The comparison of automatic traffic counting and manual traffic counting

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Abstract. The main purpose of traffic surveys is to know current state of transport and for design and solution of transport in the future. For collecting traffic data, traffic surveys are carried out which consist in counting the number of vehicles of different categories. There are many ways of collecting traffic data. This paper deals with manual counting and with automatic vehicle counter. Two traffic surveys were made and results from manual counting and automatic counting were compared. The aim is to find and describe advantages and disadvantages of selected types of traffic counting.

1. Introduction

The transport sector is influenced by a wide range of external social and economic factors such as demographics, living standards of the population, urban planning, organisation of production, structural changes in society and accessibility to transport infrastructure [1]. The main task of transport sector is to satisfy the customers’ requirements for quality, flexibility, fastness and safety in transportation of people and goods [2]. Transport is an area with obvious and perceived problems such as noise, air pollution, traffic congestion and health problems [3]. Car travel is related to energy costs (fuel consumption), climate change (greenhouse gas), consumption on fossil fuels and traffic congestion [4, 5, 6, 7]. Congestion in urban areas is currently one of the most pressing problems in transport [8]. For the above reasons, traffic survey is a summary of activities designed to get traffic information. Traffic surveys mainly serve as a basis for solving and assessing suitability and quality of transport, for solving and designing an optimum outlook arrangement in traffic, for analysing the current traffic situation and actually solving each engineering work. The purpose of traffic surveys is to know the current state of transport [9].

Traffic surveys aim to capture data that accurately reflects the real-world traffic situation in the area. It may be counting the number of vehicles on a road or collecting journey time information for example, but there are many other types of data that traffic surveys collect.

In recent years, the manual approach has been largely replaced by new modern types of data collecting. This paper deals with automatic traffic counters, another way is recording traffic using video cameras, and then analysing the video footage later in the office. But this way of counting is excessively time-consuming [10].
2. Vehicle counter

The Sierzega SR4 vehicle counter is a statistical traffic data device that permits an unbiased, accurate and straightforward acquisition of traffic information for analysis. The radar device’s inconspicuous appearance allows it to record vehicles without affecting normal flow of traffic. The radar device is powered through one or two 6-volt 12Ah batteries; each battery has enough power to last approximately one week depending on vehicle flow.

The Sierzega SR4 radar is primarily a speed measuring tool. Due to the way in which the data is gathered it gives volume, length and gap information. The data is recorded on per vehicle basis or VBV for short, each data record holds information for one vehicle, this data is made up of the following; vehicle speed in MPH (km/h), vehicle length in decimetres, gap in seconds, time and date. The data is compressed and stored in flash memory; the very latest radar devices are capable of recording 430,000 individual data records before it fills the onboard memory [11].

Once the data has been recorded and stored in memory, it is easily transferred directly to an existing PC for analysis using the standard serial port and SRA analysis software. The data can also be downloaded via a Pocket PC using pre-programmed terminal software and then synchronised to a desktop PC ready for analysis using SRA software.

There is also an option to export data to text files and then process them in another software, such as Microsoft Excel.

SRA software for data processing has predefined various diagrams which are easy to create, but also make classification of vehicles into four categories according to length of vehicles. Predefined borders for vehicles’ classification are:
- 0 – 20 dm for Category 1,
- 20 – 60 dm for Category 2,
- 60 – 120 dm for Category 3,
- 120 – 255 dm for Category 4.

Also, every data has direction + or – according to direction of vehicles. (+ means oncoming vehicles). Then the raw data from the counter are: Date, Time, Length of vehicles, Speed of vehicles, Category, Gap, and Direction.

| Date       | Time   | dm | km/h | Cat. | Gap | Dir |
|------------|--------|----|------|------|-----|-----|
| 2019-04-25 | 06:50:48 | 156 | 71   | 4    | 2.3 | +   |
| 2019-04-25 | 06:50:50 | 126 | 69   | 4    | 0.7 | +   |
| 2019-04-25 | 06:50:55 | 13  | 57   | 1    | 5.1 | +   |

**Figure 1.** Example of data collected by the traffic counter.

2.1. Guidelines for installations

There are a few guidelines that need to be adhered to for ensuring that the data produced by the radar unit is both consistent and accurate. When considering a monitoring location if possible, try and find a pole that is between 0.5 meters and 2 meters parallel to the carriageway. The optimum mounting height of the radar unit should be at 1 meter above road level, however if the location is not suitable for the optimum mounting height due to footpaths or walkways then it can be installed at a height of up to 2.2 meters.

The automatic counter Sierzega offers various pole clamps according to country specific needs. The pole width should be between 0.06 m and 0.2 m. It is also advisable to avoid, where possible, dips, bends, and big masses of metal. If two radar units are to be deployed for better lane accuracy a distance of 50 m must be kept between radar beams.
2.2. Accuracy of traffic counter Sierzega SR4

According to producer, accuracy of the vehicle counter Sierzega SR4 is +/- 3% in speed, and +/- 20% in length of vehicle. As the counter is primarily a speed measuring tool, there is no note about accuracy in number of counted vehicles. Classification of vehicles is carried out according to only one measured data, which is length of vehicles [12].

3. Vehicle counter

The manual counting means that people are standing by the side of roads and recording their observations on paper pads. The recording of vehicles makes to pre-prepared census sheets by comma method. In the case of high traffic, Arabic numerals there could be used. The crossing of vehicles is recorded at 15-minute intervals. Vehicles are divided into six categories: passenger car, motorcycle, truck, bus, heavy truck, bicycle. After the survey, these data are processed into Excel for the next evaluation [13, 14].

3.1. Accuracy of manual traffic counting

Manual counting usually refers to the practice of counting classified traffic in a ‘manual fashion’. Some examples of traffic counting include vehicle counts at intersections, estimation of average daily traffic and annual average daily traffic [15].

Manual counting and classification can be carried out on the site or alternatively from video recordings. Counting and classification are simply based on visual examination and judgments by individual observers. The data is usually recorded using tally sheets or mechanical counters. After data have been collected for an interval (e.g. 1 min), totals are calculated and registered on a data sheet which can be inputted into computer later. It is usually taken for granted that errors in manual counts are small and can be ignored.

The investigation based on the manual counts derived from video recordings found out errors:
- counting errors are small, usually less than 1%,
- classification errors are significant, with an average between 4-5%.

The main errors are classification errors, reflection of difficulties in judging vehicles by a length criterion of 5.2 m from video recordings [16].

4. Comparison of results from traffic counts

In this paper, there are compared results from manual traffic counts and traffic counts from device Sierzega SR04. As there is quite different methodology of vehicles’ classification, where vehicle counter carries out classification according to the length of vehicles and its accuracy is claimed to be +/- 20%, there is compared only total number of counted vehicles in this paper.

Supposing that errors in manual traffic counting are small [17] less than 1%, data from manual counts will be considered as the right number of vehicles. The data of manual traffic counts were collected in 15 minutes intervals.

Two surveys were conducted to compare the results of the automatic traffic count and the manual traffic count. The first survey was performed on April 25, 2019 near the town of Košice and the second survey on May 15, 2019 in the village of Palárikovo.

4.1. First survey

First survey was carried out at the selected crossing of roads R2 and III/3,401 near the town of Košice. Manually counted were all vehicles entering to the intersection, automatically counted were vehicles in two lanes at the entrance no. 3, see Figure 2.
Figure 2. The location of automatic vehicle counter - first survey.

The total number of vehicles that were manually counted was 10,120. Surprisingly the vehicle counter counted 11,149 of vehicles. This means, that automatic traffic counter counted 1,029 (10.2 \%) more vehicles than it was counted manually. Looking closer to Figure 3, it can be seen that nearly at all 15 minutes intervals the vehicle counter counted more vehicles than manual counts. The greatest difference is in the morning in the time interval 6:30 – 6:45, in which vehicle counter counted 112 vehicles more (30.9\%) than manual counts.

Figure 3. Difference in number of vehicles according to traffic volume – first survey.

The relation between traffic volume and numbers of errors was also investigated. As it can be seen in Figure 4, differences in number of counted vehicles are random. There was found no correlation between traffic volume and number of errors. The average difference from the manual traffic count calculated for intervals is 13.7\% and the standard deviation is 12.8\%.
Figure 4. Difference in number of vehicles according to traffic volume – first survey.

4.2. Second survey
Second survey was carried out at the selected crossing on the road III 1,497 in the village Palárikovo. Manually counted were all vehicles entering to the intersection, automatically counted were vehicles at the entrance no. 3, see Figure 5.

Figure 5. The location of automatic vehicle counter - second survey.

The total number of vehicles that were manually counted was 1,361. The vehicle counter counted more vehicles that it was counted manually again. The counter counted 1,439 of vehicles, that means that the counter counted 78 (5.7%) more vehicles than it was counted manually. Looking closer to the Figure 6, there can be seen differences in 15 minutes intervals; the greater difference is at the interval 14:15 – 14:30, in which the traffic counter counted 16 more vehicles than it was counted manually.
Figure 6. The comparison of manual traffic counting and automatic traffic counting – second survey.

Also, the relation between traffic volume and a number of errors was investigated. Again, differences in number of counted vehicles are random (Figure 7). There was found no correlation between traffic volume and the number of errors. The average difference from the manual traffic count calculated for intervals is 15.3% and the standard deviation is 19%.

Figure 7. Difference in number of vehicles according to traffic volume – second survey.

Traffic counting with automatic traffic counter Sierzega gives more statistical outputs about traffic flow. While the manual traffic counts provide information about traffic volume and vehicles direction at intersection. Automatic counter Sierzega gives information about number of vehicles, speed of vehicles, their length and gap between vehicles. But automatic counter Sierzega does not give information about vehicles trajectory (direction) at intersection. Also, there is no way to find out this information with this vehicle counter [18].

The main advantage of using this traffic counter is its easy installation and data collection. According to authors’ opinion this device is suitable for informative traffic counting, for long term traffic counting, and for obtaining additional traffic data for traffic modelling; e.g. vehicle’s speed is very important parameter for traffic model calibration [19, 20, 21].
5. Conclusions
To assess the operating conditions used a number of approaches, due to the fact that in practice there are different circumstances allowing (or not) to use certain methods [22]. There are differences in the number of vehicles counted when comparing manual traffic counts and traffic counts carried out by automatic counter Sierzega.

If the total number of vehicles which passed the traffic counter was considered only, the difference is not so vast. During first traffic survey in Košice it was 12,000 to 13,000 of vehicles, which means difference of 2%. During the second traffic survey in Palarikovo it was 1,200 – 1,300 vehicles, which means difference of 3%. This number can be claimed as very good accuracy of traffic counts. But if we look closer to the number of vehicles in 15 minutes intervals, the differences were much greater. The maximum difference was up to 120 vehicles (40%).

This comparison also showed, that automatic counter Sierzega can be used also for traffic counts in two lines road. The average difference in traffic count at two-line road was 5% and the average difference in traffic counts at 1-line road was 6%.

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