# Cordon counting in the territory of the city of Bitola

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**Abstract:** *The collection and analysis of transport data is of great importance for traffic engineers, who use that data to perceive existing problems and offer solutions. Depending on the type of data and the meaning available, there are different methods and equipment. Data collection can be done on sections, intersections, entire cities, hourly, daily, weekly, monthly and annually. For the city of Bitola, data collection was carried out for cars, buses and heavy goods vehicles in the peak hour according to the directions of movement, i.e. cordon counting, by setting up checkpoints with personnel on those roads that intersect with the cordon line. In this case, the vehicles in transit are important to us and we grouped them into two groups, cargo transit and individual traffic.*

**Keywords**: *PRIVATE TRANSPORT, PUBLIC TRANSPORT, CORDON, COUNTING, TRANSITIVE*

## 1. Introduction

In order to obtain information about the basic parameters of the traffic flow, the behavior of the participants in the traffic, etc. data collection is required. In the first, preparatory phase, the recording forms are prepared, the students are prepared for the data collection process for the defined area of coverage.

Traffic counting is performed manually, according to the type of vehicle (passengers, trucks, buses), counting is performed according to approaches/directions of movement. Each student was placed on a suitable approach and enters the data into a previously prepared form of a counting sheet.

The time period of data collection is 1 hour (peak hour).In this paper will be published the cordon counting of the city of Bitola, carried out at 3 counting points in the peak hour, from 14:00-15:00.

## 2. Collection and analysis of transport data

Every day we encounter a large amount of data. That data reaches the end users in a final and processed form. That data can be related to transportation, education, work, industry, etc. When it comes to transportation, the following data are presented to users: number of traffic accidents, number of transported passengers, cargo, harmful emissions, etc.

The collection and analysis of relevant data on the traffic system or its parts is of great importance for the performance of scientific research, studies, projects, expertise. These data allowes a clear understanding of the existing conditions and problems and represent a basis for solving the problems. The data collection phase implies going out into the field and serious preparations, with clearly defined objectives, methods, trained personnel and equipment for data collection.[4]

Depending on what kind of data we need, we choose the collection method, define the place and time of the collection, determine the necessary personnel and equipment, control the counters, arrive at the place on time, wear a fluorescent vest for greater security etc. Collecting can be manual, i.e. manual with a counting sheet and automatic with video cameras,control, cordon counting, etc.[2]

### 2.1. Cordon counting of vehicles

➢ **A cordon** is an imaginary boundary line around the space that is the subject of research. Usually it is a central city area or other center of activity, where it is important to determine the accumulation of vehicles in the given space. Vehicle counts in this case are carried out on all roads that cross the cordon line, classifying vehicles by direction and by time period from 15 minutes to one hour. This enables the estimation of the number of vehicles in the given area at a certain time. Sometimes cordon counts are done together with counts of a smaller intersection of roads, with this it is also possible to estimate the number of parking spaces.[2]

➢ **The cordon line** is placed so that it intersects all roads that enter the pre-defined area of interest. This intersection in the middle of blocks, between intersections, is done in order to avoid the problem of vehicles turning due to which it becomes unclear whether they enter the defined areaspace or not.It is convenient to choose the cordon line in such a way as to minimize the number of thoroughfares to be counted.[2]

➢ **The accumulation of vehicles** inside the cordon line is determined by summing up the total number of vehicles that enter and leave the given space in a certain period of time. The cordon counts should start when the street network inside the space that is the subject of the study is practically empty.If this is not possible, then counts are made of parked vehicles and vehicles on the streets to estimate the initial number of vehicles in the given space, when the cordon counting began. The accumulation of vehicles is calculated according to the formula:[2]

$$A_i = A_{i-1} + V_i - I_i$$ , where,

$A_i$ - number of vehicles in the period ''i'' ,

$A_{i-1}$ - number of vehicles in the previous period ''i-1'',

$V_i$ - number of vehicles entering period "i",

$I_i$- number of vehicles leaving in period "i",

## 3. Cordon counting for the city of Bitola

On May 20, 2022 (Friday) from 14:00-15:00, a cordon counting of vehicles was carried out together with a group of students from the traffic department at the Technical Faculty-Bitola.[1]

The subject of research is to give an estimate of the accumulation of vehicles.

The aim of the research is to give an estimate of the number and structure of vehicles that transit through the territory of the city of Bitola.

The cordon supports an imaginary border line around the city of Bitola, and the counting of vehicles was carried out on all roads that cross the cordon line, namely: [3]

1. Road with approach to - from Prilep.

2. Road with access to - from Ohrid.

3. Road with approach to – from Greece.

These checkpoints are placed in such a way that they cross all the roads entering the city of Bitola, in order to avoid the problem of vehicles turning, which makes it unclear whether they enter the defined space or not. That is,

Zone 100-Prilep

Zone 101 Ohrid

Zone 102 Greece

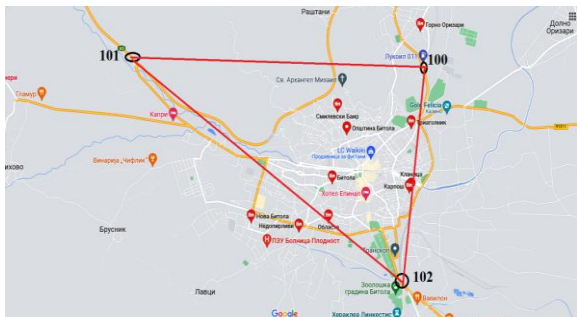Figure 1 shows the cordon line of the city of Bitola and the counting points.[1]



**Fig.1:** *Shows the cordon line and the counting points (Source: Google maps and the Paint tool)*

Figure 2 shows the cordon count form by vehicle structure where the location, date, count period, mobile phone, student, cars, buses, heavy goods vehicles are entered.[5]



**Fig.1:** *Shows the form for cordon counting by vehicle structure(Source: Created in an Excel document)*

### 3.1 Results of counts by direction of movement

The results of the counts between 14:00 and 15:00 are shown in the following table by structure of vehicles and by direction of movement.

**Table 1:** *Results of counts by directions of movement*

|  | Greece-Bitola | Bitola-Greece | Ohrid-Bitola | Bitola-Ohrid | Prilep-Bitola | Bitola-Prilep |
|---|---|---|---|---|---|---|
| **Car** | 534 | 491 | 141 | 143 | 613 | 586 |
| **Bus** | 47 | 13 | 1 | 1 | 16 | 27 |
| **HGV** | 31 | 23 | 49 | 22 | 36 | 69 |

From the obtained results we can conclude that the most intensive flows are on the direction from and to Prilep - Bitola, where about 660 vehicles are registered and in the opposite direction about 680 vehicles, while the second place in terms of intensity is the road direction from and to Greece - Bitola. There is a greater deviation on the road from and to Ohrid - Bitola, where we have registered about 190 vehicles. The largest flow of heavy goods vehicles appears on the road direction Bitola-Prilep, while the lowest flow of heavy goods vehicles occurs on the road direction Bitola-Ohrid, together with the direction Bitola-Greece.

### 3.2 Results of cordon counting

The accumulation of vehicles inside the cordon line is determined by summing up the total number of vehicles entering and leaving the given area in a certain period of time, with the results given in the following table.

**Table 2:** *Results of cordon counting*

|  | Greece-Prilep | Greece-Ohrid | Ohrid-Prilep | Ohrid-Greece | Prilep-Ohrid | Prilep-Greece |
|---|---|---|---|---|---|---|
| **Car** | 41 | 9 | 4 | 14 | 6 | 38 |
| **Bus** | 12 | 0 | 0 | 0 | 0 | 2 |
| **HGV** | 6 | 2 | 4 | 2 | 0 | 3 |

### 3.3 Results for transit freight and individual traffic

**Table 3:** *Shows the results for transit freight traffic*

| Transit freighttraffic | | | |
|---|---|---|---|
| External zone | **100** | **101** | **102** |
| **100** | 0 | 0 | 3 |
| **101** | 4 | 0 | 2 |
| **102** | 6 | 2 | 0 |

**Table 4:** *Shows the results for transit individual traffic*

| Transitindividual traffic | | | |
|---|---|---|---|
| External zone | 100 | 101 | 102 |
| **100** | 0 | 6 | 40 |
| **101** | 4 | 0 | 14 |
| **102** | 53 | 9 | 0 |

### 3.4 Graphical display of output results

Graphic display of the number of cars by direction of movement
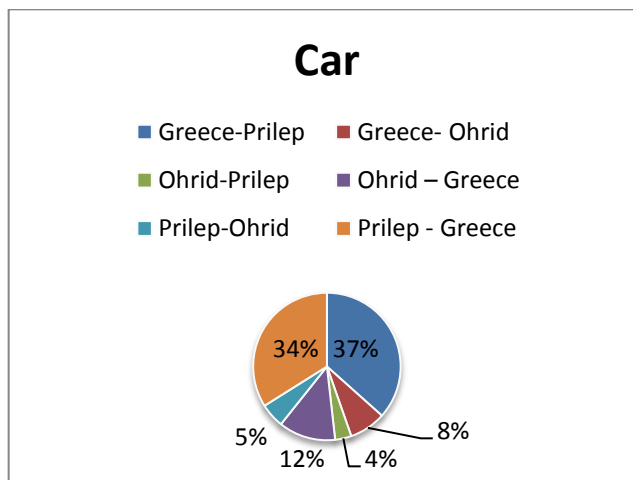


**Chart 1:** *The number of cars by direction of movement*
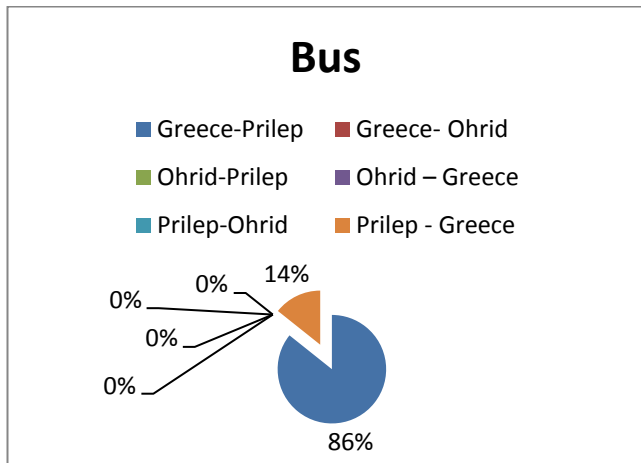
Graphic display of the number of buses by route

**Chart 2:** *The number of buses by route*

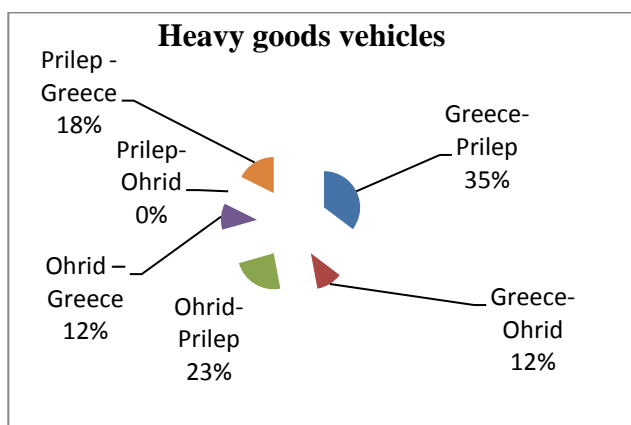Graphic display of the number of heavy goods vehicles by direction of movement.



**Chart 3:** *The number of heavy goods vehicles by direction of movement*

Graphic display of the number of vehicles and the structure of vehicles by direction of movement.
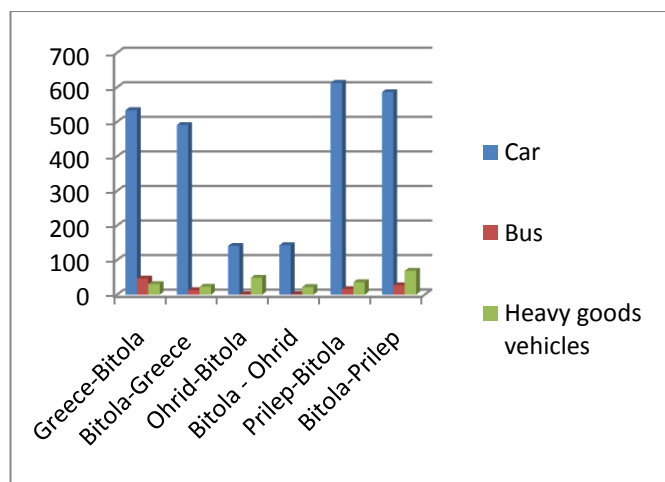


**Chart 4:** *The number of vehicles and the structure of vehicles by direction of movement*

## 4. Conclusion

The direction of movement, the composition of the traffic flow, the speed, the travel time, the following distance, the number of vehicles, the number of traffic accidents are only part of the data that are collected for various purposes, research. The cordon line is placed so that it intersects all roads that enter the pre-defined area of interest. The accumulation of vehicles inside the cordon line is determined by summing up the total number of vehicles that enter and leave the given space in a certain period of time. On the territory of the city of Bitola, 3 points were defined, that is, places where we have entry-exit flows to other cities, the collected data were analyzed and those vehicles that appear at the other point are taken as transit flows. From the obtained results we can conclude that the most intensive flows are on the direction from and to Prilep - Bitola, where about 660 vehicles are registered and in the opposite direction about 680 vehicles, while the second place in terms of intensity is the road direction from and to Greece - Bitola. There is a major deviation on the road from and to Ohrid - Bitola, where we have registered about 190 vehicles. The largest flow of heavy goods vehicles appears on the road direction Bitola-Prilep, while the lowest flow of heavy goods vehicles occurs on the road direction Bitola-Ohrid, together with the direction Bitola-Greece. In addition to tabular, a graphic presentation of the collected and processed data was also presented.

## *References*

[1] https://www.google.com/maps

[2] "Collection and Analysis of Transport Data"Associate Professor Vaska Atanasova

[3] https://mk.wikipedia.org/wiki/Bitola

[4] https://data.ontario.ca/en/dataset/cordon-data-directional-traffic-counts

[5] https://www.oracle.com/database/what-is-database/