to define a one-dimensional measure for economic driving is depending on the telematics vendor and usually is not transparent. Even the metric of the measure can be quite different between products.

In this study we illustrate this by the comparison of two widely used systems: Daimler FleetBoard and MAN TeleMatics. The grading of economic driving behavior in FleetBoard can vary between 1.0 and 10, the higher the better (Daimler FleetBoard 2015). The MAN solution however assesses economic driving in per cent, 100% being the optimum (MAN 2010).

The company which provided the data for the following analysis operates a fleet with mainly FleetBoard equipped Daimler trucks but also a significant number of MAN trucks. They were confronted with the design problem of an incentive system that was applicable to both types of trucks and their respective telematics systems. In general an incentive system has to comply with the following requirements: well defined input parameters, easy understanding of the relation between the obtained grade and the behavior of the concerned employees, the possibility to influence the grade by adapting one's own behavior, avoidance of unfair assessments (Schettgen 1996). An assessment would be perceived as unfair if the same performance could result in differing grades.

Table 1: Bonus categories for FleetBoard equipped vehicles

Economic driving measure	Bonus [€/month]	Nb of bonuses	Nb of bonuses in % of total
$x \leq 9$	0	161	18,85%
$9 < x \leq 9,3$	30	124	14,52%
$9,3 < x \leq 9,5$	60	235	27,52%
$9,5 < x \leq 9,6$	90	177	20,73%
$9,6 < x \leq 10$	120	157	18,38%
Total		854	

Table 2: Bonus categories for MAN TeleMatics equipped vehicles

Economic driving measure [%]	Bonus [€/month]	Nb of bonuses	Nb of bonuses in % of total
$x \leq 80\%$	0	41	45,56%
$80\% < x \leq 82\%$	30	9	10,00%
$82\% < x \leq 83\%$	60	7	7,78%
$83\% < x \leq 84\%$	90	11	12,22%
$84\% < x \leq 100\%$	120	22	24,44%
	Total	90	

As the two driving behavior metrics cannot be transformed from one into the other, the company decided to apply two different award tables, one for each group of vehicles (Table 1 and Table 2).

The columns “Economic driving measure” and “Bonus [€/month]” define the financial incentive paid based on the driver assessment from the telematics system. The remaining two columns contain the absolute and relative number of bonuses that have been granted to drivers in the period between January 2014 and June 2014. As can be seen from the tables, there are 854 assessments for FleetBoard and 90 for the MAN system. The mean bonus paid for drivers using the FleetBoard telematics was 61.58€ whereas the drivers on MAN trucks were paid in average 48€. But not only the average premium differed significantly between the two groups, the chance to get a bonus was much higher for FleetBoard drivers (> 80%) than for the MAN driver group, where merely half of the drivers were awarded by an extra pay. The quite different distribution of the obtained bonuses is also revealed in Figure 2. Whereas FleetBoard driver bonuses peaked at the mean bonus of 60€, MAN bonuses had their maximum number of occurrences at the minimum and maximum values respectively.

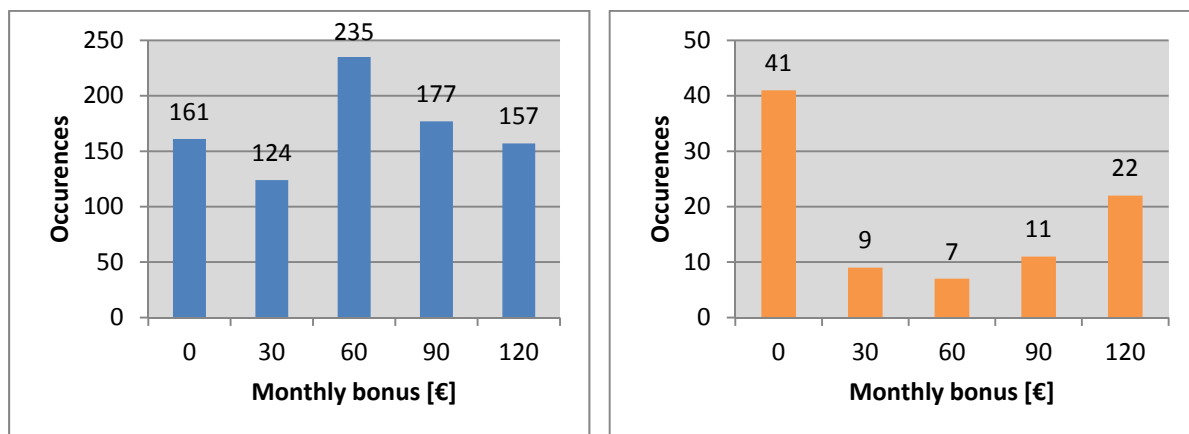


Figure 2: Distribution of the bonuses in a) FleetBoard (left) and b) MAN TeleMatics (right)

The conclusion from this analysis is that the system in place during the first half of the year 2014 did not meet the requirements of objectivity and fairness. One way to cure this would be to adapt the thresholds for getting the next premium level in one of the two systems in order to achieve comparable means and variances of the bonuses.

4 The impact of operational difficulty

In this section another source for non-objective treatment of different drivers is investigated. It is evident, that a truck running mainly on motorways allowing it to maintain a constant speed with optimal rpm (motor revolutions per minute) will consume less than a vehicle forced to many stops and accelerations. The topography and the weight of the load among others also play an important role. Therefore a measure evaluating driver behavior claiming some sort of objectivity has to assure that it is not (too much) biased by these factors.

The external factors that cannot be influenced by the driver but do have an impact on the fuel consumption and tyre usage of the vehicle can be paraphrased as “operational difficulty”. A serious provider of operations evaluations has to take this into account. This is the case for the two systems investigated in this study. Again the scale for “operational difficulty” reaches from 1 to 10 in the FleetBoard system (1 being the hardest) and from 0 to 100 per cent in the MAN TeleMatics system (100% corresponding to the highest operational demands).

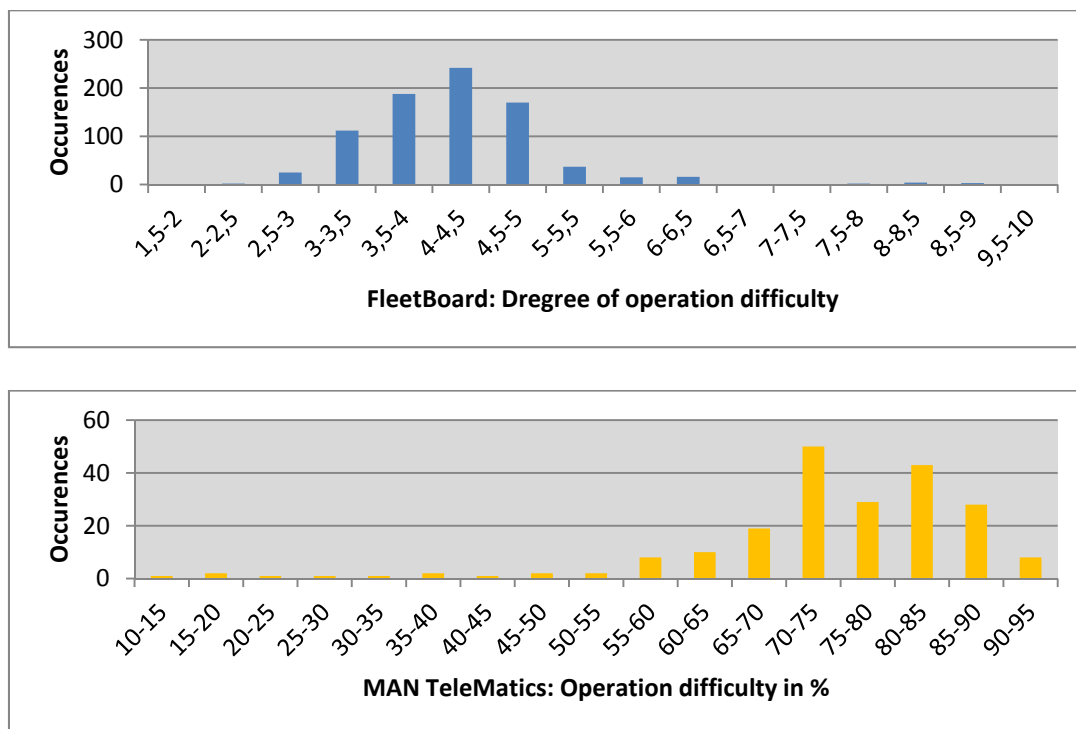


Figure 3: Measurement of “operational difficulty” in a) FleetBoard (above) and b) MAN TeleMatics (below)

Figure 3 shows that the values for “operational difficulty” follow similar distributions (keep in mind that for FleetBoard a small number means high operational demand, the opposite is the case for MAN). In an unbiased system the evaluation of the driver’s performance regarding economic driving should be independent from the “operational difficulty”. To test this hypothesis a regression analysis between the “economic driving measure” and the “operational difficulty” has been carried out for the 854 FleetBoard and 90 MAN TeleMatics data points. The result is displayed in Figure 4.

The slope of the line should be 0 in order to reflect independency of the driving assessment from external factors (“operational difficulty”). This is obviously not the case for either one of the two systems. In Figure 4 a) medium or bad grades for economic driving are not frequent but possible in combination with low operational difficulty (smaller than 5.5), while higher operational difficulty (above of 5.5) systematically leads to lower driving evaluations. A similar observation can be made for MAN TeleMatics, where an increase of 1% in “operational difficulty” statistically leads to a 0.5% decrease in the assessment of economic driving.

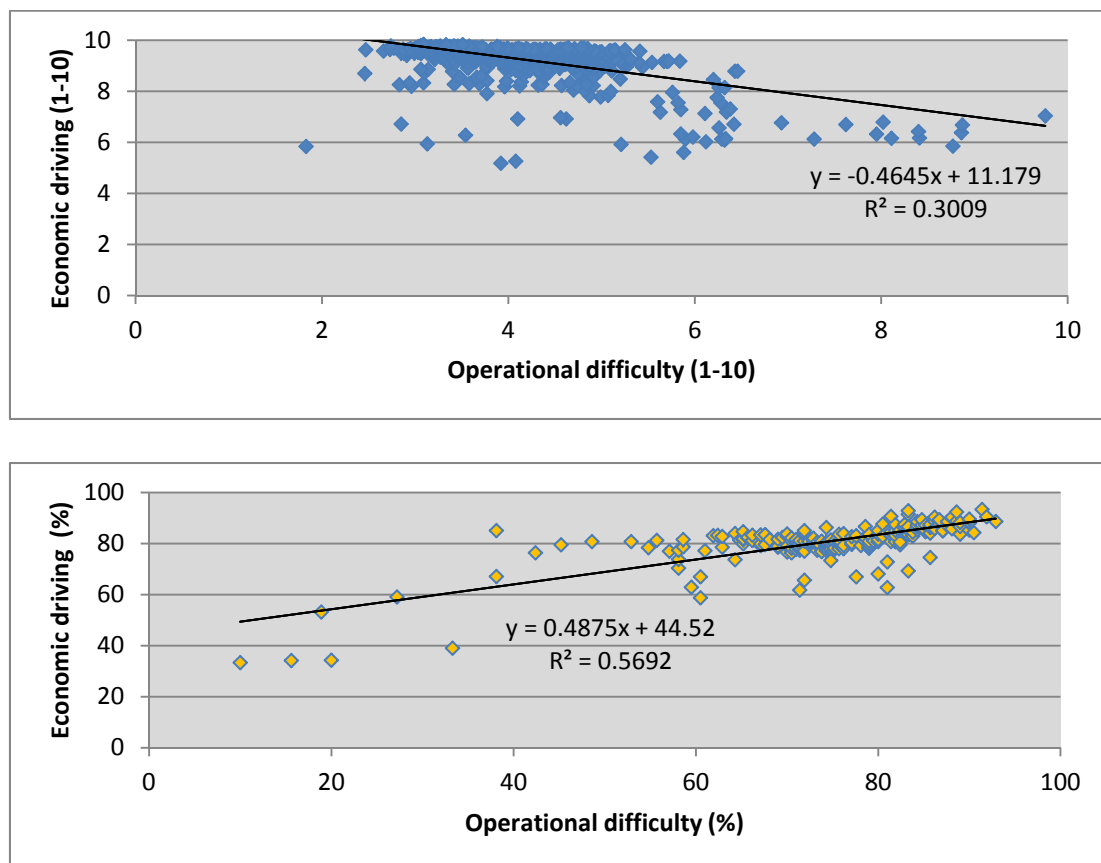


Figure 4: Regression analysis on „Economic driving measure“ against „Operational difficulty“ for a) FleetBoard data (above) and b) MAN TeleMatics data (below)

5 Conclusion

In this contribution gathering data by telematics systems and using it subsequently in human resource management is presented as an example for a “big data” application in transportation. Main technological components and modules of telematics systems are introduced with a focus on elements dealing with driving style assessment. For two concrete systems the metrics for driving assessment are presented. The incentive systems that have been implemented by the company of the case study were compared regarding objectivity, i.e. the fair chance for a driver to get a bonus independently from the vehicle he is assigned to.

The findings suggest that this was not the case for the investigated period. However, directions how to improve the equity of the incentive systems can be derived from the analysis. Thus, a major conclusion is that companies applying incentive systems that are built on top of heterogeneous telematics assessments of driving performance should check their reward systems based on statistical analysis like the one presented on this paper. Another source of bias is the impact of external factors on the grading of economic driving. Using linear regression it had been shown that the possible grade for “economic driving” is depending on the operational environment, especially as this is getting more demanding.

Acknowledgments

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