Archives of
Transport System
Telematics

Volume 7
Issue 3
September 2014

Enhancing the value of commercial vehicle telematics data through analytics and optimisation techniques

M. MESGARPOUR[a], I. DICKINSON[a]
MICROLISE LTD, Eastwood, Nottingham, NG16 3AG, UK
EMAIL: mohammad.mesgarpour@microlise.com

ABSTRACT

Telematics data has been mainly used to track the historical and live locations of vehicles. Recently, with more data available and better telecommunication technologies, fleet managers are able to investigate the root cause of faults, problems or events such as breakdown and incident. With recent development in cloud computing power, advanced analytics and optimisation techniques, fleet telematics can move to the next level, where future events can be predicted and systems can schedule maintenance to avoid breakdowns. Risk of accidents can also be raised and advance warnings given. In this paper, the evolution and current state of analytics and optimisation techniques and models in the area of telematics have been reviewed. Later, the key components, challenges and opportunities of applications of analytics in fleet telematics have been discussed.

KEYWORDS: telematics, analytics, optimisation

1. Introduction

Vehicle Telematics Systems (VTS) have significantly changed since the first mobile information system for transportation and logistics, the OmniTRACS [1], was introduced by Qualcomm in 1987. In addition, the implementation costs of VTS has also significantly dropped. The main drivers of lower costs are decreasing telematics hardware cost and subscription/transactional fees as well as reducing cost of data transmissions with the introduction of 3G and 4G networks. Thus, Lower cost makes the VTS more affordable for fleet operators as road transport fleets are usually operating on slim margins [2].

Most of the off-the-shelf vehicle telematics solutions currently provide basic tracking and tracing functionalities [3]. With recent development in cloud data storage and computing power, increasing the capabilities of on-board units, advances in automotive industry and adaptation of advanced analytics and optimisation techniques VTS can move to the next level and deploy predictive and prescriptive systems.

On the other hand, the volume, variety, veracity and velocity of telematics data are growing very quickly and will continue to grow each day that create telematics big data.

The main origins of the telematics big data are:

- High number of sensors fitted in the vehicles (volume)
- Advanced telematics units capable of capturing various type of data from vehicle CAN-bus and environment (volume/velocity/variety)
- Growing number of ECUs in vehicles (volume/velocity/variety)
- Better access to the crowd-sourced data (volume/velocity/variety/veracity)
- Excessive number of external connected devices such as smartphones, tablets, in-cab video cameras, insurance black boxes and toll collection units to the main telematics device (volume/velocity/variety)
- Faster, cheaper and more reliable telecommunication technologies (velocity)
- High number of open source datasets such as traffic, weather forecast and parking data (volume/velocity/variety/veracity)
- Reducing the cost of accurate sensors (volume/velocity/variety)

The focus of this paper is on applications of analytics methods and techniques in increasing the benefit of vehicle telematics systems. Section 2 gives an overview of various analytics systems. The applications of the analytics in VTS has been discussed in Section 3. Finally, Section 4 looks into the future telematics systems and services for vehicles.

2. Analytics from descriptive to prescriptive

analytics systems aim to analyse data in order to get actionable insights and knowledge [4]. Analytics is commonly viewed from four major perspectives: descriptive, diagnostics, predictive and prescriptive.

Fig. 1 shows a very wide spectrum of analytics systems from the simplest to the most advanced. Analytics includes techniques and solutions from looking backward to answer questions such as "what and why happened" to looking forwards to answer "what will happen and what should we do about it".

By increasing the degree of the intelligence and complexity of the analytics methods, the value of system increases. Gartner [5] encourage organisations to gain competitive advantage from higher levels of analytics maturity by moving from information and hindsight (descriptive analytics) to optimisation and foresight (prescriptive analytics). However, most organisations only use descriptive and/or diagnostics analytics.

Descriptive analytics looks at the historical data, past events and past performances for hindsight as to how to approach the future. It is the simplest use of analytics to mainly produce management and performance reports for the users. Diagnostics analytics can go a one step further by root causes, key parameters and unseen pattern using statistical analysis methods.

Predictive analytics aims to get insight of the historical and real-time data to determine likelihood of future situations and events. It takes advantage of predictive modelling techniques and forecasting methods such as computational intelligence (AI) and advanced statistics. Finally, Prescriptive analytics, which has the highest level of maturity, uses optimisation techniques and mathematical models to help decision makers gain the level of foresight they need. However, a prescriptive model can be also considered as a combination of multiple predictive systems running in parallel based on decision maker's actions.

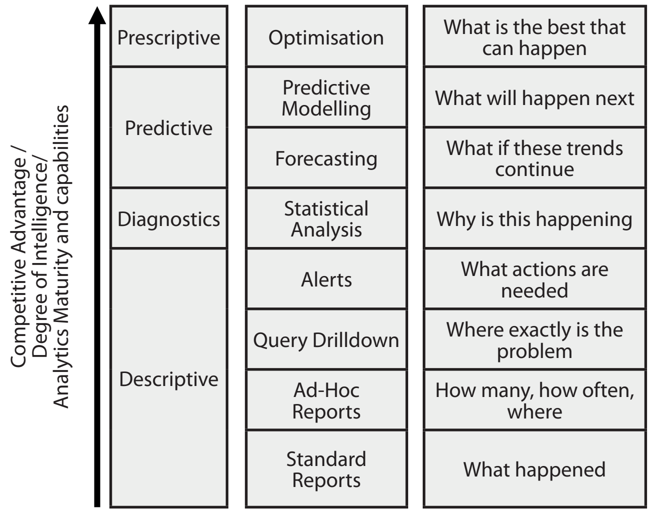

Fig. 1. Eight Levels of Analytics for Competitive Advantage (adapted from SAS Eight Levels of Analytics [6] and Gartner Analytics Ascendancy Model [5])

3. Analytics and VTS

The potential of telematics big data can revolutionise vehicle telematics system and create new opportunities for logistic operators and users. However, it can also cause challenges for telematics services and be a big threat for VTS providers. Therefore, it is necessary for the vehicle telematics solution providers to adopt analytics methods and techniques in their VTS to tackle the problem of big data. Use of advanced analytics methods will create opportunities for VTS provides to introduce new products as well as enhance their services.

Massive amounts of telematics raw data are being collected every day. VTS providers usually process a few hundreds of transactions per vehicle daily. Therefore, it becomes necessary for the telematics providers to couple telematics data with analytics methods to create useful information and knowledge for their customers. Moreover, the value of telematics data can be enhanced by aggregating telematics data with open source data and crowd-sourcing approaches.

Analytics becomes one of the main vital components of the any VTS. Predictive and prescriptive analytics will reshape the vehicle telematics industry in coming years which will have remarkable results by increasing uptime, reducing maintenance, fuel, and insurance costs as well as decreasing the CO2 emission and improving driver and vehicle safety.

On the other hand, there is an increasing call from governments and logistics sector for efficient and innovative vehicle telematics solutions which makes analytics more demanding for designing intelligent and smart VTS.

Table 1 summarises the main current and potential applications of the analytics in VTS. Following, some examples are explained in more details.

Table 1. Adopted Analytics features in VTS [own study]

Integrated Feature	Usability Feature
Descriptive System	
• GIS/GPS data • GPRS data • Interactive features • Communication features	• Web-based interface • Smartphone/tablet interface • Dashboard interface • Fleet management • Staff management • Asset management • Usage-based insurance
Diagnostic System	
• Diagnostics Trouble Codes data • Accelerometer-based data	• Interactive dashboard interface • Fuel efficiency • Fleet utilisation • Remote diagnostics • Health management • Driving style / behaviour
Predictive System	
• Vehicle CAN bus / sensor data • Safety related data • Camera data • Accident/incident data • Traffic data • Weather and environmental data	• Prognostics • Infotainment systems • Accident/incident prediction
Prescriptive System	
• Open source data • Crowd-sourcing • Collaborative system	• Dynamic multi-echelon routing and scheduling systems • Integrated loading, routing, scheduling and delivering systems • Predictive maintenance • Vehicle sharing system

Most of the current vehicle telematics solution use the descriptive analytics approaches, which is the simplest class of analytics, in their product. These approaches are useful to some extent, but not for making long-term decisions. The purpose of descriptive system is to summarise raw telematics data (past events) to make it useful information for fleet users. Fleet management solutions which provide various customised reports such as past/current locations of vehicle, speed report, vehicle usage are the common type of descriptive telematics systems.

Diagnostics systems are the next step in data reduction which have become more popular recently. The focus of the Diagnostics system is to capture patterns in telematics data as well as identify the root causes of any problem and issue. A common example of diagnostics system is Remote Diagnostics System (RDS) which allows fleet managers to do the remote vehicle diagnostics which will help them to inform the driver and workshop regarding the status of vehicle in real-time. The RDS mainly uses Diagnostics Trouble Codes (DTC) and telematics data to evaluate state-of-health of vehicle and notify drivers problem which not usually noticed or undervalued by them.

In response to market demands, vehicle telematics solution providers start taking advantage of predictive analytics and plan to add more sophisticated predictive models in their solution in the future. Predictive techniques analyse big historical and real-time data to identify patterns and predict the future events. Prognostics systems are one of the main applications of the predictive models in VTS which is becoming more important to fleet operators. This aims to predict the future behaviour, state-of-health and remaining useful life (RUL) of individual vehicle components such as battery, engine, transmission system etc [7]. As the number of electric and hybrid vehicles increased, the battery prognostics has attracted most research attentions in vehicle prognostics systems [8].

Accident prediction systems are another example of application of predictive models in VTS [9]. The system can estimate the risk of accident/incident for an individual driver in the near future. Driving behaviour, historical incident/accident, driver's state-of-health and weather data can be input to an artificial intelligence model to exploit pattern in historical and transactional data to predict the risk of an accident/incident.

Prescriptive analytics use the results obtained by the predictive system to specify the best decision for a complex problem. Predictive maintenance system can be considered as a prescriptive system. This uses the results of a prognostics system and focuses on finding the best schedule for the vehicle to visit the workshop for repair/service. Telematics-based dynamic vehicle routing systems (TDVRS) are another example of prescriptive system. TDVRS has the main functionalities of the general vehicle routing systems in addition to using real-time data such as telematics data, traffic and weather forecast data, to reschedule the delivery/pickup as well as reroute the journey in response to any disruptions during the journey.

4. Conclusion

This study focuses on understanding how analytics techniques can make better use of vehicle telematics data. Applications of four main analytics models in vehicle telematics systems have been discussed. Modern vehicle telematics solutions start deploying advanced analytics techniques as the core of the system.

Although, various applications of descriptive and diagnostics analytics can be identified in off-the-shelf vehicle telematics solutions, predictive and prescriptive telematics models are still in research phase. Accuracy and number of telematics sensors fitted in vehicles and lack of cost-benefit analysis of telematics system are the main factors which have significantly slowed down the transition of predictive and prescriptive telematics systems from research towards commercialisation.

Bibliography

[1] Omnitracs, LLC, http://www.omnitracs.com, (accesed: 25.06.2014)

[2] The Freight Transport Association (FTA), The Logistics Report 2014, (2014)

[3] GOEL, A., GRUHN, V.: A Fleet Monitoring System for Advanced Tracking of Commercial Vehicles. In: SMC'06. IEEE International Conference on Systems, Man and Cybernetics 3 (2006)

[4] GECZY, P.: Big Data Characteristics, The Macrotheme Review, 3(6) (2014)

[5] MAOZ, M., How IT Should Deepen Big Data Analysis to Support Customer-Centricity. Gartner G00248980 (2013)

[6] SAS, Eight Levels of Analytics. sascom magazine, 4th quarter (2008)
[7] MESGARPOUR, M., LANDA-SILVA, D., DICKINSON, I.: Overview of Telematics-Based Prognostics and Health Management Systems for Commercial Vehicles. In: Mikulski J. (ed.) CCIS 395, Springer Heidelberg (2013)
[8] Rezvani, M., AbuAli, M., Lee, S., Lee, J., Ni, J.: A Comparative Analysis of Techniques for Electric Vehicle Battery Prognostics and Health Management (PHM). In: SAE International (2011)
[9] FleetRisk Advisors, http://www.fleetriskadvisors.com, (accessed: 25.06.2014)