Speed data collection and analysis with telematics technology:

assessing the risk of crash involvement.

Introduction

Excessive speed is widely accepted to be a contributory factor in many vehicle crashes. Several studies have demonstrated that the risk of having an accident, involving casualties, rises exponentially with increasing speed above the mean speed of other traffic. This has been demonstrated in both urban and rural environments[1,2,3].

By recording actual speed data from its base of more than 60,000 commercial vehicles in the UK, Quartix matches vehicle data points to 2.6 million roads in the country, resulting in a database of more than 1 million speed distributions of statistical significance.

Following its launch in 2012, the "Safe Speed" database[4] was made available to fleet customers as a training and monitoring tool, allowing them to compare their drivers' speeds for each data point against the speed distribution of other road users at that location.

With this new release of the product, Quartix makes the SafeSpeed data an integral part of its driver scoring for risk assessment, with the capacity to score every movement event, and it makes the database available to its insurance and fleet customers through fast APIs in its range of web services ("QWS").

This paper describes the technology and software involved in the database, gives practical examples of speed distributions from the UK road network and demonstrates why using the SafeSpeed Database provides a much better indication of accident risk for fleet managers and insurers than measures which are based solely on statutory speed limits.

Speed as an indicator of accident risk

Although there are some variations in the findings of the studies referenced, it is generally accepted that the risk of a vehicle's involvement in an accident, where there are casualties involved, increases exponentially in relation to the variance of its speed from the mean of the speed of other free-moving traffic on the same stretch of road

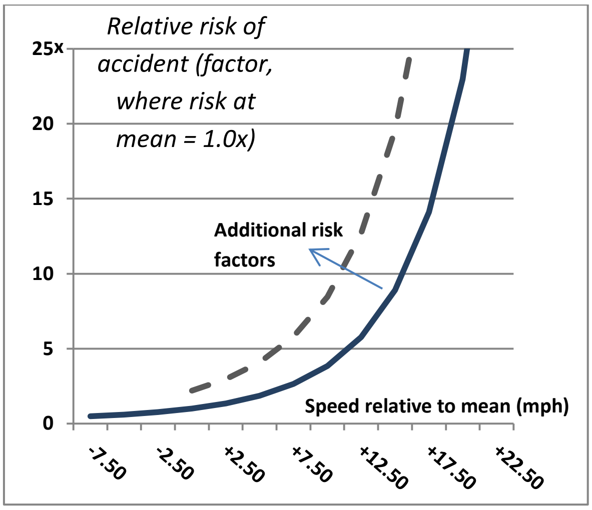


Figure 1 opposite uses the findings of the Road Accident Research Unit of Adelaide University[2] to demonstrate the expected increase in risk of accident associated with speed variation from the mean speed for free-travelling traffic on rural roads. Similar studies for urban roads have shown an even greater increase in risk in relation to speed variance.

The dotted line shows the effects of additional risk factors, such as night-time driving.

The solid line on the chart shows the increase in risk for speeds between the mean speed of traffic and up to 20mph above the mean speed. It also shows that there is a further reduction in risk at speeds just below the mean. The dotted line shows how this risk can increase if there are additional risk factors, which could include:

1. Lack of experience: the risk posed by a newly qualified driver will be magnified when driving at higher than the mean traffic speed.
2. Night-time driving: this poses an additional risk factor, and in some studies has been shown to equate to a more-than doubling of risk even at mean traffic speed.
3. Fatigue: for commercial vehicle drivers this can pose the highest risk of all, especially when combined with night-time driving at above the mean traffic speed.
4. Poor weather conditions or visibility.

<u>Statutory speed limits are an unsatisfactory benchmark for many rural roads</u>

We are often asked to provide a detailed analysis of the telematics data recorded immediately prior to, and during, a crash. These accidents involve a broad range of vehicles, including commercial trucks and vans, public sector and emergency vehicles, and cars. Many of the serious accidents which occur happen at speeds below the statutory limit, particularly on rural roads. Here are a few observations and statistics from Brake[7], the road safety charity and the DfT:

"The most common crash types on country roads are collisions at intersections, head-on collisions and running off the road – these are all related to excessive speed".

"Research suggests that driving tired can be as dangerous as drink-driving".

"Rural roads account for 82% of all car occupant deaths, for just 42% of the distance travelled".

Although speed is a strong contributory factor in each of these cases, it is more likely, in our opinion, to be related to driving at too high a speed for the road, the conditions, the driver's level of experience and the time of day, and it is often the case in serious accidents that the driver is not exceeding the statutory speed limit.

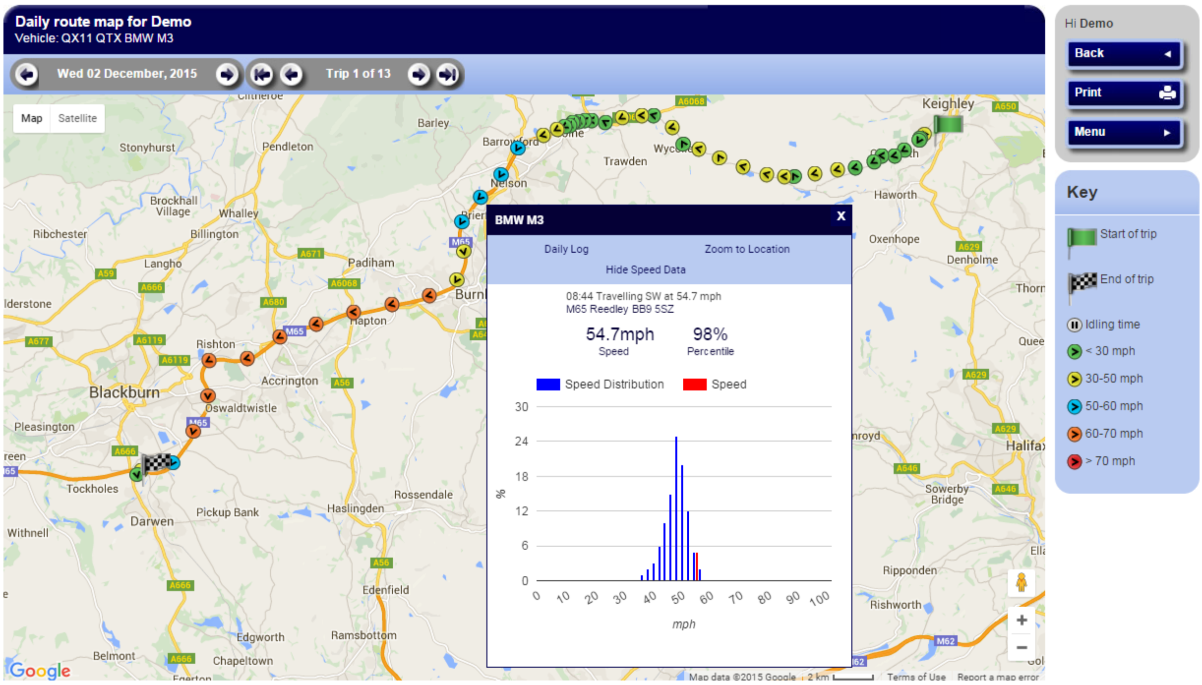
<u>How telematics can help</u>

Quartix captures more than 30 million vehicle movement events from its fleet vehicle base each day. Each of these provides location, speed and direction information. Provided the location and direction data are precise enough then the speed information from these data points can be mapped against the relevant section of the UK road network.

Figure 2 on the next page shows four stretches of road around the Banbury area, highlighted on Google maps with red lines. For each of these road sections the corresponding distribution from the SafeSpeed database is shown, together with the statutory speed limit, which is shown as a red line. More than one million of these speed distributions have now been generated from the existing fleet base.

Figure 2 below shows four sample speed distributions on roads in the Banbury region.

Figure 3 below shows the presentation of vehicle routes in the Quartix fleet tracking application: individual data points are colour-coded according to speed and the driver's position in the speed distribution is highlighted in red on the speed data "pop-up".



Each data point can be selected individually, providing both a clear view of the speed distributions of other drivers on the road and the vehicle being tracked, which in this case is on the 98th percentile.

A practical example on a rural road

It is clear from the speed distributions of the fleet vehicles that we track that the appropriate speed for a given stretch of road is often considerably lower than the statutory speed limit, and that this is particularly the case in rural areas. Figure 4 below shows a stretch of road with 60mph limit (highlighted in red) which is situated between Foxton and Barrington, in Cambridgeshire. It is badly worn and has two sharp bends, one of which is shown in the photo.

Figure 4 shows the road between Foxton and Barrington in Cambridgeshire (60mph speed limit)

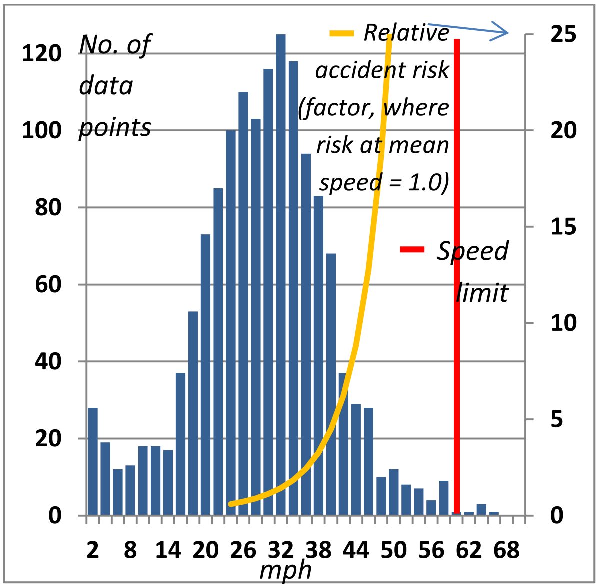


Figure 5 (left) shows the distribution data that the SafeSpeed database holds for this short stretch of road, together with the speed limit and the relative accident risk (right hand scale), calculated in accordance with the exponential relationship discussed in the first part of this paper, and based on the mean speed of approximately 30mph for the distribution.

The chart clearly demonstrates that the safe speed for this stretch of road is significantly lower than the speed limit: the distribution shows a mean speed of just 30mph, against a speed limit of 60mph.

In this particular example a driver would be at or around the 99th percentile in order to exceed the speed limit, and there is a real acceleration of accident risk from the 75th percentile onwards. There is therefore a significant gap between the speed distribution and the speed limit. It is clear, however, that single data points cannot be taken in isolation as points of comparison as the road does include some straight stretches which would have clear visibility in good conditions. But maintaining an average speed percentile above 95 on this road would indicate a very high-risk driving style.

Why white-van man provides a good benchmark for driving behaviour

Contrary to public perception, the accident rates associated with light commercial vehicles (<3.5t) are significantly lower than those for cars: of the accidents involving personal injury recorded by the police in 2014, 11,330 vans and 144,883 cars were involved (from Department for Transport Statistics[5]). The number of vans and cars on the road were approximately 3.7million and 31.5million, respectively, in 2014 (The BCA Used Car Market Report[6]).

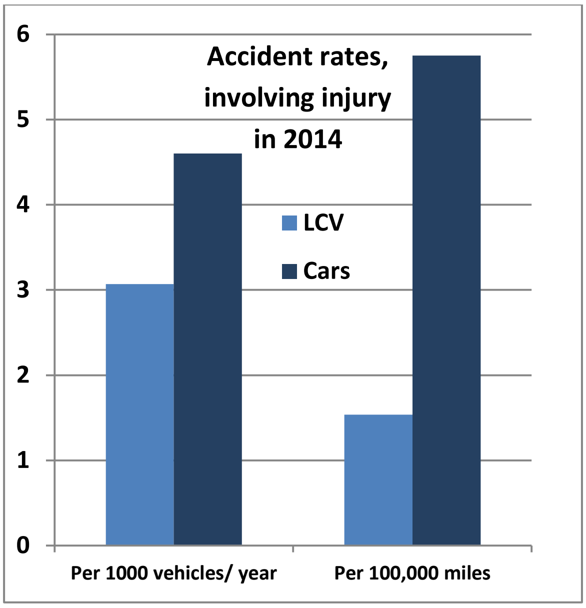


Figure 6 shows the serious accident rate per 1000 vehicles per year for both vans and cars in 2014, based on the statistics quoted above. There are 1.5 times as many accidents in cars per 1000 vehicles per year as there are in vans.

The pair of columns on the right shows the rate based on mileage. Using figures of 8,000 p.a. for cars (DfT figures for 2014) and 20,000 p.a. for vans (Quartix data) then there are 3.7 times as many serious accidents per 100,000 miles travelled in cars as there are in vans. Accident rates for young drivers in cars can be 6 times greater than for car drivers in general.

In essence, the speed distributions recorded across the UK road network in Quartix's SafeSpeed database are based on a population of professional drivers who have a lower accident rate than the rest of the general public. They provide a very useful data set against which to measure all drivers, including van drivers themselves.

Implementation

In making the SafeSpeed database an integral part of its driver scoring, Quartix has gone beyond conventional database technology capabilities in designing algorithms which can match vast amounts of vehicle movement data to the entire UK road network, at all levels, in real-time. Here are some of the key features of the system:

- At least 30million commercial vehicle movements are processed by the database each day
- Each data point is completely anonymised: there is no identification of the vehicle from which it originated.
- Each event is matched in just 60 microseconds to one of more than 15 million segments of the 2.6 million roads making up the UK network – still leaving huge room for expansion of the database as the Quartix fleet customer base grows
- Events are batched in order of receipt as they are fed into the speed distributions
- Each road speed distribution (of which there are now more than 1 million of statistical significance) is updated as new data arrives, at a rate which is dependent on the traffic flow on that road

In the most recent development, Quartix has developed fast application programming interfaces(APIs) which are capable of interrogating the speed distributions for every single data point received from a particular vehicle in order to provide a speed profile score as a percentile within each distribution. These capabilities open up a broad range of application uses, which are outlined in the next section.

<u>Practical application of the SafeSpeed database, and future developments</u>

The most important first use of the database is in providing Quartix's fleet customers with another effective tool to help them improve the safety of their drivers on the road and reduce the number of accidents they are involved in. Coupling this with the use of Quartix driving style monitoring can also lead to a substantial reduction in fuel usage:

Figure 7 shows the "Daily Driver Briefing" report from the Quartix system. This chart is widely used by fleet operators in monitoring levels of acceleration (shown in green on the bottom chart) and braking (shown in red). This analysis is used to give the driver a score out of 100, based on his driving style when compared with other Quartix fleet drivers. Speed profile for the day is shown in blue at the top of the chart, and the driver's average speed distribution percentile is now also displayed on the dial at the bottom right.

From the speed distribution given for the road from Foxton to Barrington, and using the accident risk formula shown in reference 2, there would have been a doubling in the risk of accident in travelling at the 75th percentile, as opposed to the mean. We have therefore shown this as the limit of the "green zone". We have shown anything above the 95th percentile in dark red, as this could represent a tenfold increase in accident risk on a rural road such as this.

Other applications and developments of the SafeSpeed database which are being evaluated include:

1. Assigning higher risk factors to speed percentiles (and therefore the driver's overall safety score) when these are combined with other known risk indicators:
    a. Night time driving – during hours of darkness
    b. Fatigue – the number of hours driven since the last rest break or since the start of the day.
    c. Lack of experience – lower thresholds could be set for drivers who have more recently passed their driving test, for example, or for employees who are new to driving as part of their job.
2. Identification of high-risk routes – where there is a significant gap between the speed distribution and the statutory speed limit, then the road almost certainly has a relatively high level of risk for driving while tired, in bad weather conditions or at night.
3. Setting of speed limits - several of the quoted studies recommend the setting of speed limits in relation to the distribution of free-flowing traffic on any particular route, generally putting the limit at somewhere between the mean and the 85th percentile.

Rural roads account for 82% of all car occupant deaths, for just 42% of the distance travelled[8], and travelling at an inappropriately high speed for the road, which may still be less than the speed limit, is a particular source of risk. Quartix's SafeSpeed database provides a unique management tool for fleet operators and commercial vehicle insurers to measure and control risk and potentially reduce road accidents.

References:

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4. The right speed for the road: Quartix pitches in (March 2012) http://mlog.edelivery.net/magazine/54/the_right_speed_for_.shtml
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