5. Automatic counts - unused source of information

Risto Kulmala

5.1. WHY AUTOMATIC COUNTS?

Traditionally, measurements of traffic behaviour for road safety research have been done manually. This has been only partly caused by the lack of sophisticated other means of data collection. We also know that interpretation of human behaviour is very difficult and requires usually the close presence of a qualified human observer. Nevertheless, we can foresee a transition from manual measurements and counts to an increased use of automatic ones for several reasons.

Firstly, technological advances have produced new, reliable means of collecting data on traffic behaviour also in a quite comprehensive way.

Secondly, automatic counts produce objective data in a repeatable manner. All manual forms of data collection suffer from reliability problems related to the observers' subjective interpretation of the behaviour.

Thirdly, automatic counts provide a means to collect extensive data sets of traffic behaviour usually for a relatively modest cost.

Furthermore, automatic counts are the only practical way to collect data on traffic behaviour in rare circumstances, when it is difficult to predict the occurrence of such conditions. An example of this is data collection from slippery road conditions, which is extremely difficult by manual means. If the observers would rely on weather forecasts, they could very seldom make observations on slippery road surfaces as the road maintenance would have spread salt or sand on the road before the observers had reached the location. The road maintenance operators also rely on forecasts and their forecast services are the most sophisticated in any country. Hence manual observers would have to be in constant stand-by close to the road sections to be studied, which is extremely tedious and costly. With automatic counts, comprehensive data collection on speeds, headways and flows is possible with minor costs (see e.g. Rämä et al 1996).

Finally, a large number of systems collecting and registering data on traffic behaviour exists already and the number of systems in full operation is rapidly growing. So far, only a few of these are being utilized for collecting data on traffic behaviour for safety research purposes as their main applications lie elsewhere. Nevertheless, these systems produce data that could very easily be also utilized in safety research with very low additional costs and labour.

5.2. EXISTING TECHNOLOGIES

The technologies for automatic counts can be divided in three main categories based on the location of the measurement devices or sensors. Roadside systems can be either 1) pavement based or 2)non-intrusive (requiring no physical contact to the vehicle). In addition to roadside systems, a number of 3) in-vehicle systems are used. The technologies used in the various categories are: (TTP 1995)

Pavement based

- inductive loop
- magnetic, magnetometer, microloop
- pneumatic tube
- weigh-in-motion (WIM) sensor systems

Non-intrusive

- acoustic
- infrared
- microwave
- millimetre wave
- optical, video

In-vehicle

- tachographs
- satellite based systems
- black boxes

The systems collect data on an individual basis (usually vehicle by vehicle) concerning the road users' location at a specific moment of time or during a period of time. They can also provide data on their speed, headway in time and space in relation to other road users, and their cargo.

These technologies are currently being applied to the following purposes:

- traffic counting and monitoring
- vehicle classification data collection
- road occupancy data collection and occupancy based traffic control (e.g. signal control)
- incident detection and management
- violation enforcement (e.g. speed control, toll roads)

- vehicle identification (e.g. automatic debiting)
- freight identification (e.g. hazardous goods monitoring)
- security and surveillance (e.g. parking establishments)

5.3. USE OF AUTOMATIC COUNTS IN ROAD SAFETY RESEARCH

Accidents are often looked upon as break-downs in the interaction between road users. The interaction between road users can be described as a continuum of events, often described in the form of the safety pyramid (see e.g. Hydén 1987).

On the basis of the pyramid lie the largest number of events with very low accident risk. On a road section, this can be measured by road user passages i.e. traffic flow. Some forms of traffic flow or passages have higher risk than others, e.g. vehicles speeding or following too closely. Overtakings are also a form of interaction with an accident risk higher than just a normal passage. Some interactions within e.g. overtaking situations have also higher accident risk than others i.e. are closer the top of the pyramid. Interactions with a very close resemblance to accidents and situated close to the top of the pyramid are conflicts.

Automatic counting systems relate to all parts of the safety pyramid, starting from the bottom to the top:

- exposure data
- encounters
- driving behaviour
- conflicts
- accidents

Exposure measures quantify the amount that the road users are exposed to the risk of being involved in a road accident. Different types of accidents are connected to a different type of exposure measure. E.g. for motor vehicle accidents the number of vehicle kilometres could be a reasonable measure of exposure for most purposes, whereas for accidents involving vulnerable road users (VRU) the number of kilometres travelled by VRUs is probably insufficient as an exposure measure. The VRU's risk of accidents is almost totally caused by motor vehicles and the amount of motor vehicle traffic should also be taken into account when determining the exposure for VRU accidents. One solution is to use e.g. the product of motor vehicle kilometres and VRU kilometres or the square root of that product as the measure of VRU exposure.

Very many of the automatic counting systems in operation today produce data suitable for the estimation of exposure. Many systems produce data on traffic flows on road sections, ramps, toll booths etc., often aggregated in time. The aggregation period varies from 30 seconds to 24 hours, usually being less than an hour. The flow data cover almost solely motor vehicles, and flow data is even classified by vehicle type. Automatically collected data on VRU flows hardly exist. These systems as well many in-vehicle systems enable us to measure the amount of exposure in risky conditions, e.g. in the dark, in poor weather conditions etc. This naturally requires links to other databases describing the occurrence of such conditions.

The number of incidents is available from many traffic management systems and especially specific automatic incident detection systems. This number is a relevant exposure measure for so-called secondary accidents or chain accidents on congested road networks. The number of violations is also a valid measure of exposure, e.g. for accidents involving cars driving against red at traffic signals, although it can also be used as a measure for traffic risk, e.g. the percent of drivers speeding.

Automatic counts could be especially useful for counting the number of encounters i.e. instances where two or more road users would have been simultaneously present at the same spot in the road system without any evasive action or other reaction from at least one of the road users. This number would probably be the most valid measure of exposure for accidents involving VRUs. The promising developments in the automatic detection of VRUs for traffic control and other purposes should be continued in order to implementing reliable encounter counting systems in the future. We can foresee that combined with e.g. image processing systems, an automatic encounter detection systems could pick out the interesting events in the traffic process for further analysis.

Automatic systems can also be used for studying traffic behaviour of various sorts. Image processing systems make it possible to score pedestrians' street crossing route, waiting times at kerb etc. In-vehicle systems make is possible to study driving habits, decelerations and accelerations etc.

Automatic systems already in use enable us to obtain extensive data sets on drivers' speed and headway choice. This type of data can be easily used for counting the number of disturbances or otherwise risky situations in the traffic flow. When we know the speeds and headways of individual vehicles in the traffic flow, we can estimate risk indices such as time-to-collision (TTC). A powerful demonstration of the possibilities of such tools has been presented by Oppe et al 1995. Systems enabling on-line estimation of the state of risk in the traffic flow could revolutionize the concept of traffic management, by transforming it from the management of incidents and accidents to their prevention. Systems like these only require data registration vehicle by vehicle, which , unfortunately, is not the case today when the data are collected for other that safety purposes.

Manually done conflict studies are quite costly especially at locations with a low expected number of conflicts, where the data collection period must often be several tens of hours in order to obtain a sufficient number of conflicts for research purposes. Automatic conflict scoring systems based on image processing could be answer here (see e.g. Odelid & Svensson 1993). These systems could screen sets of video tapes, detect automatically encounters, interactions and potential conflicts, analyze them for the presence and severity of evasive actions, and finally produce a collection of the most interesting situations for manual checking and further analysis.

Automatic counting systems also correspond to the top of the pyramid - accidents. Semi-automatic data collection systems by video already exist (Pasanen 1992), and here image processing could be used as with conflict situations. The incident detection systems of today already detect the occurrence of accidents automatically. Linking the incident data to the traffic flow data at the time preceding the incidents could provide valuable understanding in the safety processes in traffic flow. The data exists but has not been used for safety research. In-vehicle systems have also shown their value in the analysis of events leading to the accidents. Tachograph discs are often analyzed for the purpose of reconstructing accidents of lorries (e.g.

Kallberg & Anila 1994). The increasing introduction of digital tachographs, satellite based freight and fleet management systems, and black boxes in heavy and other vehicles produce valuable data for safety researchers to study the events leading to accidents, and the role of various factors in accident occurrence.

5.4. CONCLUSIONS

In the preceding pages I have tried to suggest ways to utilize automatic counts in road safety research. I think that automatic data collection and datasets based on these offer clear benefits. The technology already exists and automatic counting systems are in full operation around the clock on the road and street networks all over the world. These systems produce extensive datasets containing data that could be used directly or with minor modifications in road safety research. The main modification required is that data should be collected and stored vehicle by vehicle and not aggregated just to save storage space.

Partly, the neglect has been caused by the fact that the road safety research methods are not suitable as such for the analysis of data produced by the automatic systems but rather tuned in for the use of manual observations in the field. The manual observations by humans is still the best way to study human behaviour, where an interpretation and insight into the motives and purposes of different actions and manoeuvres are required. New methods for the on-line evaluation of safety of the traffic process can be and have already been developed. Methods and systems of these type can revolutionize the concept of traffic management as well as road safety work itself, by a transition into the era of risk-actuated automatic accident prevention systems.

5.5 REFERENCES

HYDÉN, C. 1987. The development of a method for traffic safety evaluation: The Swedish Traffic Conflicts Technique. Department of Traffic Planning and Engineering, University of Lund.

KALLBERG, V.-P. & ANILA, M. 1994. Ajopiirturikiekon tutkiminen (Study on a tachograph disc). Technical Research Centre of Finland, Communities and infrastructure, Transport Research 3/76/94-YKI63. 5 p. (Confidential statement on a road accident)

ODELID, K. & SVENSSON, Å. 1993. A more automatic conflict technique with image processing. Proceedings of the 6th workshop of ICTCT in Salzburg, October 1993. Pp. 285 - 290.

OPPE, S. LINDEIJER, J. E. & HEIJER, T. 1995. Incident Warning Systems: The Analysis of Traffic Behaviour. HOPES Deliverable 22. Institute for Road Safety Research SWOV.

PASANEN, E. 1992. Video recording of traffic accidents. Proceedings of the 5th workshop of ICTCT in Helsinki & Tallinn, October 1992. Pp. 121 - 143.

RÄMÄ, P., KULMALA, R. & HEINONEN, M. 1996. Muuttuvien kelivaroitusmerkkien vaikutus ajonopeuksiin, aikaväleihin ja kuljettajien käsityksiin (The effect of variable road condition warning signs. Finnish National Road Administration, Finnra Reports 1/1996. 54 p. + app. 23 p.

TTP 1995. Advanced Traffic Detection: Emerging Technologies and Market Forecast. Brochure of Transport Technology Publications. 4 p.