Master of Science in Civil Engineering

Master Thesis

Development of Safety Performance Functions for Road Segments in Turin

Supervisors

prof. Marco Bassani

Dipartimento di Ingegneria dellÁmbiente, del Territore e delle infrastructture – Politecnico di Torino

prof. Emanuele Sacchi

Dept. of Civil, Geological, and Environmental Engineering – University of Saskatchewan

Candidate

Shiva Mohammad Golzari

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Abstract

In Italy, approximately two-thirds of all crashes occur in urban areas, so identifying roadway and traffic factors that influence crashes occurring in such a context is an important area of research. According to the literature, there were no previous studies about parameters influencing crashes occurring in Italian urban areas, and in particular in Turin. This study involves developing safety performance functions (SPFs) for road segments in the city of Turin, including speed and geometric variables as main covariates in the model. The SPF is a mathematical regression model that predicts the crash frequency for road segments and intersections. Also, SPFs are an essential tool for conducting network screening studies and evaluating road safety improvements' effectiveness.

In this study, the negative binomial distribution was used to model crash frequency. In fact, crashes are rare and random events in a statistical sense and can be modelled as count data accounting for overdispersion. The overdispersion parameter represents the degree of overdispersion in a negative binomial model. Generalized Linear Modelling (GLM) was used to estimate regression parameters of the SPF. Two different types of SPFs were developed to identify influencing factors on crash frequency; in the first type, the operating speed (V85) and average speed (V50) of each lane of the road were estimated by using a model proposed by Bassani et al. (2014). In the second type, geometric variables such as median (M), parking lane (PL), access points density (ACD), driveway (DD), and pedestrian crossing density (PCD). Based on the results, a low correlation was found between speed and crash frequency. In addition, based on the literature, the probability of crash occurrence should increase by increasing speed, but the results showed an opposite behaviour in this specific case study. Among geometry features, access density and driveway density are the most influential factors on crash occurrence.

Considering that predictive road safety analyses were mainly conducted in North American, where functional and geometrical features are different from Italian roads, this study can be considered as a step forward to predict crash frequencies of Italian urban roads.

KEYWORDS: SPFs, Average speed, Operating Speed, AADT, Length.

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Chapter 1

1 Introduction

According to the World Health Organization website (2020), more than 1.35 million individuals are killed on roads worldwide every year due to road crashes. In addition, between 20 and 50 million more people suffer non-fatal injuries, with many incurring a disability because of their injury. Both fatal and non-fatal crashes will cost more than 1.8 trillion dollars between 2015-2030 years. But this massive amount of money does not include the suffering of individuals involved in accidents and the pain of family and friends. These irreversible effects of crashes on the society, economy, and health of the injured individuals cause road safety to be one of the main study topics. Although inhibiting collisions is somehow impossible, reducing the number and severity of crashes is a reasonable approach. But which road can be identified as unsafe, and what is the best method to identify some locations as unsafe? In the past, road agencies used a subjective view to identify hazardous locations by measuring the absolute number of crashes at locations or the ratio between crashes and Traffic volume. However, in recent years, researchers have tried to understand the reason for crashes. With this new approach, by evaluating influential factors on crash frequency, road agencies can act against factors causing unacceptable crash frequency (Tegge et al., 2010).

1.1 Terminology

This section presents essential terminologies, which are used in this thesis. Crash refers to a collision between two vehicles or a vehicle and any object or road user that can cause material damage or physical damage to people.

The KABCO scale is used by Highway Safety Manual (2010) for ranking crash severity. According to the KABCO scale, there are five categories for crash severity, which follows:

- K—An injury that results in death is a fatal injury;
- A—An injury, other than the K category that the injured person cannot walk, drive, or normally continue after the injury occurred is an incapacitating injury is any injury;
- B—The injury, other than K and A categories, that is evident; to observers at the place of the crash in which the injury occurred is non-incapacitating evident injury;
- C—Any injury reported or claimed that is not inside the above-mentioned categories and includes the claim of injuries not evident is a possible injury;
- O—No Injury includes Property Damage Only (PDO) crashes.

The Italian policy considers three categories that can be obtained by regrouping the KABCO in three classes: K as a Fatal class, A, B, and C as an Injury class, and O as a PDO class. The last class of collisions type is not included in the official Italian road crash database.

Crash frequency refers to the number of crashes occurring in a specific period at a particular intersection or along a road segment. According to HSM (2010), a safety performance function refers to a mathematical regression model for road segments and intersections that predicts crash frequency per year # as a function of traffic volume and, in some cases, roadway or intersection characteristics (e.g., number of lanes, traffic control, or type of median).

In this study, intersection refers to an area in which two or more roads meet each other. A roadway segment refers to a road portion between two intersections. Access point refers to a roadway where it meets a secondary road, and vehicles can enter the roadway or exit. The intersection of them is typically not signalized. A driveway access point refers to the point where a roadway meets a private road of a private area or a building.

Finally, operating speed (V85) refers to the 85th percentile of a sample of observed speeds that drivers operate in free-flow conditions. Average speed (V50) refers to an average observed speed in a section where drivers operate in free-flow conditions (Bassani et al., 2015).

1.2 Background

Due to the harmful effects of crashes, transportation safety has become an essential topic among transportation engineers. The main goal is to understand the reason for crashes and implement suitable strategies to make roadways safer. Observational studies evaluate the effectiveness of road safety engineering countermeasures. In observational studies, crash data and information on the roadway characteristics such as AADT, grade, median type, etc., are analysed statistically to find any correlation between crash frequency and influential factors. Safety Performance Functions (SPFs) provide a statistical relationship between the predicted number of crashes per specific period and roadway characteristics. Since intersections and road segments are entirely different, different SPFs are needed to predict their crash frequencies. For instance, to develop SPFs of road segments, characteristics such as AADT, length, lane width, median width, etc., are used. At the same time, SPF for intersections depends on other factors such as AADT for both legs, type of intersection, turning lane, etc.

1.2.1 Safety Performance Functions

SPFs can be developed for different road types (i.e., rural roads, urban arterials, and freeways and elements (i.e., tangent, curves, intersections, etc.). Independent variables considered in a model should have a reasonable correlation with crash frequencies to develop an SPF. The best model is an SPF that best predicts crashes and shows a logical connection between the independent variables and the predicted value. However, because of limited time and resources, analysts use a limited number of variables for their SPFs.

Many studies were done on Safety Performance Functions (SPFs) to find a reasonable correlation between crash frequency and road- and traffic-related variables. Mayora et al. (2003) claimed that the highway variables with the highest correlation with crash rates in Spain's two-lane rural roads are: access density, average sight distance, average speed limit, and the proportion of no-passing zones. Greibe (2003) found that explanatory variables describing the road environment, number of minor side roads, parking facilities, and speed limit proved to be significant variables for predicting the crash frequency of road segments. Sawalha et al. (2001) indicated that section length, traffic volume, unsignalized intersection density, driveway density, pedestrian crosswalk density, number of traffic lanes, type of median, and land use type significantly affected accident occurrence. Cafiso et al. (2010) recommended three models based on statistical significance and goodness of fit indicators: the first includes only the exposure variables, length, and traffic volume, the second one provides length, traffic volume, driveway density, curvature ratio, and the standard deviation of the operating speed profile, and the third one includes length, traffic volume, driveway density, roadside hazard rating, curvature ratio and the number of speed differentials higher than 10 km/h. Marizwan et al. (2013) concluded that increased access points per kilometre and the average traffic volume are highly associated with increased motorcycle fatalities per kilometre. Sacchi et al. (2015) estimated that when the predicted traffic conflicts increase 1%, predicted collisions increase 0.8%. Mehta et al. (2013) concluded that the SPF, which estimates the mean crash frequency as a function of annual average daily traffic, segment length, lane width, year, and the speed limit, was the best one. Reddy Geedipally et al. (2017) found that the skid number variable is statistically significant, besides traffic volume, curve radius, and cross-sectional widths.

Some studies were done to evaluate how speed affects crash frequencies. Garber et al. (2000) concluded that there is a relationship between crash rates and the independent variables of the standard deviation of speed, mean speed, and flow per lane. On the one hand, Kockelman et al. (2007) concluded that there is no evidence to support a hypothesis that speed conditions influence crash occurrence. On the other hand, Quddus (2013) studied a series of relationships between segment-level average speeds, speed variation, and accident rates based on nonspatial and spatial statistical models using a panel data set obtained from a significant road network around London. Also, Xu et al. (2019) found that a more significant spatial and temporal speed variance increases the probability of crashes on an urban expressway. These contradictions may need further analysis to clarify the possible relationship between speed and crash frequencies. Moreover, these studies used different methods to collect data related to speed for estimating speed or speed variance, so that this reason can be the nature of these contradictions. According to Subasish et al. (2021), the increased variability in hourly operating speed within a day and monthly operating speeds within a year are both statistically significant for modelling crash frequency.

1.2.2 Negative Binomial Distribution

As far as the approaches, the Poisson model has been at first utilized in the SPF assessment since the crash frequencies are non-negative integers (Lord et al., 2010). Nonetheless, the Poisson model has its limitation distribution of data – the variance of the data is constrained to be obliged to be equivalent to the mean. This limitation may be problematic as the variance of crash data is normally greater than the mean (overdispersed data) (Washington et al., 2011).

According to the HSM (2010), SPFs are calibrated via Generalized Linear Model (GLM) using observed crash occurring data collected over several years at intersections or road segments with similar characteristics and containing a wide range of AADTs. The regression parameters of the SPFs are defined by assuming that crash occurrence follows a negative binomial distribution. Since crash is a rare event on roadways that exhibit significant overdispersion, the negative binomial distribution more accurately models the crash frequencies associated with road segments and intersections (Persaud, 2001). Hence, because observed accident data are overdispersed, the negative binomial distribution is preferred over the Poisson distribution. (Harwood et al., 2000).

To represent the degree of overdispersion in a negative binomial model, the overdispersion parameter is estimated. If the value of the overdispersion parameter increases, the crash data will vary compared to a Poisson distribution with the same mean. (HSM, 2010)

1.3 Objective and Scope of Study

In Italy, approximately two-thirds of all crashes occur in urban areas, so identifying roadway and traffic factors that influence crashes occurring in such a context is an important area of research. According to the literature, there were no previous studies about parameters influencing crashes occurrence in Italian urban areas, and in particular in Turin. This study involves developing safety performance functions (SPFs) for road segments in the city of Turin, including speed and geometric variables as main covariates in the model. In this study, crash frequencies are modelled only by negative binomial regression. The degree of overdispersion in a negative binomial model is represented by the overdispersion parameter. To calibrate SPFs, Generalized Linear Modelling (GLM) was used because of the discrete nature of crash frequency. Two different kinds of SPFs for selected segments of the Turin road network were calibrated considering a time framework of 5 years (2012-2016). Initially, the first group of SPFs was calibrated by using the Average Annual Daily Traffic (AADT), segment length, the Operating speed (V85), and Average Speed (these speeds were estimated using a Speed Model based on the geometrical characteristics of the road) as explanatory variables. Furthermore, the second group of SPFs was calibrated using the Average Annual Daily Traffic (AADT), the length of the segment, and geometric characteristics variables.

Chapter 2 is devoted to data collection and methodology. Then, the results of the models are presented in chapter 3. In addition, chapter 4 consists of summaries and conclusions. Finally, references and appendixes, which contain tables of the data, are the last part of this manuscript.

Chapter 2

2 Database and Methodology

This chapter is separated into two main parts; the first part is related to the database used in this thesis; the second part is associated with the methodology used to calibrate SPFs.

2.1 DataBase

In this study, QGIS (version: 3.4.4-Madeira) was used to organize, analyze and represent spatial data related to road network AADT, and crash data. In the following parts, the procedure of collecting and managing the database is discussed.

2.1.1 Road Network

Some roads of Turin were selected as a case study and, the selection of roads was made in two phases. In the first phase, 12 roads were selected, and in the second phase, five other roads were added to the sample. The summary statistics of the investigated road are reported in Table 2-1. The whole road network of Turin is shown in figure 2-1. After the selection of roads, their segmentation was the next primary step. According to the HSM (2010), the segmentation process produces road segments with different lengths by considering that they are homogeneous with respect to traffic volumes, roadway design characteristics, and traffic control features.

Table 2-1 Summary statistics of the road investigated network.

#	Road name	Total number of segments	*Segment Length[km]*			
			min	max	mean	Standard Deviation
		The first phase				
1	Via Reiss Remoli	9	0.16	0.44	0.27	0.11
2	Via Guido Reni	9	0.1	0.32	0.2	0.06
3	Via Filadelfia	15	0.24	0.59	0.37	0.14
4	Corso Traiano	7	0.15	0.42	0.25	0.1
5	Corso Svizzera	9	0.07	0.42	0.24	0.11
6	Corso Sebastopoli	6	0.1	0.55	0.29	0.15
7	Corso Regina Margherita	18	0.1	0.88	0.27	0.19
8	Corso Racconigi	7	0.22	0.75	0.39	0.19
9	Corso Moncalieri	14	0.038	1.1	0.4	0.31
10	Corso Massimo d'Azeglio	6	0.21	0.36	0.27	0.06
11	Corso Francia	7	0.1	0.61	0.37	0.16
12	Corso Casale	11	0.07	0.54	0.3	0.12
		The second phase				
13	Via Bologna	5	0.272	0.454	0.34	0.07
14	Corso Giulio Cesare	9	0.15	0.42	0.26	0.1
15	Corso Belgio	7	0.16	0.37	0.26	0.08
16	Corso Orbassano	9	0.12	0.4	0.215	0.09
17	Via Pio VII	4	0.24	0.36	0.3	0.05

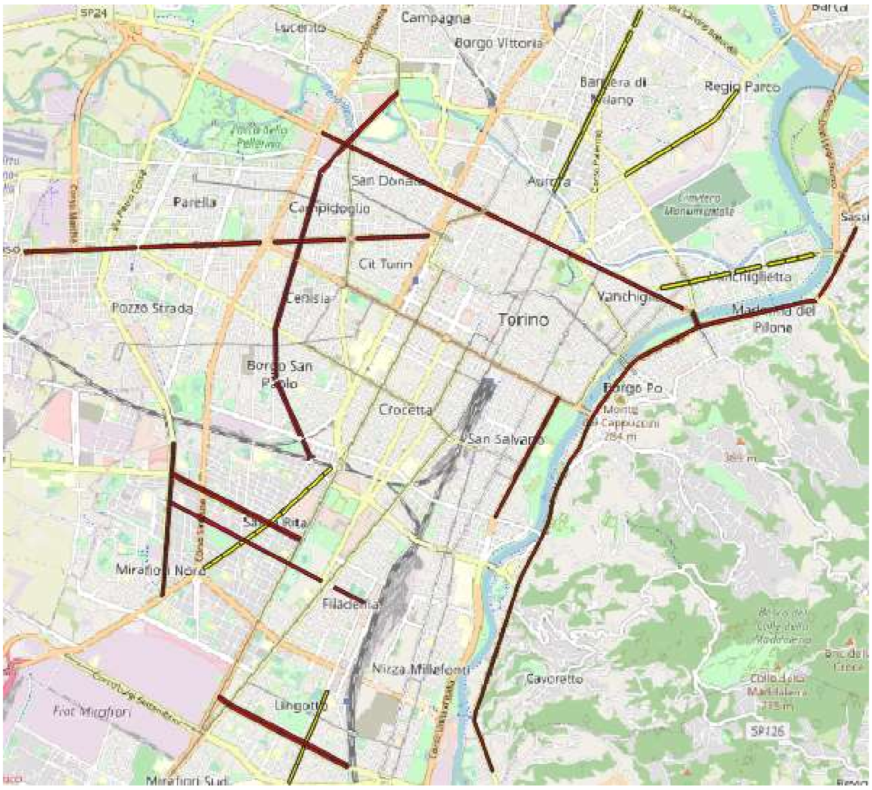

Figure 2-1 Total Road Network. Red roads belong to the first sample, and the yellow ones belong to the second sample.

In this study, the roads were segmentized when there is a traffic light, and there is a change in AADT along the road. The definition of the segment length in the HSM (2010) was considered to identify the length of each segment. According to Figure 2-2, the segment length(L) for a single homogenous roadway segment is the length of the road between two intersections. According to Figure 2-3, the distance between centres of two intersections controlled by traffic lights was considered road segment length. The result of segmentation is in Appendix 2. (Table A.2)

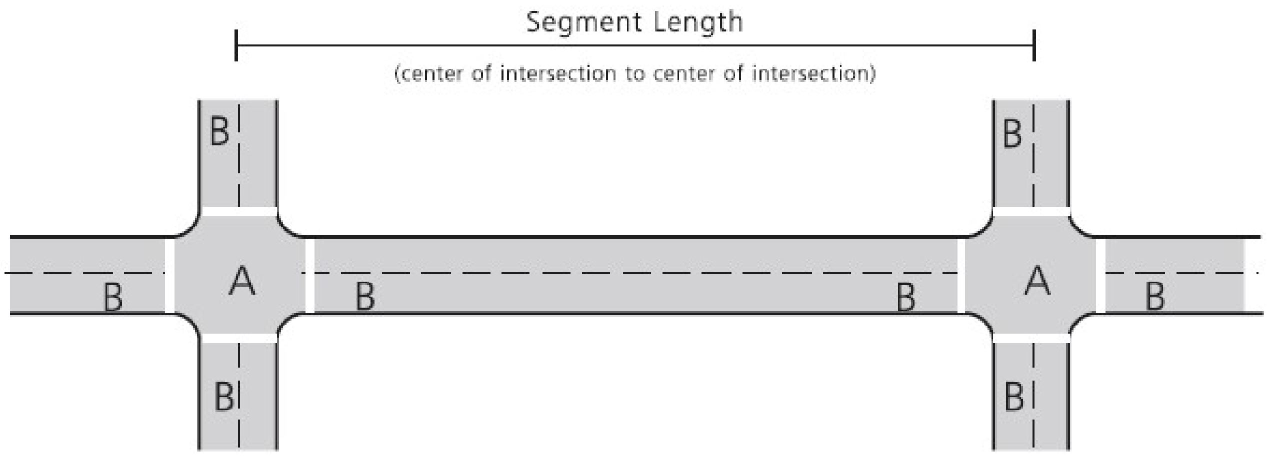

Figure 2-2 Definition of Segment Length. Taken from (HSM- 2010)

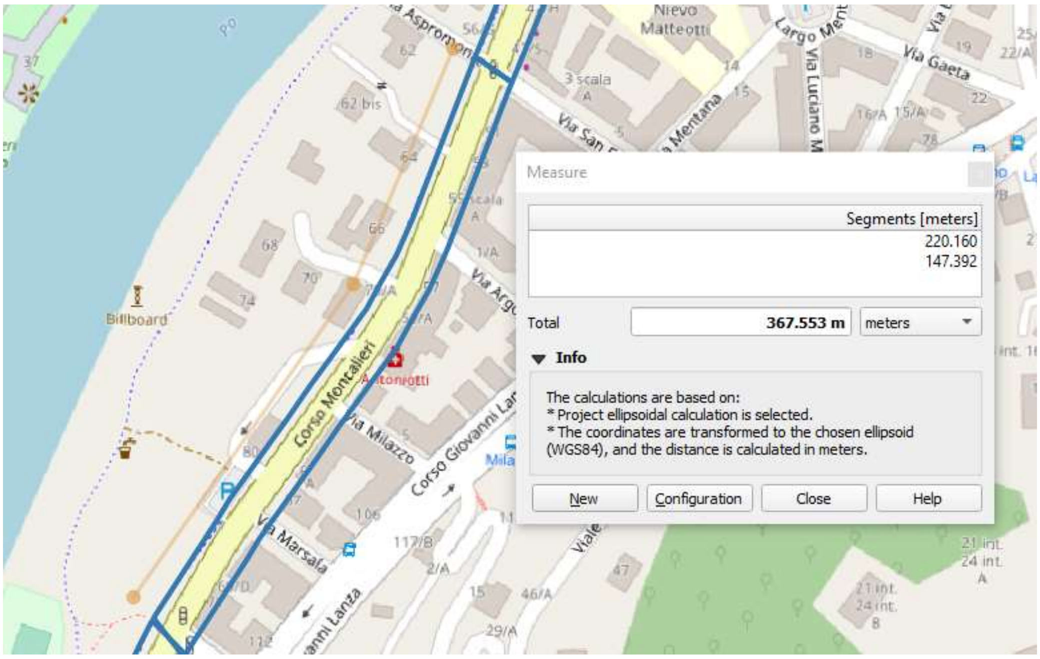

Figure 2-3 An example of roadway segmentation.

2.1.2 AADT

5T – Telematic Technologies for Traffic and Transport in Turin S.r.l company provided the vehicle flow data used. The 5T metropolitan system is one of the most vital European mobility management systems based on ITS and includes nine subsystems, including UTC (Urban Traffic Control), which deals with traffic light regulation in agreement with local vehicle flow measures. The system currently operates on 330 traffic lights at intersections, with 2754 traffic detection units (loops), 1264 of which are not perfectly functioning (Masci et al., 2015).

Inductive sensors are near the intersections and detect the outgoing vehicular flow. Flow data is collected every minute and then averaged every 5 to obtain an aggregate flow rate of 5 minutes. By analysing the collected data and considering data of 365 days in a year, the AADT value was calculated along each direction of travel, so the AADT of both directions was summed to find the AADT of the roads. AADT data was provided for six years (2011-2016) in the shapefile used in QGIS.

According to Table 2-2, by considering the mean and standard deviation of AADT, there was no consistency in AADT data during years on some roads. For example, the mean and standard deviation of Via Filadelfia in 2012 are 8448 and 4776, respectively. In the following year, 2013, and they increased to 21456 and 24912. Then, they decreased to 14643 and 17488 in 2014. These kind of AADT fluctuations during years are suspect, so a method is needed to identify road segments which are outliers and eliminate them from the sample.

Table 2-2 Summary statistic of AADT of Roadways

#	Road name	Year	AADT			
			min	max	mean	Standard Deviation
1	Via Reiss Remoli	2012	7776	25632	18149	7347
		2013	9168	41976	19096	13136
		2014	9576	19080	14256	4270
		2015	5424	20520	10784	6058
		2016	6024	19776	11008	5610
2	Via Guido Reni	2012	5208	28536	15667	10355
		2013	8520	28488	17059	7845
		2014	11736	33696	17795	9142
		2015	3792	26760	14307	10013
		2016	4056	26904	14685	9579
3	Via Filadelfia	2012	6720	2328	8448	4776
		2013	25704	35472	21456	24912
		2014	20979	14757	14643	17488
		2015	7675	10018	4471	7309
		2016	6720	2328	8448	4776
4	Corso Traiano	2012	10896	28008	17729	5974
		2013	7560	20784	17671	4683
		2014	19776	29448	24411	4797
		2015	8904	16584	13371	2790
		2016	10032	16800	12525	3134
5	Corso Svizzera	2012	4320	38136	19957	12821
		2013	5472	22080	11797	5151
		2014	5952	39960	20251	11961
		2015	4632	41208	21261	12501
		2016	4776	42312	21781	12519
6	Corso Sebastopoli	2012	11352	32760	19864	10139
		2013	13992	22560	17104	4241
		2014	6000	28320	20924	8477
		2015	7968	20424	13988	5169
		2016	7488	19608	13096	4865
7	Corso Regina Margherita	2012	8088	35832	22257	8696
		2013	7344	40104	22116	9236
		2014	2688	40992	20293	11037
		2015	2376	35616	13409	9023
		2016	2520	34056	13021	8252
8	Corso Racconigi	2012	6192	16800	12045	3590
		2013	6336	17112	12569	3436
		2014	5472	17160	12254	3672
		2015	9264	25896	21041	5544
		2016	8880	26544	20506	5834
9	Corso Moncalieri	2012	8880	23208	18511	5171
		2013	12288	38544	24360	9885
		2014	6624	34680	20810	9563
		2015	4152	23880	15055	7180
		2016	4608	23184	14808	6358

#	Road name	Year	AADT			
			min	max	mean	Standard Deviation
10	Corso Massimo d'Azeglio	2012	10944	27096	23468	6176
		2013	20568	43320	35684	7879
		2014	13200	45696	25304	10928
		2015	5904	32784	17656	9838
		2016	6288	33912	18228	10106
11	Corso Francia	2012	7920	43683	27964	10213
		2013	5760	38184	19440	13652
		2014	5184	40368	23018	10477
		2015	8016	39672	19580	10320
		2016	7584	31752	18107	8857
12	Corso Casale	2012	15384	34464	24528	7752
		2013	16272	37488	24853	9351
		2014	13560	40032	22610	9529
		2015	5400	18504	11954	4037
		2016	5136	18648	12731	3968
13	Via Bologna	2012	18576	20544	19128	800
		2013	11016	22944	13872	5173
		2014	9120	19752	17198	4610
		2015	7512	29208	17424	7718
		2016	7272	27816	17472	7264
14	Corso Giulio Cesare	2012	5568	29424	12917	7556
		2013	3672	46248	16669	13179
		2014	1848	26592	11813	9374
		2015	7344	35136	19915	8582
		2016	7728	34680	19053	8040
15	Corso Belgio	2012	9720	21216	17037	4347
		2013	9264	23112	17390	5776
		2014	12984	30144	22591	6367
		2015	5232	11640	8753	2313
		2016	5568	14904	8849	3404
16	Corso Orbassano	2012	8070	18240	13662	3075
		2013	7968	27840	16325	6815
		2014	13032	45576	26499	11693
		2015	7320	23520	19077	7598
		2016	6744	22992	18686	7386
17	Via Pio VII	2012	16080	22560	19536	3510
		2013	19608	22704	21096	1721
		2014	18048	22656	20514	2487
		2015	8136	22488	16680	6068
		2016	7992	25752	18768	7574

A modified Z-score was used to detect outliers, and roads that did not have any consistency during years were deleted. According to Iglewicz et al. (1993), in the Modified Z-score method, median and MAD (the median of the absolute deviations) are used instead of mean and Standard deviation, and modified Z-scores defined as follows:

$$M_i = \frac{0.6745(x_i - \tilde{x})}{MAD} \qquad (2\text{-}1)$$

where, $\tilde{x}$ is the median. In this study, the median refers to the median value of AADT during years (2011-2016).

MAD can be defined as follows:

$$MAD = median(\,|x_i - \tilde{x}|) \qquad (2\text{-}2)$$

Observations will be labelled outliers when the absolute amount of M_i is larger than D. Iglewicz et al. (1993) recommended 3.5 for D. In the following, one of the road segments is selected. Then, the steps mentioned above are performed to clarify the procedure.

For example, the tenth road segment's AADT from 2011 to 2016 is 12816, 8952, 10224, 11640, 24728, respectively. The median of this segment is 12228, and the absolute deviations of AADTs about median are 588, 3276, 2004, 588, 22500, 22740. As a result, MAD is equal to 2640. By putting values in Eq (2-1), modified Z-scores of AADTs are 0.15, 0.84, 0.51, 0.15, 5.75 and 5.81. According to Iglewicz et al. (1993), AADT of 2015 and 2016 are outliers, so this segment should be removed from the sample. The results related to all road segments are in Appendix 1. (Table A.1)

2.1.3 Crash Data

According to Masci et al. (2015), the crash data was provided by the Regional Monitoring Center of the Piedmont Road Safety Department (CMRSS), which performs coordination functions and support, technical-operational, and documentation, which deals with collecting information in Piedmont territory on behalf of the Italian National Institute of Statistics (ISTAT). In Italy, the information framework on accidents is mainly fed from the statistics conducted by ISTAT through the investigation into the causes of death and the survey on road accidents developed in collaboration with the Italian Automobile Club (ACI). Until 2007, statistical information on accidents was collected by ISTAT through a monthly survey of all road accidents that have occurred throughout Italy that had caused at least an injury to people (i.e., fatalities and injury crashes are collected only). As a result, and according to Chapter 1, the property damage-only crashes (PDO) are not recorded.

The data was provided on an excel file which contains six years of crashes (2011-2016). The information includes the location and the type of collisions together with other relevant data. Starting from the Regional database, Turin's crashes were separated to form needed data for the task. The following steps were done to extract crash data related to each segment.

First, to present crash data on QGIS, the coordination of the location crashes was needed in the excel file. Although there were some crashes without coordination, the addresses of the nearest building to the locations where crashes happened were in the file. However, the coordination of crashes could be found by using georeferencing tools. Inside crash data related to 2011, there were 360 crashes out of 3576 without coordination. Most of them could not be georeferenced because their addresses were not available; thus, the crashes of 2011 were excluded from the database. From 2012 to 2016, there were 159 crashes without coordinates, 80 crashes were out of Turin, and 66 crashes were inside Turin. To find coordinates of crashes without X and Y inside Turin, GPS Visualizer's Address Locator was used using the addresses provided in the excel file.

Second, the officers used three different coordinate reference systems to localize crashes: WGS 84 / UTM zone 32N, WGS 84, and Monte Mario (Rome) / Italy zone 1. The conversion of these reference systems to a united reference system was needed; therefore, WGS 84 / UTM zone 32Nand Monte Mario (Rome) / Italy zone 1 were converted to WGS 84. Then, the crash data of years were separated and saved in different shapefiles.

Third, in this study, the attention was on calibrating SPFs of road segments, so there was a need for a definition to distinguish segments' crashes from intersections' ones. According to HSM (2010), crashes that occur between intersections and are not related to the presence of an intersection are assigned to the roadway segment on which they occur; this includes crashes that occur within the intersection limits but are unrelated to the presence of the intersection. In this study, the braking distance of a car with 70 km/h speed, 50 m, before and after intersections, was considered part of intersections. As a result, the crashes located outside the so-called "functional area" of the intersection were labelled as segment crashes (Figure 2-6).

The crashes of each segment were counted, and the aggregated data are in Appendix 3. (Table A.3).

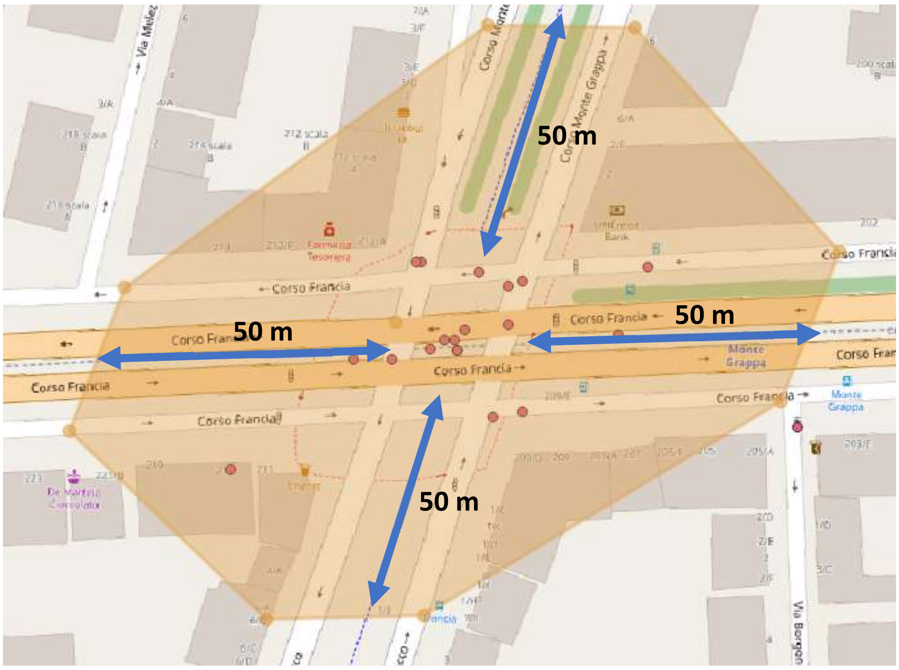

Figure 2-4 Definition of functional area

2.1.4 Speed Data

In this study, to estimate average speed (V50) and operating speed (V85), the model proposed by Bassani et al. (2014) was used. In Bassani et al. (2014), an in-field speed survey was carried out to collect speed data from each lane of 16 different road sections. The final dataset has the following characteristics:

- vehicles in free-flow conditions; commercial vehicles were not sufficient in number to form a consistent group of observations, so data corresponding to commercial vehicles was excluded;
- cars moving at a uniform speed; any acceleration/deceleration because of traffic lights and priority signals at intersections were not considered;
- very high radiuses characterize tangent and curved segments because of the square grid pattern of the road network system of Torino; in only a few cases, there are just a few curved segments with radiuses greater than 250, which do not cause significant speed variation on contiguous segments.

The segments with high variability in features along their length were excluded from the case study. The variables that form the database and abbreviations used in this paper are presented in Table 2-1. According to Table 2-1, some variables are numerical continuous (NC), some are numerical discrete (ND), and some are Boolean (B).

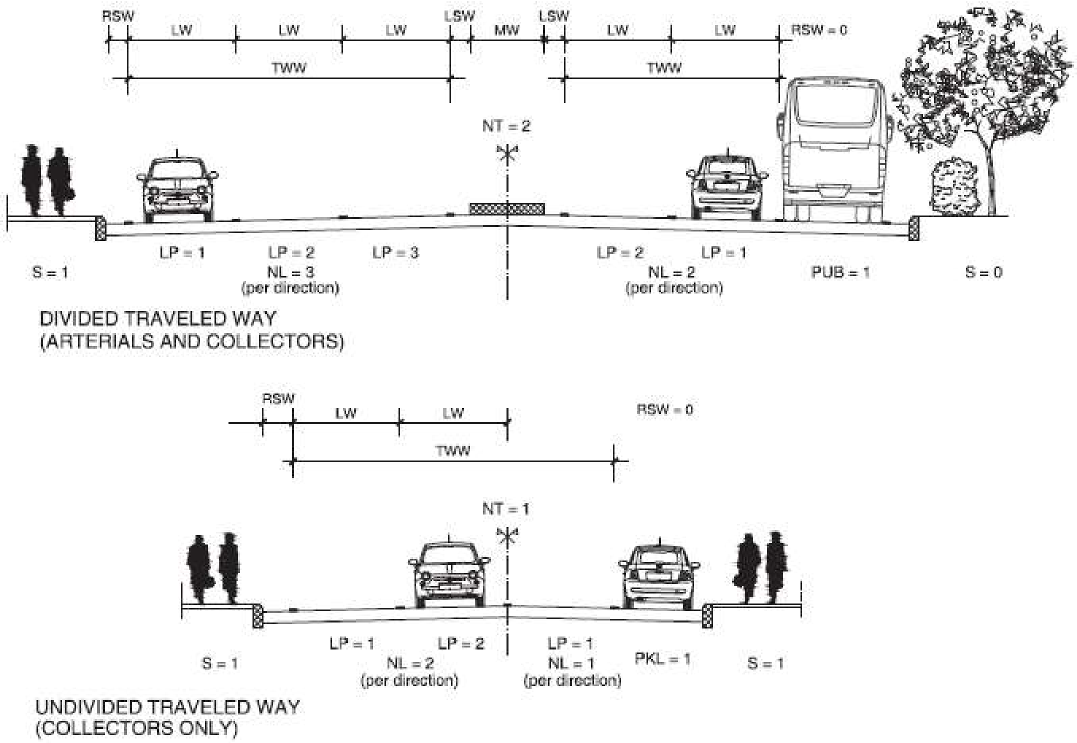

Figure 2-5 Transversal section parameters for divided and undivided carriageways. Taken from Bassani, 2014

Table 2-3 Summarized statistics of considered variables. Taken from Bassani, 2014

#	Variable	Symbol	Type	Unit	min.	max.	μ	σ	Frequency	
1	Lane position	LP	ND	–	1.0	3.0	1.6	0.778	76	100%
2	Posted speed limit	PSL	ND	km/h	30.0	70.0	56.6	12.707	76	100%
3	No. of travelled ways	NT	ND	–	1.0	2.0	1.7	0.462	76	100%
4	Travelled way width	TWW	NC	m	7.0	17.0	10.2	2.626	76	100%
5	No. of lanes per direction	NL	ND	–	1.0	3.0	2.3	0.836	76	100%
6	Lane width	LW	NC	m	2.8	5.9	3.6	0.774	76	100%
7	Median width	MW	NC	m	0.0	9.1	3.9	3.753	53	70%
8	Right shoulder	RS	B	–	0	1	–	–	24	32%
9	Right shoulder width	RSW	NC	m	0.0	3.0	0.3	0.695	24	32%
10	Left shoulder	LS	B	–	0	1	–	–	20	26%
11	Left shoulder width	LSW	NC	m	0.0	1.3	0.1	0.284	20	26%
12	Curvature	$1/R$	NC	m^{-1}	0.0	$4.02 \cdot 10^{-3}$	$5.26 \cdot 10^{-4}$	$1.17 \cdot 10^{-3}$	19	25%
13	Dedicated bus and taxi lane	PUB	B	–	0	1	–	–	4	5%
14	Deviation	Dev	B	–	0	1	–	–	37	49%
15	Deviation density	DevD	NC	No./km	0.0	8.0	2.2	2.741	37	49%
16	Driveways	D	B	–	0	1	–	–	39	51%
17	Driveway density	DD	NC	No./km	0.0	18.2	4.1	6.206	39	51%
18	Intersections	I	B	–	0	1	–	–	20	26%
19	Intersection density	ID	NC	No./km	0.0	10.0	1.5	2.983	20	26%
20	Sidewalk	S	B	–	0	1	–	–	56	74%
21	Pedestrian crossing	Ped	B	–	0	1	–	–	39	51%
22	Pedestrian crossing density	PedD	NC	No./km	0.0	18.2	4.3	4.789	39	51%
23	Parking lanes	PKL	B	–	0	1	–	–	16	21%
24	Traffic calming devices	TCD	B	–	0	1	–	–	21	28%

- Dev and DevD show if there is any deviation or not and the number of deviations per km respectively (dedicated lanes for leaving or entering the primary carriageway),
- D and DD indicate if there is any driveway or not and the number of driveways per km respectively, and
- I and ID present if there is any intersection or not and the number of intersections per km, respectively, with the considered carriageway.

Simple multiple regression analysis is used by considering all the variables selected according to the BIC criterion in this model, a fixed-effect (FE) model. Then, the dependent variable is calibrated from a random effect (RE) model as follows, Taken from Bassani, 2014:

$$V_{rdl,i} = \beta_0 + \sum_{k=1}^{K} \beta_k^C \cdot X_{ki} + \sum_{j=1}^{J} \beta_j^D \cdot (Z_p \cdot X_{ji}) + a_r + a_{s|r} + a_{l|sr} + \varepsilon_{rsl,i} \qquad 2\text{-}3)$$

in which ε_{rsl}, is the error/bias correlated with each measurement, β_0 is the general model intercept, β_k^C is calibration parameter for the variables affecting the estimated mean (X_k), and $\beta_j^D$is calibration parameter for the variables affecting the estimated standard deviation (X_j) respectively, and Z_p is the standardized normal variable. By excluding the three random effects (ar_r, $a_{s|r}$, $a_{l|sr}$) from Eq. (2-3), the model becomes a fixed effect (FE). In Eq. (2-3), the following additional subscripts have been accepted:

- p, for the selected percentile;
- k, for the number of significant variables affecting the central tendency (X_k), with 1 ≤ k ≤ K, where K = 24 as presented in Table 2-1; and
- j, for the number of significant variables affecting the deviation from the mean (X_j), with 1 ≤ j ≤J, where J = 25 (variables reported in Table 2-1 with Z_p).

For the calibration, each observation has been connected with the identical percentile p (Z_p) modelled from the lane speed distribution identified by its mean and standard deviation; in particular, Z_j = 0 for V50 (p = 50%), and Z_j = 1.036 for V85 (p = 85%).

The data analysis was performed by using R-software version 3.0.2. Results were found via the Bayesian Information Criterion (BIC) application, which identifies the most significant variables from those selected as possible independent variables. Eq (2-4) is used to calculate the lowest BIC function value (f_{BIC}).

$$f_{BIC} = -2 \cdot \hat{L} + p \cdot ln\,(n) \tag{2-4)}$$

where $\hat{L}$ is the maximized value of the log-Likelihood function, n the number of observations, and p is the number of parameters included in the model as follows:

$$p = 1 + K + J \tag{2-5)}$$

where the values 1, K, and J are the size of β_0, β_k^C and β_j^D respectively. The independent variables that influence the minimization of the BIC function are the most significant and should be selected in the model. The results obtained from the application of the model are summarized in Table 2-4.

Table 2-4 Model coefficients and significant variables. Taken from Bassani, 2014

#	Variable	Calibration strategy #1			
		Estimate	Std. error	t-Value	Pr (>|t|)
–	Intercept	89.63	11.49	7.80	$<2 \cdot 10^{-16}$
1	LP	6.20	0.10	59.26	$<2 \cdot 10^{-16}$
2	PSL	0.05	0.02	2.18	0.029
3	NT	41.39	2.56	16.18	$<2 \cdot 10^{-16}$
4	TWW	−0.58	0.29	−1.99	0.047
5	NL	−6.42	1.19	−5.42	$6.31 \cdot 10^{-8}$
6	LW	−7.53	0.55	−13.73	$<2 \cdot 10^{-16}$
7	MW	−7.32	0.46	−15.75	$<2 \cdot 10^{-16}$
8	RS	−3.16	1.80	−1.76	0.078
9	RSW	−7.80	1.03	−7.57	$4.53 \cdot 10^{-14}$
10	LS	−38.48	3.25	−11.84	$<2 \cdot 10^{-16}$
11	LSW	19.82	2.49	7.97	$1.97 \cdot 10^{-15}$
12	$1/R$	−2553.00	807.60	−3.16	0.001
13	PUB	11.95	0.77	15.52	$<2 \cdot 10^{-16}$
14	Dev	6.64	0.50	13.28	$<2 \cdot 10^{-16}$
15	DevD	–	–	–	–
16	D	5.17	0.72	7.20	$6.98 \cdot 10^{-13}$
17	DD	−0.93	0.05	−17.42	$<2 \cdot 10^{-16}$
18	I	−1.32	0.38	−3.47	0.0005
19	ID	−0.72	0.08	−9.06	$<2 \cdot 10^{-16}$
20	S	−8.84	1.39	−6.35	$2.34 \cdot 10^{-10}$
21	Ped	−27.72	2.35	−11.81	$<2 \cdot 10^{-16}$
22	PedD	−0.64	0.10	−6.51	$8.47 \cdot 10^{-11}$
23	PKL	7.65	0.61	12.46	$<2 \cdot 10^{-16}$
24	TCD	5.98	0.38	15.75	$<2 \cdot 10^{-16}$
25	Z_p	–	–	–	–
26	$Z_p \cdot$ LP	1.09	0.09	12.15	$<2 \cdot 10^{-16}$
27	$Z_p \cdot$ PSL	0.10	0.01	18.04	$<2 \cdot 10^{-16}$
28	$Z_p \cdot$ NT	–	–	–	–
29	$Z_p \cdot$ TWW	−0.12	0.04	−3.11	0.001
30	$Z_p \cdot$ NL	–	–	–	–
31	$Z_p \cdot$ LW	0.98	0.13	7.44	$1.13 \cdot 10^{-13}$
32	$Z_p \cdot$ MW	–	–	–	–
33	$Z_p \cdot$ RS	–	–	–	–
34	$Z_p \cdot$ RSW	0.44	0.10	4.54	$5.86 \cdot 10^{-6}$
35	$Z_p \cdot$ LS	–	–	–	–
36	$Z_p \cdot$ LSW	–	–	–	–
37	$Z_p \cdot 1/R$	–	–	–	–
38	$Z_p \cdot$ PUB	2.21	0.40	5.51	$3.68 \cdot 10^{-8}$
39	$Z_p \cdot$ Dev	2.65	0.29	9.11	$<2 \cdot 10^{-16}$
40	$Z_p \cdot$ DevD	−0.32	0.05	−6.14	$8.72 \cdot 10^{-10}$
41	$Z_p \cdot$ D	–	–	–	–
42	$Z_p \cdot$ DD	–	–	–	–
43	$Z_p \cdot$ I	–	–	–	–
44	$Z_p \cdot$ ID	–	–	–	–
45	$Z_p \cdot$ S	–	–	–	–
46	$Z_p \cdot$ Ped	–	–	–	–
47	$Z_p \cdot$ PedD	–	–	–	–
48	$Z_p \cdot$ PKL	−0.82	0.26	−3.14	0.001
49	$Z_p \cdot$ TCD	−0.41	0.20	−2.06	0.039

Before estimation of operating speed(V85) and average speed(V50) of segments by using eq (2-3), the variables of segments were found by using google satellite. Then, V85 and V50 of segments were estimated for each lane and each direction. The result will be presented in Appendix 4. (Table A.4). To evaluate the influence of lane speeds on crash occurrence, the average, max, and standard variance of V50 and V85 of lanes as covariates in models.

2.1.5 Other variables

The other variables of segments such as median, presence of parking line, number of access points per km, number of pedestrian crossing per km, and number of driveways per km were found using google satellite.

2.2 Methodology

Road safety is predicted through the number of collisions per unit of time at a roadway site. Nevertheless, the unit of time in this study is five years. To predict the crash frequency, the calibration of SPFs is a crucial step that needs some assumptions. The first assumption is related to probability (statistical) distributions of the number of collisions that follow discrete probability distributions, so Poisson distribution and Negative binomial distribution can describe crash frequency. As already said, the negative binomial distribution is an extension of the Poisson distribution and is better suited than the Poisson distribution to model crash data. The Poisson distribution is appropriate when the mean and the variance of the data are equal. There is large evidence and consensus that in crash data, the variance largely exceeds the mean. Data for which the variance exceeds the mean are overdispersed, and the negative binomial distribution is very well suited for overdispersed data.

A regression model is needed to calibrate SPFs and the relationship between independent and dependent variables of interest, i.e., the crash frequency. The best choice is to use Generalized Linear Modelling (GLM) because of the discrete nature of crash frequency. The next step is the validation process of regression model development. In the following section, the content mentioned above will be thoroughly discussed.

2.2.1 Generalized Linear Model (GLM)

According to SAS/STAT® 13.1 User's Guide (2013), the form of the traditional linear model is:

$$y_i = x_i\beta + \varepsilon_i \qquad (2\text{-}6)$$

where y_i is the ith observation's response variable. The quantity x_i is a fixed, or nonrandom, column vector of covariates, or explanatory variables, for observation i that is known from the experimental environment β. The least squares fit the data y is used to estimate the vector of unknown coefficients. The ε_i are random variables that are supposed to be independent and normal, which are called residuals. The predicted value of y_i , denoted by m, is:

$$m = x_i\beta \qquad (2\text{-}7)$$

Traditional linear models are widely employed in statistical data analysis, although they are not ideal for some problems, such as those listed below.

- For instance, when modelling counts or measured proportions that are regarded discrete, the normal distribution (which is continuous) may not be suitable.
- The traditional linear model may not be appropriate if the data's mean is naturally constrained to a range of values because the linear predictor $x_i\beta$ can take any value. The mean of a measured proportion, for example, is between 0 and 1 but in a standard linear model, the linear predictor of the mean is not constrained to this range.
- It is possible that assuming that the variance of the data is constant across all observations is unrealistic. It is not uncommon, for example, to see data where the variance increase as the data's mean increases.

A generalized linear model is an extension of the traditional linear model that can be used to solve a broader range of data analysis problems. The following are the components of a generalized linear model:

- the linear component is as same as traditional linear models:

$$\eta_i = x_i\beta \qquad (2\text{-}8)$$

- The relationship between the expected value of y_i and the linear predictor η_i is monotonic differentiable link function g:

$$g(m) = x_i\beta \qquad (2\text{-}9)$$

- the response variables y_i are independent for i = 1, 2, . . . and its probability distribution is an exponential distribution, which means that the variance of the response depends on the mean m via a variance function V:

$$Var(y_i) = \frac{V(m)}{\varphi\omega_i} \qquad (2\text{-}10)$$

  where φ is an overdispersion parameter and ω_i is a known weight for each observation. The dispersion parameter $(\frac{1}{\varphi})$ is equal to one for binomial or Poisson distribution or must be estimated.

2.2.2 Negative Binomial Distribution

According to Washington et al. (2011), in Poisson distribution, the mean and variance are equal ($E[yi] = VAR[yi]$). If they are not equal, the data are under dispersed ($E[yi] > VAR[yi]$) or overdispersed ($E[yi] < VAR[yi]$). Overdispersion can happen because of a variety of reasons, which depend on the phenomenon under investigation. In many investigations, the main reason is that variables influencing the Poisson rate across observations have been eliminated from the regression.

After rewriting Poisson's equation, the negative binomial model is derived as follow, for each observation i:

$$E[m] = EXP(\beta \boldsymbol{xi} + \varepsilon i) \qquad (2\text{-}11)$$

where $EXP(\varepsilon i)$ is a disturbance term of Gamma-distributed with mean one and variance $1/\varphi$. The additional part allows the variance to be different from the mean, as follow:

$$VAR[y_i] = E[m] + VAR[m] = E[y_i][1 + \frac{1}{\varphi}E[y_i]] = \bar{y} + \frac{1}{\varphi}\bar{y}^2 \qquad (2\text{-}12)$$

where, $E[m]$ and $VAR[m]$ are the mean and the variance m's of units the population, respectively. While $\bar{y} = E[y_i]$ is the mean number of observed crashes per unit of time. The parameter φ is the overdispersion parameter. The negative binomial distribution is as follow:

$$P(y_i) = \frac{\Gamma(y_i+b)}{\Gamma(b)y_i!}\left(\frac{a}{a+1}\right)^b \left(\frac{1}{a+y_i}\right)^{y_i} \qquad (2\text{-}13)$$

where a and b are parameters of gamma distribution which are:

$$a = \frac{E[m]}{Var[m]} \qquad (2\text{-}14)$$

$$b = \frac{E[m]^2}{Var[m]} \qquad (2\text{-}15)$$

and $\Gamma(\cdot)$ is a gamma function which results in the likelihood function:

$$L(m) = \prod_i \frac{\Gamma(y_i+b)}{\Gamma(b)y_i!}\left(\frac{a}{a+1}\right)^b \left(\frac{1}{a+y_i}\right)^{y_i} \qquad (2\text{-}16)$$

According to HSM 2010, as the overdispersion parameter value increases, more emphasis is placed on the observed rather than the predicted crash frequency. When the data used to develop a model are greatly dispersed, the reliability of the resulting predicted crash frequency is likely to be lower. On the other hand, when the data used to develop a model have little overdispersion, the reliability of the resulting SPF is likely to be higher.

2.2.3 Goodness of Fit

According to SAS/STAT® 13.1 User's Guide (2013), two statistics to assess the goodness of fit of a given generalized linear model are the scaled deviance and Pearson's chi-square statistic. When the dispersion parameter ($1/\varphi$) is a fixed value, the scaled deviance is twice the difference between the maximum achievable log-likelihood and the log-likelihood at the maximum likelihood estimates of the regression parameters.

Where $l(y,m)$ is the log-likelihood function represented as a function of the predicted mean values (m) and the vector (y) of response values, the scaled deviance is:

$$D^*(y,m) = 2(l(y,y) - l(y,m)) \qquad (2\text{-}17)$$

The deviance for the Negative binomial probability distributions is:

$$Negetive\ Binomial \qquad 2\sum_i \left[ylog(y/m) - (y + \varphi\omega_i)log\ (\frac{y+\varphi\omega_i}{m+\varphi\omega_i})\right] \qquad \textit{(2-18)}$$

Pearson's chi-square statistic is defined as:

$$X^2 = \sum_i \frac{\omega_i(y_i - m)^2}{V[m]} \qquad \textit{(2-19)}$$

and the scaled Pearson's chi-square is X^2/φ. Both the scaled deviance and the Pearson X^2-statistic are asymptotically X^2-distributed with $n-p$ degrees of freedom when p denotes the number of model parameters and n number of observations (Aitkin et al., 1989). For a well-fitted SPF, scaled deviance (SD) and Pearson's chi-square values should be approximately equal to the degree of freedom (DF).

Under the particular condition, the scaled deviance and the scaled Pearson's chi-square have a limiting chi-square distribution, with degrees of freedom equal to the difference between the number of observations and the number of estimated model parameters. Thus, the scaled version is helpful as an approximate guide for the goodness of fit of a given model.

2.2.4 Other Fit Statistics

According to Mehta et al. (2013), A statistical model's goodness of fit refers to how well it matches the data. Goodness-of-fit approaches, on the other hand, have been used to develop an optimal crash prediction model and select the models that best fit the data. Furthermore, when too many parameters are included in the regression model, goodness-of-fit methods aid in lowering the risk of SPF overfitting can occur (Srinivasan et al., 2013). The Akaike Information Criterion (AIC), Akaike Information Criterion corrected (AICC), and the Bayesian Information Criterion (BIC) were employed in this study to examine the goodness-of-fit and overfitting of the developed models. In the following subsections, these good-of-fit measurements are further explained.

2.2.4.1 Akaike Information Criterion (AIC)

The AIC is a numerical assessment of the model's consistency for the data collected. AIC, on the other hand, is a model selection criterion that evaluates a model's goodness-of-fit. The AIC is represented by the following equation taken from Khan et al. (2013).

$$AIC = 2p - 2ln(L) \qquad \textit{(2-20)}$$

where p is the number of parameters in the model, and L is the maximized log-likelihood for the model.

2.2.4.2 Akaike information criterion corrected (AICC)

The Akaike information criterion corrected (AICC) value is proportional to the sample size; the lower the AICC value, the better the model. When choosing a model based on AICC, increasing sample size generates an increasing trend to accept the more complex model (Garber et al., 2001). The model's AICC value can be calculated using the equation below taken from Dissanayake et al. (2016).

$$AICC = 2p - 2ln(L) + \frac{2p(p+1)}{n-p-1} \tag{2-21}$$

where n is the number of model observations.

2.2.4.3 Bayesian information criterion (BIC)

A related metric is the Bayesian information criterion (BIC), which is defined by:

$$BIC = -2Ln\,(L) + pLn\,(n) \tag{2-22}$$

2.2.5 Safety Performance Function

An SPF is a regression model used in road safety to estimate the E[m], i.e., the predicted number of collisions per unit of time for different facility types such as intersections and road segments. The independent variables of the regression model are usually roadway and traffic features. The SPF form for road segments, which is used in this study, is the following:

$$E(m) = e^{a_0} \cdot AADT^{a_1} \cdot L^{a_2} \cdot exp^{\sum b_j \cdot x_j} \tag{2-23}$$

The linearized form of SPF is the following:

$$ln\,(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + \sum b_j \cdot x_j \tag{2-24}$$

where $E(m)$ predicted number of collisions per unit of time; a_0, a_1, a_2 and b_j are the regression parameters; L is the length of the segment; AADT is the Average Annual Daily Traffic; and x_j are a further variable. In this study, SAS studio software was used to calibrate Safety Performance functions.

Chapter 3

3 Results and Discussion

The development of SPFs was carried out in two steps. First, SPFs were estimated on 83 segments, and then segments were increased to 105, and the new SPFs were calibrated on them. In each step, two groups of SPFs were developed; the first group is related to speed variables, and the second group is related to geometric variables. Before discussing the results of calibration of SPFs, the variables used in the calibration of SPFs will be introduced in the following table:

Table 3-1 List of variables

#	Variable	Symbol	Unit	min.	max.	mean	SD
1	Average annual daily traffic	AADT	-	8744	36880	17757.23	5201.84
2	Length of segments	L	km	0.04	1.10	0.29	0.16
3	Average of the operating speed of lanes	V85	km/h	24.08	136.72	83.66	26.64
4	Average of the average speed of lanes	V50	km/h	13.56	126.31	74.53	26.70
5	Maximum of the operating speed of lanes	V85Max	km/h	27.74	140.38	86.72	25.89
6	Maximum of the average speed of lanes	V50Max:	km/h	16.66	129.41	77.13	26.09
7	The standard deviation of the operating speed of lanes	V85SD	km/h	0	7.33	3.95	2.56
8	The standard deviation of the average speed of lanes	V50SD	km/h	0	6.20	3.36	2.17
9	Median	M*	-	0	1	-	-
10	Parking line	PL**	-	0	1	-	-
11	Number of access points per km	ACD	No/km	0	14.32	4.03	4.01
12	Number of pedestrian crossing per km	PCD	No/km	0	26.49	1.06	2.98
13	Number of driveways per km	DD	No/km	0	92.72	16.13	16.18

* M shows the presence of median (1= presence of median, 0= Otherwise)

**PL shows the presence of parking line (1= presence of parking line, 0= Otherwise)

3.1 The Frist Step

In this step, 116 road segments were selected for calibration of SPFs, and after deleting AADT outliers, 83 segments remained to calibrate SPFs.

3.1.1 Speed-based SPFs

Before starting calibration of SPFs, in order to consider speed as an independent variable, two different approaches were tested. In the first approach, the natural logarithm of speed was regarded as a variable. In the second approach, speed was assumed to have a linear function with a natural logarithm of the crash frequency. For testing, V50 (average speed) was used. The results are as follow:

- First approach:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot ln(V50) \quad (3\text{-}1)$$

Where, $E(m)$ is predicted crash frequency in 5 years.

Table 3-2 Summary of results of estimation for the first approach

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.0004	3.9379	-13.7186	1.7178	2.32	0.1276
ln(AADT)	1	a_1	1.0761	0.3861	0.3194	1.8327	7.77	0.0053
ln(L)	1	a_2	1.8934	0.2533	1.3969	2.3899	55.86	<.0001
ln(V50)	1	b_1	-0.2484	0.2472	-0.7328	0.2361	1.01	0.3149
Dispersion	1	$1/\varphi$	0.5192	0.1418	0.3040	0.8869		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	79	87.4725	1.1072
Scaled Deviance	79	87.4725	1.1072
Pearson Chi-Square	79	75.1298	0.9510
Scaled Pearson X2	79	75.1298	0.9510
Log Likelihood		250.8844	
Full Log Likelihood		-177.3049	
AIC (smaller is better)		364.6097	
AICC (smaller is better)		365.3889	
BIC (smaller is better)		376.7039	

- Second approach:

$$\mathrm{Ln}(E(m)) = \mathrm{a}_0 + \mathrm{a}_1 \cdot \ln(\mathrm{AADT}) + \mathrm{a}_2 \cdot \ln(\mathrm{L}) + \mathrm{b}_1 \cdot \mathrm{V50} \qquad (3\text{-}2)$$

Table 3-3 Summary of results of estimation for the second approach

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.2668	3.7524	-13.6214	1.0877	2.79	0.0949
ln(AADT)	1	a_1	1.0456	0.3824	0.2961	1.7951	7.48	0.0063
ln(L)	1	a_2	1.9037	0.2492	1.4153	2.3921	58.37	<.0001
V50	1	b_1	-0.0066	0.0043	-0.0151	0.0019	2.30	0.1292
Dispersion	1	$1/\varphi$	0.4980	0.1392	0.2880	0.8613		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	79	88.0030	1.1140
Scaled Deviance	79	88.0030	1.1140
Pearson Chi-Square	79	76.3643	0.9666
Scaled Pearson X2	79	76.3643	0.9666
Log Likelihood		251.4982	
Full Log Likelihood		-176.6911	
AIC (smaller is better)		363.3821	
AICC (smaller is better)		364.1613	
BIC (smaller is better)		375.4763	

The Scaled Deviance (SD) and Pearson chi-square statistic, AIC, AICC, and BIC were used to assess the goodness of fit of the models. The SD and Pearson X^2-statistics of the first and second models are 87.47, 75.13, 88.00, and 76.36, respectively. By considering, the degree of freedom is equal to 79; the first approach is better than the second one. While the first model's AIC, AICC, and BIC values are smaller than the first one, the second approach is a better approach by considering overfitting parameters. In addition, at the 5% level of significance, the second model has provided a good fit to the current data set. Considering all analyses together, the second model is better than the first one; therefore, the next SPFs will be developed based on the second model.

3.1.1.1 SPF (1st trail)

In this SPF, length, AADT, and average V50 of lanes are considered independent variables, and the results are represented in the following table.

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V50 \quad (3\text{-}3)$$

Table 3-4 Summary of results of estimation for SPF (1st trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.2668	3.7524	-13.6214	1.0877	2.79	0.0949
ln(AADT)	1	a_1	1.0456	0.3824	0.2961	1.7951	7.48	0.0063
ln(L)	1	a_2	1.9037	0.2492	1.4153	2.3921	58.37	<.0001
V50	1	b_1	-0.0066	0.0043	-0.0151	0.0019	2.30	0.1292
Dispersion	1	$1/\varphi$	0.4980	0.1392	0.2880	0.8613		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	79	88.0030	1.1140
Scaled Deviance	79	88.0030	1.1140
Pearson Chi-Square	79	76.3643	0.9666
Scaled Pearson X2	79	76.3643	0.9666
Log Likelihood		251.4982	
Full Log Likelihood		-176.6911	
AIC (smaller is better)		363.3821	
AICC (smaller is better)		364.1613	
BIC (smaller is better)		375.4763	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept and $V50$ are not significant. The estimate b_1 in Table 3-4 is negative, indicating that the predicted crash frequency decreases with speed, which is not reasonable because, by increasing speed, the probability of a crash occurring should increase. Also, $ln\,(AADT)$ and $ln(L)$ are significant at the 5% level of significance. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 88.00, and 76.36 respectively, and the degrees of freedom is 79 indicating that the model is well fitted.

Operating speed is the threshold between aggressive and less aggressive drivers, which can influence the crash occurrence, so the next model is based on V85 (average operating speed of lanes) will be used instead of V50.

3.1.1.2 SPF (2nd trail)

In this SPF, length, AADT, and average V85 are considered as independent variables, and the results follow:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V85 \qquad (3\text{-}4)$$

Table 3-5 Summary of results of estimation for SPF (2nd trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF		Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.2050	3.7529	-13.5606	1.1506	2.73	0.0983
ln(AADT)	1	a_1	1.0480	0.3819	0.2995	1.7965	7.53	0.0061
ln(L)	1	a_2	1.9076	0.2492	1.4192	2.3961	58.59	<.0001
V85	1	b_1	-0.0068	0.0044	-0.0155	0.0018	2.43	0.1191
Dispersion	1	$1/\varphi$	0.4962	0.1389	0.2867	0.8590		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	79	88.0323	1.1143
Scaled Deviance	79	88.0323	1.1143
Pearson Chi-Square	79	76.4488	0.9677
Scaled Pearson X2	79	76.4488	0.9677
Log Likelihood		251.5571	
Full Log Likelihood		-176.6322	
AIC (smaller is better)		363.2644	
AICC (smaller is better)		364.0436	
BIC (smaller is better)		375.3586	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept and $V85$ are not significant. The estimate b_1 in Table 3-5 is negative, indicating that the predicted crash frequency decreases with speed. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 88.03, and 76.44 respectively, and the degrees of freedom is 79 indicating that the model is well fitted.

Based on the background section, in some studies, the SPFs were calibrated by considering average and standard deviation of speed as a variable, so the two following SPFs are calibrated based on average speeds of lanes and standard deviation.

3.1.1.3 SPF (3rd trail)

In this SPF, length, AADT, V50, and V50SD are considered as independent variables, and the results are the following:

$$Ln\big(E(m)\big) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V50 + b_2 \cdot V50SD \qquad (3\text{-}5)$$

Table 3-6 Summary of results of estimation for SPF (3rd trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF		Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-7.0013	3.5886	-14.0348	0.0322	3.81	0.0511
ln(AADT)	1	a_1	1.1914	0.3698	0.4667	1.9161	10.38	0.0013
ln(L)	1	a_2	1.8118	0.2385	1.3444	2.2792	57.72	<.0001
V50	1	b_1	-0.0111	0.0044	-0.0196	-0.0025	6.47	0.0110
V50SD	1	b_2	-0.1536	0.0531	-0.2576	-0.0496	8.38	0.0038
Dispersion	1	$1/\varphi$	0.4181	0.1225	0.2354	0.7426		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	78	86.8107	1.1130
Scaled Deviance	78	86.8107	1.1130
Pearson Chi-Square	78	78.7524	1.0096
Scaled Pearson X2	78	78.7524	1.0096
Log Likelihood		255.6135	
Full Log Likelihood		-172.5758	
AIC (smaller is better)		357.1515	
AICC (smaller is better)		358.2568	
BIC (smaller is better)		371.6646	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, the intercept is not significant at the 5% level of significance. The estimate b_1 and b_2 in Table 3-6 are negative significant, indicating that the predicted crash frequency decreases with speed, which is not reasonable because, by increasing speed, the probability of a crash occurring should increase, so the sign of b_1 should be positive. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 86.81, and 78.75 respectively, and the degrees of freedom is 78 indicating that the model is well fitted.

3.1.1.4 SPF (4th trail)

In this SPF, length, AADT, average V85 of lanes, and standard deviation of V85 are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V85 + b_2 \cdot V85SD \qquad (3\text{-}6)$$

Table 3-7 Summary of results of estimation for SPF (4th trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF		Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.9129	3.5897	-13.9486	0.1228	3.71	0.0541
ln(AADT)	1	a_1	1.1945	0.3696	0.4700	1.9190	10.44	0.0012
ln(L)	1	a_2	1.8171	0.2385	1.3497	2.2844	58.06	<.0001
V85	1	b_1	-0.0114	0.0044	-0.0200	-0.0027	6.64	0.0100
V85SD	1	b_2	-0.1274	0.0444	-0.2145	-0.0403	8.21	0.0042
Dispersion	1	$1/\varphi$	0.4173	0.1227	0.2345	0.7424		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	78	86.9483	1.1147
Scaled Deviance	78	86.9483	1.1147
Pearson Chi-Square	78	79.7828	1.0229
Scaled Pearson X2	78	79.7828	1.0229
Log Likelihood		255.5841	
Full Log Likelihood		-172.6052	
AIC (smaller is better)		357.2104	
AICC (smaller is better)		358.3156	
BIC (smaller is better)		371.7234	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept is not significant. The estimate b_1 and b_2 in Table 3-7 are negative significant, indicating that the predicted crash frequency decreases with speed. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 86.94, and 79.78 respectively, and the degrees of freedom is 78 indicating that the model is well fitted.

According to the European Commission website (2021), More recent studies, mainly conducted in Australia and Great Britain, also found that higher accident risk is related to faster drivers. As a result, the SPFs are calibrated by considering the maximum speed of lanes in the two subsequent trials.

3.1.1.5 SPF (5th trail)

In this SPF, length, AADT, and V50Max are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V50max \quad (3\text{-}7)$$

Table 3-8 Summary of results of estimation for SPF (5th trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF		Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.1523	3.7269	-13.4570	1.1524	2.73	0.0988
ln(AADT)	1	a_1	1.0434	0.3798	0.2990	1.7878	7.55	0.0060
ln(L)	1	a_2	1.9037	0.2469	1.4198	2.3876	59.45	<.0001
V50max	1	b_1	-0.0077	0.0044	-0.0163	0.0010	3.01	0.0826
Dispersion	1	$1/\varphi$	0.4874	0.1378	0.2801	0.8482		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	79	88.2318	1.1169
Scaled Deviance	79	88.2318	1.1169
Pearson Chi-Square	79	76.9449	0.9740
Scaled Pearson X2	79	76.9449	0.9740
Log Likelihood		251.8305	
Full Log Likelihood		-176.3588	
AIC (smaller is better)		362.7176	
AICC (smaller is better)		363.4968	
BIC (smaller is better)		374.8118	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept and $V50max$ are not significant. The estimate b_1 in Table 3-8 is negative, indicating that the predicted crash frequency decreases with speed, which is not reasonable. Also, the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 88.23, and 76.95 respectively, and the degrees of freedom is 79 indicating that the model is well fitted.

3.1.1.6 SPF (6th trail)

In this SPF, length, AADT, and V85Max are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V85max \quad (3\text{-}8)$$

Table 3-9 Summary of results of estimation for SPF (6th trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF		Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.0592	3.7218	-13.3538	1.2353	2.65	0.1035
ln(AADT)	1	a_1	1.0462	0.3788	0.3038	1.7885	7.63	0.0057
ln(L)	1	a_2	1.9079	0.2464	1.4250	2.3909	59.95	<.0001
V85max	1	b_1	-0.0082	0.0045	-0.0170	0.0006	3.32	0.0683
Dispersion	1	$1/\varphi$	0.4832	0.1372	0.2770	0.8428		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	79	88.3072	1.1178
Scaled Deviance	79	88.3072	1.1178
Pearson Chi-Square	79	77.2100	0.9773
Scaled Pearson X2	79	77.2100	0.9773
Log Likelihood		251.9735	
Full Log Likelihood		-176.2158	
AIC (smaller is better)		362.4316	
AICC (smaller is better)		363.2108	
BIC (smaller is better)		374.5258	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept and $V85max$ are not significant. The estimate b_1 in Table 3-9 is negative, indicating that the predicted crash frequency decreases with speed. Also, the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 88.31, and 77.21 respectively, and the degrees of freedom is 79 indicating that the model is well fitted.

In the two successive trials, the SPFs are calibrated by considering the maximum speed of lanes, the average speed of lanes, and standard deviation of speed as variables to estimate how they are influential in a crash occurring.

3.1.1.7 SPF(7th trail)

In this SPF, length, AADT, average V50, V50SD, V50max are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V50 + b_2 \cdot V50SD + b_3 \cdot V50max \quad (3\text{-}9)$$

Table 3-10 Summary of results of estimation SPF (7th trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF		Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.6138	3.4895	-13.4531	0.2256	3.59	0.0581
ln(AADT)	1	a_1	1.1433	0.3594	0.4390	1.8477	10.12	0.0015
ln(L)	1	a_2	1.7020	0.2278	1.2556	2.1484	55.84	<.0001
V50	1	b_1	0.4731	0.2455	-0.0081	0.9543	3.71	0.0540
V50SD	1	b_2	0.2249	0.1963	-0.1598	0.6097	1.31	0.2518
V50max	1	b_3	-0.4855	0.2460	-0.9677	-0.0033	3.89	0.0484
Dispersion	1	$1/\varphi$	0.3554	0.1135	0.1900	0.6646		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	77	89.0115	1.1560
Scaled Deviance	77	89.0115	1.1560
Pearson Chi-Square	77	80.2990	1.0428
Scaled Pearson X2	77	80.2990	1.0428
Log Likelihood		257.5575	
Full Log Likelihood		-170.6318	
AIC (smaller is better)		355.2635	
AICC (smaller is better)		356.7569	
BIC (smaller is better)		372.1954	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept, $V50$, and $V50SD$ are not significant. The estimate b_1 and b_2 in Table 3-10 are positive, indicating that the predicted crash frequency increases with increasing speed. While $V50max$ is significant and the estimate b_3 in Table 3-10 is negative. Also, the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 89.01, and 80.30 respectively, and the degrees of freedom is 77 indicating that the model compared to previous models is not well fitted.

3.1.1.8 SPF (8th trail)

In this SPF, length, AADT, average V85 of lanes, the standard deviation of V85, and maximum V85 of lanes are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V85 + b_2 \cdot V85SD + b_3 \cdot V85max \quad (3\text{-}10)$$

Table 3-11 Summary of results of estimation for SPF (8th trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.3271	3.4870	-13.1614	0.5072	3.29	0.0696
ln(AADT)	1	a_1	1.1305	0.3588	0.4273	1.8336	9.93	0.0016
ln(L)	1	a_2	1.7119	0.2265	1.2680	2.1559	57.12	<.0001
V85	1	b_1	0.4100	0.2047	0.0089	0.8112	4.01	0.0452
V85SD	1	b_2	0.2013	0.1633	-0.1187	0.5212	1.52	0.2177
V85max	1	b_3	-0.4230	0.2053	-0.8254	-0.0207	4.25	0.0393
Dispersion	1	$1/\varphi$	0.3512	0.1129	0.1871	0.6593		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	77	89.1510	1.1578
Scaled Deviance	77	89.1510	1.1578
Pearson Chi-Square	77	81.5714	1.0594
Scaled Pearson X2	77	81.5714	1.0594
Log Likelihood		257.7005	
Full Log Likelihood		-170.4888	
AIC (smaller is better)		354.9776	
AICC (smaller is better)		356.4709	
BIC (smaller is better)		371.9095	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept and $V85SD$ are not significant. The estimate b_1 and b_2 in Table 3-11 are positive, indicating that the predicted crash frequency increases with increasing speed. While V50max is significant and the estimate b_3 is negative. Also, the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 89.15, and 80.57 respectively, and the degrees of freedom is 77 indicating that the model compared to previous models is not well fitted.

3.1.2 Geometric features SPFs

For calibration of the second group of SPFs, a different methodology was followed. The method is based on Greibe (2001). In this study, all variables were included in the first model for the regression analysis, and insignificant variables were excluded one by one, starting with the least significant variables for the following models. The result will be presented in the following sections.

3.1.2.1 SPF (9th trail)

For calibration of this SPF, AADT, Length, M, PL, ACD, PCD, and DD were used, and the result is as follow:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot M + b_2 \cdot PL + b_3 \cdot ACD + b_4 \cdot PCD + b_5 \cdot DD \quad (3\text{-}11)$$

Table 3-12 Summary of results of estimation for SPF (9th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-9.5621	3.0942	-15.6267	-3.497	9.55	0.0020
ln(AADT)	1	a_1	1.1738	0.3150	0.5564	1.7911	13.89	0.0002
ln(L)	1	a_2	1.3877	0.2176	0.9612	1.8141	40.67	<.0001
M	1	b_1	-0.0999	0.1786	-0.4499	0.2502	0.31	0.5760
PL	1	b_2	0.1386	0.1986	-0.2506	0.5278	0.49	0.4853
ACD	1	b_3	0.1062	0.0225	0.0622	0.1503	22.40	<.0001
PCD	1	b_4	0.0833	0.0726	-0.0591	0.2256	1.31	0.2515
DD	1	b_5	0.0151	0.0064	0.0026	0.0276	5.64	0.0176
Dispersion	1	$1/\varphi$	0.1759	0.0751	0.0762	0.4060		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	75	87.8811	1.1717
Scaled Deviance	75	87.8811	1.1717
Pearson Chi-Square	75	72.4174	0.9656
Scaled Pearson X2	75	72.4174	0.9656
Log Likelihood		268.9371	
Full Log Likelihood		-159.2522	
AIC (smaller is better)		336.5044	
AICC (smaller is better)		338.9701	
BIC (smaller is better)		358.2739	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to Table 3-12, at the 5% level of significance, significance M, PL, and PCD are not significant. The estimate b_1 is negative, indicating that the predicted crashes decrease with the median presence. While the estimate b_2 is positive, which shows that the presence of a parking line increases the probability of the crash occurrence. Nevertheless, the estimate b_3, b_4 and b_5 are positive, indicating that the predicted crashes increase by increasing pedestrian crossing, driveway, access points of road segments. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance, and the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 87.88, and 72,41 respectively, and the degrees of freedom is 75 indicating that the model is somehow well fitted.

According to Table 3-12, the lowest significance level is related to the median, so It will be deleted in the next SPFs.

3.1.2.2 SPF (10th trail)

For calibration of this SPF, AADT, length, PL, ACD, PCD, and DD were used, and the result follows:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot ACD + b_2 \cdot PCD + b_3 \cdot PL + b_4 \cdot DD \quad (3\text{-}12)$$

According to Table 3-13, at the 5% level of significance, PL and PCD are not significant. The estimate b_2 and b_3 are positive, showing that parking line and pedestrian crossing density increase the probability of crash occurrence. Nevertheless, the estimate b_1 and b_4 are positive and significant at the 5% level of significance, indicating that the predicted crashes increase by the increasing driveway and access points of the road segments. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance, and the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2Statistics models are 88.10 and 72.55, respectively, and the degrees of freedom are 76, indicating that the model is somehow well fitted.

According to Table 3-13, the lowest significance level is related to PL, so It will be deleted in the next SPFs.

Table 3-13 Summary of results of estimation for SPF (10th rail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-9.7097	3.0862	-15.7586	-3.6609	9.90	0.0017
ln(AADT)	1	a_1	1.1857	0.3145	0.5693	1.8022	14.21	0.0002
ln(L)	1	a_2	1.3936	0.2177	0.9668	1.8204	40.96	<.0001
ACD	1	b_1	0.1066	0.0225	0.0625	0.1506	22.51	<.0001
PCD	1	b_2	0.0762	0.0715	-0.0640	0.2163	1.13	0.2869
PL	1	b_3	0.1001	0.1865	-0.2654	0.4656	0.29	0.5913
DD	1	b_4	0.0157	0.0063	0.0034	0.0280	6.21	0.0127
Dispersion	1	$1/\varphi$	0.1765	0.0754	0.0764	0.4078		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	76	88.1015	1.1592
Scaled Deviance	76	88.1015	1.1592
Pearson Chi-Square	76	72.5557	0.9547
Scaled Pearson X2	76	72.5557	0.9547
Log Likelihood		268.7806	
Full Log Likelihood		-159.4087	
AIC (smaller is better)		334.8174	
AICC (smaller is better)		336.7633	
BIC (smaller is better)		354.1681	

* The significant variables are highlighted with green, and the other is highlighted with red.

3.1.2.3 SPF (11th trail)

For calibration of this SPF, AADT, length, ACD, PCD, and DD were used, and the result is as follow:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot ACD + b_2 \cdot PCD + b_3 \cdot DD \quad (3\text{-}13)$$

Table 3-14 Summary of results of estimation for SPF (11th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-9.8146	3.0959	-15.8824	-3.7468	10.05	0.0015
ln(AADT)	1	a_1	1.2022	0.3147	0.5854	1.8190	14.59	0.0001
ln(L)	1	a_2	1.3902	0.2184	0.9620	1.8183	40.50	<.0001
ACD	1	b_1	0.1069	0.0226	0.0627	0.1511	22.45	<.0001
PCD	1	b_2	0.0713	0.0713	-0.0684	0.2110	1.00	0.3172
DD	1	b_3	0.0165	0.0061	0.0045	0.0285	7.26	0.0070
Dispersion	1	$1/\varphi$	0.1801	0.0759	0.0789	0.4115		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	77	87.8630	1.1411
Scaled Deviance	77	87.8630	1.1411
Pearson Chi-Square	77	72.4178	0.9405
Scaled Pearson X2	77	72.4178	0.9405
Log Likelihood		268.6372	
Full Log Likelihood		-159.5521	
AIC (smaller is better)		333.1042	
AICC (smaller is better)		334.5975	
BIC (smaller is better)		350.0361	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the table, at the 5% level of significance, PCD is not significant, and the estimate b_2 is positive, which shows pedestrian crossing density is increasing the probability of crash occurrence. Nevertheless, the estimate b_1 and b_3 are positive and significant at the 5% level of significance, indicating that the predicted crashes increase by the increasing driveway and access points of the road segments. Also, and the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-Statistic models are 87.86, and 72,41 respectively, and the degrees of freedom is 77, indicating that the model is somehow well fitted. Among variables, the PCD is not significant, so that it would be deleted in the next SPFs.

3.1.2.4 SPF (12th trail)

For calibration of this SPF, AADT, length, ACD and DD were used, and the result is as follow:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot ACD + b_2 \cdot DD \quad (3\text{-}14)$$

Table 3-15 Summary of results of estimation for SPF (12th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-9.8015	3.1167	-15.9100	-3.693	9.89	0.0017
ln(AADT)	1	a_1	1.2150	0.3167	0.5943	1.8357	14.72	0.0001
ln(L)	1	a_2	1.5122	0.1867	1.1463	1.8781	65.60	<.0001
ACD	1	b_1	0.1173	0.0203	0.0775	0.1570	33.37	<.0001
DD	1	b_2	0.0178	0.0060	0.0059	0.0296	8.64	0.0033
Dispersion	1	$1/\varphi$	0.1879	0.0778	0.0834	0.4231		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	78	87.7469	1.1250
Scaled Deviance	78	87.7469	1.1250
Pearson Chi-Square	78	73.0603	0.9367
Scaled Pearson X2	78	73.0603	0.9367
Log Likelihood		268.1419	
Full Log Likelihood		-160.0474	
AIC (smaller is better)		332.0948	
AICC (smaller is better)		333.2000	
BIC (smaller is better)		346.6078	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, ACD and DD are significant. The estimate b_1 and b_2 are positive, indicating that the predicted crashes increase by the driveway and access points. Also, and the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 87.74, and 73,06 respectively, and the degrees of freedom is 78 indicating that the model is well fitted.

3.2 The Second Step

In this step, some other segments were added to the sample to improve models, and the total number of road segments increased to 105 segments. The previous SPFs were calibrated again on a new sample, and the results are summarized in the following.

3.2.1 Speed SPFs

3.2.1.1 SPF (1st trail)

In this SPF, length, AADT, and average V50 of lanes are considered as independent variables, and the results are as follow:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V50 \tag{3-15}$$

Table 3-16 Summary of results of estimation for SPF (1st trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-3.9299	3.3908	-10.5758	2.7161	1.34	0.2465
ln(AADT)	1	a_1	0.7701	0.3413	0.1011	1.4391	5.09	0.0241
ln(L)	1	a_2	1.8141	0.2264	1.3705	2.2578	64.22	<.0001
V50	1	b_1	-0.0019	0.0038	-0.0093	0.0055	0.25	0.6142
Dispersion	1	$1/\varphi$	0.5065	0.1261	0.3109	0.8252		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	101	112.8785	1.1176
Scaled Deviance	101	112.8785	1.1176
Pearson Chi-Square	101	106.1085	1.0506
Scaled Pearson X2	101	106.1085	1.0506
Log Likelihood		281.0171	
Full Log Likelihood		-224.8484	
AIC (smaller is better)		459.6968	
AICC (smaller is better)		460.3029	
BIC (smaller is better)		472.9666	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept and $V50$ are not significant. The estimate b_1 in Table 3-16 is negative, indicating that the predicted crash frequency decreases with speed, which is not reasonable because, by increasing speed, the probability of a crash occurring should increase, so the sign of b_1 should be positive. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 112.87, and 106.11 respectively, and the degrees of freedom is 101 indicating that the model is well fitted.

3.2.1.2 SPF (2nd trail)

In this SPF, length, AADT, and average V85 are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V85 \qquad (3\text{-}16)$$

Table 3-17 Summary of results of estimation for SPF (2nd trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-3.9560	3.4034	-10.6266	2.7145	1.35	0.2451
ln(AADT)	1	a_1	0.7729	0.3417	0.1033	1.4426	5.12	0.0237
ln(L)	1	a_2	1.8139	0.2266	1.3697	2.2580	64.06	<.0001
V85	1	b_1	-0.0017	0.0038	-0.0091	0.0057	0.21	0.6506
Dispersion	1	$1/\varphi$	0.5077	0.1263	0.3118	0.8266		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	101	112.8052	1.1169
Scaled Deviance	101	112.8052	1.1169
Pearson Chi-Square	101	105.9862	1.0494
Scaled Pearson X2	101	105.9862	1.0494
Log Likelihood		280.9929	
Full Log Likelihood		-224.8726	
AIC (smaller is better)		459.7452	
AICC (smaller is better)		460.3512	
BIC (smaller is better)		473.0150	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept and $V85$ are not significant. The estimate b_1 in Table 3-17 is negative, indicating that the predicted crash frequency decreases with speed, which is not reasonable because, by increasing speed, the probability of a crash occurring should increase, so the sign of b_1 should be positive. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 112.80, and 105.99 respectively, and the degrees of freedom is 101 indicating that the model is well fitted.

3.2.1.3 SPF (3rd trail)

In this SPF, length, AADT, V50, and V50SD are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V50 + b_2 \cdot V50SD \qquad (3\text{-}17)$$

Table 3-18 Summary of results of estimation for SPF (3rd trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF		Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-4.1384	3.3192	-10.6438	2.3671	1.55	0.2125
ln(AADT)	1	a_1	0.8198	0.3357	0.1618	1.4778	5.96	0.0146
ln(L)	1	a_2	1.7477	0.2243	1.3081	2.1874	60.71	<.0001
V50	1	b_1	-0.0038	0.0039	-0.0114	0.0038	0.96	0.3266
V50SD	1	b_2	-0.0681	0.0447	-0.1557	0.0194	2.33	0.1273
Dispersion	1	$1/\varphi$	0.4761	0.1222	0.2879	0.7873		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	100	113.8664	1.1387
Scaled Deviance	100	113.8664	1.1387
Pearson Chi-Square	100	118.4218	1.1842
Scaled Pearson X2	100	118.4218	1.1842
Log Likelihood		282.1574	
Full Log Likelihood		-223.7081	
AIC (smaller is better)		459.4162	
AICC (smaller is better)		460.2734	
BIC (smaller is better)		475.3400	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, intercept, $V50$, and $V50SD$ are not significant. The estimate b_1 and b_2 in Table 3-18 are negative significant indicating that the predicted crash frequency decreases with speed, which is not reasonable because, by increasing speed, the probability of a crash occurring should increase, so the sign of b_1 should be positive. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 113,87 and 118.42 respectively, and the degrees of freedom is 100 indicating that the model is not well fitted compared to the previous models.

3.2.1.4 SPF (4th trail)

In this SPF, length, AADT, average V85 of lanes, and standard deviation of V85 are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V85 + b_2 \cdot V85SD \qquad (3\text{-}18)$$

Table 3-19 Summary of results of estimation for SPF (4th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-4.1633	3.3267	-10.6835	2.3570	1.57	0.2108
ln(AADT)	1	a_1	0.8280	0.3358	0.1699	1.4860	6.08	0.0137
ln(L)	1	a_2	1.7463	0.2239	1.3074	2.1851	60.83	<.0001
V85	1	b_1	-0.0039	0.0039	-0.0116	0.0038	0.99	0.3201
V85SD	1	b_2	-0.0620	0.0381	-0.1366	0.0126	2.65	0.1034
Dispersion	1	$1/\varphi$	0.4753	0.1219	0.2874	0.7858		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	100	113.6897	1.1369
Scaled Deviance	100	113.6897	1.1369
Pearson Chi-Square	100	117.7561	1.1776
Scaled Pearson X2	100	117.7561	1.1776
Log Likelihood		282.2922	
Full Log Likelihood		-223.5733	
AIC (smaller is better)		459.1466	
AICC (smaller is better)		460.0037	
BIC (smaller is better)		475.0703	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, intercept, *V85* and *V85SD* are not significant. The estimate b_1 and b_2 in Table 3-19 are negative significant indicating that the predicted crash frequency decreases with speed. Also, The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 113,87 and 117.75 respectively, and the degrees of freedom is 100 indicating that the model is not well fitted compared to the previous models.

3.2.1.5 SPF (5th trail)

In this SPF, length, AADT, and V50Max are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V50max \quad (3\text{-}19)$$

Table 3-20 Summary of results of estimation for SPF (5th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF		Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-3.8373	3.3813	-10.4646	2.7900	1.29	0.2564
ln(AADT)	1	a_1	0.7647	0.3402	0.0979	1.4316	5.05	0.0246
ln(L)	1	a_2	1.8130	0.2256	1.3709	2.2552	64.59	<.0001
V50max	1	b_1	-0.0024	0.0038	-0.0099	0.0052	0.38	0.5359
Dispersion	1	$1/\varphi$	0.5032	0.1259	0.3081	0.8217		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	101	113.1047	1.1198
Scaled Deviance	101	113.1047	1.1198
Pearson Chi-Square	101	106.8694	1.0581
Scaled Pearson X2	101	106.8694	1.0581
Log Likelihood		281.0804	
Full Log Likelihood		-224.7851	
AIC (smaller is better)		459.5701	
AICC (smaller is better)		460.1762	
BIC (smaller is better)		472.8399	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept and $V50max$ are not significant. The estimate b_1 in Table 3-20 is negative, indicating that the predicted crash frequency decreases with speed. Also, ln(AADT) and ln(L) are significant at the 5% level of significance. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 113.10, and 106.86 respectively, and the degrees of freedom is 101 indicating that the model is well fitted.

3.2.1.6 SPF (6th trail)

In this SPF, length, AADT, and V85Max are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V85max \quad (3\text{-}20)$$

Table 3-21 Summary of results of estimation for SPF (6th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-3.8335	3.3922	-10.4822	2.8151	1.28	0.2584
ln(AADT)	1	a_1	0.7660	0.3403	0.0990	1.4331	5.07	0.0244
ln(L)	1	a_2	1.8129	0.2257	1.3705	2.2552	64.52	<.0001
V85max	1	b_1	-0.0023	0.0039	-0.0099	0.0053	0.36	0.5512
Dispersion	1	$1/\varphi$	0.5036	0.1260	0.3084	0.8224		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	101	113.0871	1.1197
Scaled Deviance	101	113.0871	1.1197
Pearson Chi-Square	101	106.9196	1.0586
Scaled Pearson X2	101	106.9196	1.0586
Log Likelihood		281.0665	
Full Log Likelihood		-224.7989	
AIC (smaller is better)		459.5979	
AICC (smaller is better)		460.2039	
BIC (smaller is better)		472.8677	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept and $V85max$ are not significant. The estimate b_1 in Table 3-21 is negative, indicating that the predicted crash frequency decreases with speed. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 113.10, and 106.91 respectively, and the degrees of freedom is 101 indicating that the model is well fitted.

3.2.1.7 SPF (7th trail)

In this SPF, length, AADT, average V50, V50SD, V50max are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V50 + b_2 \cdot V50SD + b_3 \cdot V50max \quad (3\text{-}21)$$

Table 3-22 Summary of results of estimation for SPF (7th trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-4.0529	3.3201	-10.5601	2.4543	1.49	0.2222
ln(AADT)	1	a_1	0.8093	0.3358	0.1511	1.4675	5.81	0.0160
ln(L)	1	a_2	1.7363	0.2242	1.2968	2.1757	59.97	<.0001
V50	1	b_1	0.1107	0.1892	-0.2600	0.4815	0.34	0.5583
V50SD	1	b_2	0.0246	0.1595	-0.2881	0.3373	0.02	0.8775
V50max	1	b_3	-0.1147	0.1894	-0.4859	0.2564	0.37	0.5447
Dispersion	1	$1/\varphi$	0.4711	0.1218	0.2838	0.7821		

Criteria For Assessing Goodness of Fit

Criterion	DF	Value	Value/DF
Deviance	99	114.0496	1.1520
Scaled Deviance	99	114.0496	1.1520
Pearson Chi-Square	99	116.3583	1.1753
Scaled Pearson X2	99	116.3583	1.1753
Log Likelihood		282.3399	
Full Log Likelihood		-223.5256	
AIC (smaller is better)		461.0512	
AICC (smaller is better)		462.2058	
BIC (smaller is better)		479.6289	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the above table, at the 5% level of significance, the intercept, $V50$, $V50SD$, and $V50max$ are not significant. The estimate b_1 and b_2 in Table 3-22 are positive, indicating that the predicted crash frequency increases with increasing speed. While the estimate b_3 in Table 3-22 is negative. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-Statistics models are 114.05, and 116.36 respectively, and the degree of freedom is 99, indicating that the model compared to previous models is not well fitted.

3.2.1.8 SPF (8th trail)

In this SPF, length, AADT, average V85 of lanes, the standard deviation of V85, and maximum V85 of lanes are considered as independent variables, and the results are the following:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot V85 + b_2 \cdot V85SD + b_3 \cdot V85max \quad (3\text{-}22)$$

Table 3-23 Summary of results of estimation for SPF (8th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-4.0395	3.3304	-10.5669	2.4879	1.47	0.2252
ln(AADT)	1	a_1	0.8141	0.3362	0.1552	1.4730	5.86	0.0155
ln(L)	1	a_2	1.7360	0.2237	1.2975	2.1744	60.22	<.0001
V85	1	b_1	0.0869	0.1591	-0.2250	0.3988	0.30	0.5851
V85SD	1	b_2	0.0115	0.1344	-0.2519	0.2750	0.01	0.9316
V85max	1	b_3	-0.0910	0.1594	-0.4034	0.2214	0.33	0.5682
Dispersion	1	$1/\varphi$	0.4702	0.1216	0.2832	0.7805		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	99	113.9255	1.1508
Scaled Deviance	99	113.9255	1.1508
Pearson Chi-Square	99	116.3494	1.1752
Scaled Pearson X2	99	116.3494	1.1752
Log Likelihood		282.4541	
Full Log Likelihood		-223.4114	
AIC (smaller is better)		460.8227	
AICC (smaller is better)		461.9773	
BIC (smaller is better)		479.4004	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the table, at the 5% level of significance, the intercept, $V85$, $V85SD$, and $V85max$ are not significant. The estimate b_1 and b_2 in Table 3-23 are positive and not significant at the 5% level of significance, indicating that the predicted crash frequency increases with increasing speed, while the estimate b_3 is negative. The estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-Statistic models are 113.92, and 116.35 respectively, and the degree of freedom is 99, indicating that is not well fitted.

3.2.2 Geometric features SPFs

The SPFs calibrated in the first step were calibrated again on the new sample, and the results will be summarized in the following section.

3.2.2.1 SPF (9th trail)

For calibration of this SPF, AADT, length, M, PL, ACD, PCD, and DD were used, and the result is as follow:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot M + b_2 \cdot PL + b_3 \cdot ACD + b_4 \cdot PCD + b_5 \cdot DD \qquad (3\text{-}23)$$

Table 3-24 Summary of results of estimation for SPF (9th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.5682	2.7390	-11.9365	-1.1999	5.75	0.0165
ln(AADT)	1	a_1	0.8981	0.2784	0.3525	1.4437	10.41	0.0013
ln(L)	1	a_2	1.5173	0.1783	1.1679	1.8667	72.43	<.0001
M	1	b_1	-0.1739	0.1520	-0.4718	0.1241	1.31	0.2528
PL	1	b_2	0.1957	0.1800	-0.1571	0.5484	1.18	0.2770
ACD	1	b_3	0.1234	0.0196	0.0851	0.1618	39.77	<.0001
PCD	1	b_4	0.0081	0.0308	-0.0522	0.0684	0.07	0.7931
DD	1	b_5	0.0088	0.0055	-0.0020	0.0196	2.55	0.1104
Dispersion	1	$1/\varphi$	0.2001	0.0775	0.0937	0.4276		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	97	116.7886	1.2040
Scaled Deviance	97	116.7886	1.2040
Pearson Chi-Square	97	106.4396	1.0973
Scaled Pearson X2	97	106.4396	1.0973
Log Likelihood		299.3852	
Full Log Likelihood		-206.4803	
AIC (smaller is better)		430.9605	
AICC (smaller is better)		432.8552	
BIC (smaller is better)		454.8462	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to the table, at the 5% level of significance, significance M, PL, DD, and PCD are not significant. The estimate b_1 is negative, indicating that the predicted crashes decrease with the median presence. While the estimate b_2 is positive, which shows that the parking line is increasing the probability of crash occurrence. Nevertheless, the estimate b_3, b_4 and b_5 are positive, indicating that the predicted crashes increase by increasing pedestrian crossing, driveway, and access points. Also, the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 116.79, and 106.44 respectively, and the degrees of freedom is 97 indicating that the model is somehow well fitted.

3.2.2.2 SPF (10th trail)

For calibration of this SPF, AADT, length, PL, ACD, PCD, and DD were used, and the result follows:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot ACD + b_2 \cdot PCD + b_3 \cdot PL + b_4 \cdot DD \quad (3\text{-}24)$$

Table 3-25 Summary of results of estimation for SPF (10th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.6935	2.7411	-12.0659	-1.3211	5.96	0.0146
ln(AADT)	1	a_1	0.9024	0.2787	0.3561	1.4487	10.48	0.0012
ln(L)	1	a_2	1.4981	0.1778	1.1496	1.8466	70.99	<.0001
ACD	1	b_1	0.1203	0.0194	0.0823	0.1583	38.49	<.0001
PCD	1	b_2	0.0097	0.0307	-0.0504	0.0699	0.10	0.7515
PL	1	b_3	0.1645	0.1783	-0.1848	0.5139	0.85	0.3560
DD	1	b_4	0.0094	0.0055	-0.0014	0.0202	2.90	0.0887
Dispersion	1	$1/\varphi$	0.2033	0.0788	0.0951	0.4345		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	98	117.5602	1.1996
Scaled Deviance	98	117.5602	1.1996
Pearson Chi-Square	98	109.1388	1.1137
Scaled Pearson X2	98	109.1388	1.1137
Log Likelihood		298.7274	
Full Log Likelihood		-207.1380	
AIC (smaller is better)		430.2761	
AICC (smaller is better)		431.7761	
BIC (smaller is better)		451.5078	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to Table 3-25, at the 5% level of significance, PCD, PL, DD are not significant. The estimate b_2 and b_3 are positive, showing that parking lines and pedestrian crossing density increase the probability of crash occurrence. Nevertheless, the estimate b_1 and b_4 are positive, indicating that the predicted crashes increase by the increasing driveway and access points of the road segments. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance, and the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 117.56, and 109.14 respectively, and the degrees of freedom is 98 indicating that the model is not well fitted.

3.2.2.3 SPF (11th trail)

For calibration of this SPF, AADT, length, ACD, PCD, and DD were used, and the result is as follow:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot ACD + b_2 \cdot PCD + b_3 \cdot DD \qquad (3\text{-}25)$$

Table 3-26 Summary of results of estimation for SPF (11th trail)

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.7399	2.7582	-12.1459	-1.3339	5.97	0.0145
ln(AADT)	1	a_1	0.9167	0.2802	0.3675	1.4660	10.70	0.0011
ln(L)	1	a_2	1.4806	0.1771	1.1335	1.8277	69.89	<.0001
ACD	1	b_1	0.1196	0.0195	0.0813	0.1579	37.43	<.0001
PCD	1	b_2	0.0078	0.0308	-0.0526	0.0683	0.06	0.7992
DD	1	b_3	0.0104	0.0054	-0.0003	0.0210	3.64	0.0563
Dispersion	1	$1/\varphi$	0.2097	0.0796	0.0996	0.4411		

Criteria For Assessing Goodness of Fit			
Criterion	DF	Value	Value/DF
Deviance	99	117.3230	1.1851
Scaled Deviance	99	117.3230	1.1851
Pearson Chi-Square	99	110.2829	1.1140
Scaled Pearson X2	99	110.2829	1.1140
Log Likelihood		298.3033	
Full Log Likelihood		-207.5621	
AIC (smaller is better)		429.1243	
AICC (smaller is better)		430.2789	
BIC (smaller is better)		447.7020	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to Table 3-26, at the 5% level of significance, DD and PCD are not significant. The estimate b_1, b_2 and b_3 are positive, indicating that the predicted crashes increase by increasing pedestrian crossing, driveway, and access points of the road segments. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance, and the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 117.32, and 110.28 respectively, and the degrees of freedom is 99 indicating that the model is somehow well fitted.

3.2.2.4 SPF (12th trail)

For calibration of this SPF, AADT, length, ACD and DD were used, and the result is as follow:

$$Ln(E(m)) = a_0 + a_1 \cdot ln(AADT) + a_2 \cdot ln(L) + b_1 \cdot ACD + b_2 \cdot DD \quad (3\text{-}26)$$

Table 3-27 Summary of results of estimation for SPF (12th trail)

Analysis Of Maximum Likelihood Parameter Estimates

Parameter	DF	Estimate		Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	a_0	-6.7417	2.7653	-12.1616	-1.3218	5.94	0.0148
ln(AADT)	1	a_1	0.9178	0.2809	0.3672	1.4684	10.68	0.0011
ln(L)	1	a_2	1.4903	0.1740	1.1493	1.8313	73.36	<.0001
ACD	1	b_1	0.1203	0.0194	0.0823	0.1583	38.47	<.0001
DD	1	b_2	0.0109	0.0050	0.0011	0.0207	4.74	0.0295
Dispersion	1	$1/\varphi$	0.2125	0.0792	0.1023	0.4413		

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	100	116.9043	1.1690
Scaled Deviance	100	116.9043	1.1690
Pearson Chi-Square	100	110.1763	1.1018
Scaled Pearson X2	100	110.1763	1.1018
Log Likelihood		298.2715	
Full Log Likelihood		-207.5940	
AIC (smaller is better)		427.1880	
AICC (smaller is better)		428.0451	
BIC (smaller is better)		443.1118	

* The significant variables are highlighted with green, and the other is highlighted with red.

According to Table 3-27, at the 5% level of significance, ACD and DD are significant. The estimate b_1 and b_2 are positive, indicating that the predicted crashes increase by the increasing driveway and access points of the road segments. Also, $ln(AADT)$ and $ln(L)$ are significant at the 5% level of significance, and the estimate of a_1 and a_2 are positive and significant, indicating that the predicted crashes increase with the traffic volume and segment length. The SD and Pearson X^2-statistic model are 116.91, and 110.18 respectively, and the degrees of freedom is 100 indicating that the model is well fitted compared to previous models.

3.3 Summary of Results and Discussion

In the previous step, each model was analysed separately without considering the result of the earlier models. In this section, models will be compared with each other in two stages; At first, the results of SPFs of speed variables will be discussed. Then, the development of SPFs that were calibrated based on geometric variables will be presented. The results of the first group of SPFs are summarized in Table 3-28.

Table 3-28 The summary of the first group of SPFs

SPF	Pr > ChiSq						Scaled Deviance	Pearson Chi-Square	AIC	AICC	BIC	1/φ
	V50	V50sd	V50max	V85	V85SD	V85max						
The first phase												
1st	0.13	-	-	-	-	-	1.11	0.97	363	364	375	0.49
2nd	-	-	-	0.12	-	-	1.11	0.97	363	364	375	0.49
3rd	0.01	0.004	-	-	-	-	1.11	1.01	357	358	371	0.42
4th	-	-	-	0.01	0.004	-	1.11	1.03	357	358	371	0.42
5th	-	-	0.083	-	-	-	1.11	0.97	363	363	375	0.49
6th	-	-	-	-	-	0.07	1.12	0.98	362	363	374	0.48
7th	0.05	0.25	0.048	-	-	-	1.16	1.04	355	357	372	0.35
8th	-	-	-	0.04	0.22	0.04	1.16	1.06	355	356	372	0.35
The second phase												
1st	0.61	-	-	-	-	-	1.12	1.05	460	460	473	0.51
2nd	-	-	-	0.65	-	-	1.12	1.05	460	460	473	0.51
3rd	0.33	0.13	-	-	-	-	1.14	1.18	459	460	475	0.48
4th	-	-	-	0.32	0.1	-	1.14	1.18	459	460	475	0.47
5th	-	-	0.53	-	-	-	1.12	1.06	459	460	473	0.50
6th	-	-	-	-	-	0.55	1.12	1.06	460	460	473	0.50
7th	0.56	0.88	0.54	-	-	-	1.15	1.17	461	462	480	0.47
8th	-	-	-	0.58	0.93	0.56	1.15	1.1				

** The scaled deviance and Pearson Chi-square, in the table, represent the ratio between values of these tests and degree of freedom. The closer to one, the more well-fitted a model.*
*** The significant variables are highlighted with green.*

According to Table 3-28, in the first phase of the study, speed covariates are significant at the 5% level of significance, and there are some well-fitted models such as SPF (3rd trail) and SPF (4th trail); In these models the variance and average speed of lanes considered as the covariates. Also, the Criteria for Assessing Goodness of Fit show that the models are pretty well fitted. However, by adding other road segments to the sample in the second phase, the speed covariates are not significant anymore. Therefore, there is not any correlation between speed variables and crash frequency. As a result, for the urban roads of Turin, speed variables are not suitable variables to describe crash frequency.

Some controversial studies in which speed contributes to crash occurrence: First, Garber et al. (2000) concluded a relationship between crash rates and the independent variables of the standard deviation of speed mean speed and flow per lane. Second, Quddus (2013) studied a series of relationships between segment-level average speeds, speed variation, and accident rates based on nonspatial and spatial statistical models using a panel data set obtained from a significant road network around London. Third, Xu et al. (2019) found that a more significant spatial and temporal speed variance increases the probability of crashes on an urban expressway. These case studies were done on highways and freeways around or outside of cities. In contrast, Turin is a small city, and its road network consists of narrow lanes and short road segments. According to the HSM (2010), SPFs predict the average crash frequency for a specific site type, so the results of the studies mentioned above cannot be compared with this case study. Because Turin's urban road segments are entirely different from those road segments, functionally and geometrically.

The results of the second group of SPFs are summarized in Table 3-29.

Table 3-29 The summary of the second group of SPFs

SPF	Pr > ChiSq					Scaled Deviance	Pearson Chi-Square	AIC	AICC	BIC	1/φ
	M	PL	ACD	PCD	DD						
The first phase											
9th	0.58	0.48	<.0001	0.25	0.018	1.17	0.97	336	339	358	0.18
10th	-	0.59	<.0001	0.29	0.013	1.16	0.95	335	337	354	0.18
11th	-	-	<.0001	0.32	0.007	1.14	0.94	333	334	350	0.18
12th	-	-	<.0001	-	0.003	1.12	0.94	332	333	347	0.19
The second phase											
9th	0.25	0.28	<.0001	0.79	0.11	1.20	1.10	431	432	455	0.2
10th	-	0.36	<.0001	0.75	0.09	1.20	1.11	430	432	451	0.2
11th	-	-	<.0001	0.80	0.06	1.18	1.11	429	430	448	0.21
12th	-	-	<.0001	-	0.03	1.17	1.10	427	428	443	0.21

** The scaled deviance and Pearson Chi-square, in the table, represent the ratio between values of these tests and degree of freedom. The closer to one, the more well-fitted a model.*

*** The significant variables are highlighted with green.*

According to the above table, M, PL, and PCD are not significant at the 5% significance level in all models. Comparing models clarifies that the best model is related to SPF (12th trail); its variables are significant. Its goodness of fitting values represents that it is well fitted compared to the other models. Between geometric variables, access point density and driveway density were significant, and they have a high correlation with crash frequency. Considering, Sacchi et al. (2015) estimated that when the predicted traffic conflicts increase 1%, predicted collisions increase 0.8%, the result is rational because by increasing the number of access points and driveways, the number of conflict points increases.

Some studies on highways and rural roads predicted access point density as an influencing factor on the crash frequency which will be discussed. Mayora et al. (2003) claimed that the highway variables with the highest correlation with crash rates in Spain's two-lane rural roads are: access density, average sight distance, average speed limit, and the proportion of no-passing zones. Furthermore, Mayora et al. (2003) claimed that the highway variables with the highest correlation with crash rates in Spain's two-lane rural roads are: access density, average sight distance, average speed limit, and the proportion of no-passing zones. Then, Marizwan Abdul Manan et al. (2013) concluded that increased access points per kilometre and the average traffic volume are highly associated with increased motorcycle fatalities per kilometre. Although these results are related to rural roads, which are entirely different from this case study, it is a confirmation that the location of access points can be Hazardous.

In addition, Greibe (2003) concluded that explanatory variables describing the road environment, number of minor side roads (access point), parking facilities, and speed limit proved to be significant variables for predicting the crash frequency of road segments. Also, Sawalha et al. (2001) concluded that section length, traffic volume, unsignalized intersection density (access point density), driveway density, pedestrian crosswalk density, number of traffic lanes, type of median, and land use type significantly affected accident occurrence. These studies were done on urban roads, and they confirm that the access points and driveway density are influential factors on the higher the accident risk.

Chapter 4

4 Conclusions

According to the World Health Organization, more than 1.35 million individuals are killed on roads worldwide every year. Between 20 and 50 million more people suffer non-fatal injuries, with many incurring a disability because of their injury. Both fatal and non-fatal crashes will cost more than 1.8 trillion dollars from 2015-2030. Due to the harmful effects of crashes, transportation safety has become an essential topic among transportation engineers. Describing crash phenomena can help to identify sites that have the highest potential for improvement.

Safety Performance function results from observational studies that provide a statistical relationship between the predicted number of crashes per specific period and roadway characteristics. An SPF is a regression model used in road safety to estimate the number of collisions per unit of time for different facility types such as intersections and road segments. The independent variables of the regression model are usually roadway and traffic features.

In Italy, approximately two-thirds of all crashes occur in urban areas, so identifying roadway and traffic factors that influence crashes occurring in such a context is an important area of research. According to the literature, there were no previous studies about parameters influencing crashes occurring in Italian urban areas, and in particular in Turin. Most earlier studies on North American roads were entirely different from Italian roads functionality and geometrically. As a result, the goal of this study is the calibration of SPFs by considering geometric and speed features of Turin's urban roads as influential factors and developing models such a way to be useful for Italian urban roads.

Before developing models, some steps were followed to gather and manage datasets, and different software was used to collect data sets, such as QGIS and Excel. There was some uncertainty on AADT because of strange fluctuation of traffic data along roads. To overcome this problem, the Modified Z-score method was used to detect and delete outliers of the AADT data set, leading to more reliable data. There were no reported data for geometric features of the road, so Google map satellite was used for extracting geometric features. About speed data, a model from Bassani et al. (2014) was used to estimate average and operating speed.

In this study, negative binomial distribution was considered probability (statistical) distributions of the number of collisions and the degree of overdispersion in a negative binomial model represented by a statistical parameter known as the overdispersion parameter. To calibrate SPFs, Generalized Linear Modelling (GLM) was used because of the discrete nature of crash frequency. The calibration of SPFs was performed in two steps; First, the SPFs were calibrated on 83 road segments of Turin, and then road segments were increased to 105, and the calibration of SPFs was again on the new sample. Nevertheless, except segment length and AADT, speed and the geometrical characteristics of the road.

From the results of the research reported in this paper, the following conclusions were obtained:

1. based on statistical significance and goodness of fit of SPFs calibrated on speed data, there is a low correlation between speed and crash frequency. In addition, based on previous expectations, by increasing speed, the probability of a crash occurring will increase. In contrast, an opposite behaviour was found in this specific case study with a negative sign of regression parameters for speed covariates;
2. among geometry features, access density and driveway density have the highest correlation with crash frequency because they were significant in models related to geometric variables;
3. the best SPF was found at the 12th trail, in which AADT, Segment length, Access density, and driveway density were found statistically significant.

Despite the limitations of this study, such as the absence of data related to Property Damage Only (PDO) crashes, the results mentioned above can be a step forward to estimate crash frequencies of Italian urban roads. Furthermore, indicating the most contributing factors in crashes occurring can be a guideline to distinguish the most hazardous road segments and choose the best countermeasures to improve road safety of urban roads. Considering the high correlation between access point density and crash frequency, enhancing visibility and using traffic lights at access points can improve the safety level of the road segment in Turin. In addition, constructing service loads along main roads to minimize the conflict points between driveways and road segments can be practical.

Nevertheless, this study is just an onset to describe crash phenomena in Italian urban roads, and there is a long journey toward understanding and improving road safety. Future studies can collect detailed information about crashes such as driver gender, weather condition, vehicle speed, road condition, etc. The next step is calibrating the safety performance function to clarify influential factors describing crash phenomena.

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Appendix 1:

In this part, the result of detecting outliers of AADT will be presented. The segments highlighted red are outliers that were removed from the study sample.

Table 0-1 The result of detecting outlier of AADT data

Section	AADT						Median	MAD	AADT					
	2011	2012	2013	2014	2015	2016			2011	2012	2013	2014	2015	2016
1	14376	28536	8520	11736	26760	26904	20568	7152	OK	OK	OK	OK	OK	OK
2	14376	28536	8520	11736	26760	26904	20568	7152	OK	OK	OK	OK	OK	OK
3	14376	28536	8520	11736	26760	26904	20568	7152	OK	OK	OK	OK	OK	OK
4	17424	5208	16128	15648	6720	10344	12996	3780	OK	OK	OK	OK	OK	OK
5	17424	5208	16128	15648	6720	10344	12996	3780	OK	OK	OK	OK	OK	OK
6	16056	7248	19368	13128	3792	4056	10188	6000	OK	OK	OK	OK	OK	OK
7	16056	7248	19368	13128	3792	4056	10188	6000	OK	OK	OK	OK	OK	OK
8	27936	15240	28488	33696	13728	11328	21588	7380	OK	OK	OK	OK	OK	OK
9	27936	15240	28488	33696	13728	11328	21588	7380	OK	OK	OK	OK	OK	OK
10	12816	8952	10224	11640	34728	34968	12228	2640	OK	OK	OK	OK	NOT OK	NOT OK
11	9192	4320	5472	20112	18648	23544	13920	7320	OK	OK	OK	OK	OK	OK
12	8760	30288	14592	29352	11232	11472	13032	3036	OK	NOT OK	OK	NOT OK	OK	OK
13	12720	32280	8136	31032	4632	4776	10428	5724	OK	OK	OK	OK	OK	OK
14	8880	11688	8136	12888	13104	13728	12288	1128	OK	OK	OK	OK	OK	OK
15	8712	28968	8352	25200	41208	42312	27084	14676	OK	OK	OK	OK	OK	OK
16	28776	19536	13608	39960	20424	20376	20400	3828	OK	OK	OK	OK	OK	OK
17	19992	38136	22080	5952	33888	32232	27156	6948	OK	OK	OK	OK	OK	OK
18	21288	5448	15576	6120	13488	12624	13056	4728	OK	OK	OK	OK	OK	OK
19	16440	11256	17112	11832	9264	8880	11544	2472	OK	OK	OK	OK	OK	OK
20	14616	14736	13536	14352	20328	20064	14676	732	OK	OK	OK	OK	NOT OK	NOT OK
21	11712	16800	14592	17160	23400	22920	16980	3828	OK	OK	OK	OK	OK	OK
22	13200	14640	14088	14304	24816	26544	14472	828	OK	OK	OK	OK	NOT OK	NOT OK
23	12024	10536	11040	10920	21192	21960	11532	804	OK	OK	OK	OK	NOT OK	NOT OK
24	6864	6192	6336	5472	25896	24912	6600	768	OK	OK	OK	OK	NOT OK	NOT OK
25	11880	10152	11280	11736	22392	18264	11808	1092	OK	OK	OK	OK	NOT OK	NOT OK
26	8256	22848	13320	18456	5424	6120	10788	5016	OK	OK	OK	OK	OK	OK
27	8256	22848	13320	18456	5424	6120	10788	5016	OK	OK	OK	OK	OK	OK
28	8256	22848	13320	18456	5424	6120	10788	5016	OK	OK	OK	OK	OK	OK
29	16224	7776	9216	13248	11976	11760	11868	2016	OK	OK	OK	OK	OK	OK
30	15816	16368	9168	19080	6744	6024	12492	4812	OK	OK	OK	OK	OK	OK
31	23808	25632	41976	9576	20520	19776	22164	2928	OK	OK	NOT OK	OK	OK	OK
32	23808	25632	41976	9576	20520	19776	22164	2928	OK	OK	NOT OK	OK	OK	OK
33	25680	9696	14784	10728	10512	11688	11208	1104	NOT OK	OK	OK	OK	OK	OK
34	25680	9696	14784	10728	10512	11688	11208	1104	NOT OK	OK	OK	OK	OK	OK
35	25752	32760	22560	28320	7968	7488	24156	6384	OK	OK	OK	OK	OK	OK

Section	AADT						Median	MAD	AADT					
	2011	2012	2013	2014	2015	2016			2011	2012	2013	2014	2015	2016
36	25752	32760	22560	28320	7968	7488	24156	6384	OK	OK	OK	OK	OK	OK
37	18672	11928	14160	18480	16872	14616	15744	2160	OK	OK	OK	OK	OK	OK
38	13704	11352	15024	6000	20424	19608	14364	4128	OK	OK	OK	OK	OK	OK
39	10848	14112	14328	19224	13392	13008	13752	660	OK	OK	OK	NOT OK	OK	OK
40	10560	16272	13992	25200	17304	16368	16320	1656	OK	OK	OK	NOT OK	OK	OK
41	13296	8880	12600	8640	23400	19968	12948	4188	OK	OK	OK	OK	OK	OK
42	13152	19896	12288	18696	15336	15336	15336	2616	OK	OK	OK	OK	OK	OK
43	13152	19896	12288	18696	15336	15336	15336	2616	OK	OK	OK	OK	OK	OK
44	29280	20856	27864	18432	23880	23184	23532	3504	OK	OK	OK	OK	OK	OK
45	29280	20856	27864	18432	23880	23184	23532	3504	OK	OK	OK	OK	OK	OK
46	18408	22176	16536	34680	10536	10656	17472	5760	OK	OK	OK	OK	OK	OK
47	18408	22176	16536	34680	10536	10656	17472	5760	OK	OK	OK	OK	OK	OK
48	18408	22176	16536	34680	10536	10656	17472	5760	OK	OK	OK	OK	OK	OK
49	44808	23208	38544	20280	4152	4608	21744	16968	OK	OK	OK	OK	OK	OK
50	44808	23208	38544	20280	4152	4608	21744	16968	OK	OK	OK	OK	OK	OK
51	35016	18216	25728	25296	11640	12984	21756	6372	OK	OK	OK	OK	OK	OK
52	35016	18216	25728	25296	11640	12984	21756	6372	OK	OK	OK	OK	OK	OK
53	38904	9696	34992	6624	22872	21576	22224	12648	OK	OK	OK	OK	OK	OK
54	38904	9696	34992	6624	22872	21576	22224	12648	OK	OK	OK	OK	OK	OK
55	33456	34464	37488	31296	9624	10272	32376	3600	OK	OK	OK	OK	NOT OK	NOT OK
56	33456	34464	37488	31296	9624	10272	32376	3600	OK	OK	OK	OK	NOT OK	NOT OK
57	33456	34464	37488	31296	9624	10272	32376	3600	OK	OK	OK	OK	NOT OK	NOT OK
58	32664	30072	30912	40032	5400	5136	30492	5856	OK	OK	OK	OK	OK	OK
59	23808	21360	18072	16176	10752	12696	17124	4332	OK	OK	OK	OK	OK	OK
60	23808	21360	18072	16176	10752	12696	17124	4332	OK	OK	OK	OK	OK	OK
61	23808	21360	18072	16176	10752	12696	17124	4332	OK	OK	OK	OK	OK	OK
62	16056	15384	16272	13560	18504	18648	16164	1560	OK	OK	OK	OK	OK	OK
63	16056	15384	16272	13560	18504	18648	16164	1560	OK	OK	OK	OK	OK	OK
64	23328	25656	26760	25560	15624	16128	24444	1764	OK	OK	OK	OK	OK	OK
65	11232	15840	16488	13584	12336	12576	13080	1296	OK	OK	OK	OK	OK	OK
66	12240	28008	7560	19776	10920	10728	11580	2436	OK	NOT OK	OK	OK	OK	OK
67	19200	10896	17832	20112	16584	16800	17316	1308	OK	OK	OK	OK	OK	OK
68	19200	10896	17832	20112	16584	16800	17316	1308	OK	OK	OK	OK	OK	OK
69	19032	21600	18120	22536	8904	13248	18576	3492	OK	OK	OK	OK	OK	OK
70	18576	17568	20784	29448	13536	10032	18072	3624	OK	OK	OK	OK	OK	OK
71	18576	17568	20784	29448	13536	10032	18072	3624	OK	OK	OK	OK	OK	OK
72	18576	17568	20784	29448	13536	10032	18072	3624	OK	OK	OK	OK	OK	OK
73	7728	24264	11184	18672	4776	4632	9456	4752	OK	OK	OK	OK	OK	OK
74	12096	25704	13728	14544	20712	20184	17364	3492	OK	OK	OK	OK	OK	OK
75	12096	25704	13728	14544	20712	20184	17364	3492	OK	OK	OK	OK	OK	OK
76	12096	25704	13728	14544	20712	20184	17364	3492	OK	OK	OK	OK	OK	OK
77	13968	6720	13128	10296			11712	3624	OK	OK	OK	OK	Not OK	Not OK
78	1728	13584	2328	8448	13104	16632	10776	4332	OK	OK	OK	OK	OK	OK

Section	AADT						Median	MAD	AADT					
	2011	2012	2013	2014	2015	2016			2011	2012	2013	2014	2015	2016
79	39264	25176	35472	21456	24912	24696	25044	1968	NOT OK	OK	NOT OK	OK	OK	OK
80	39264	25176	35472	21456	24912	24696	25044	1968	NOT OK	OK	NOT OK	OK	OK	OK
81	42240	26208	20568	21168	18024	20208	20868	1752	NOT OK	OK	OK	OK	OK	OK
82	43032	26136	39720	45696	32784	33912	36816	5124	OK	OK	OK	OK	OK	OK
83	47784	10944	43320	26328	10800	11136	18732	7860	OK	OK	OK	OK	OK	OK
84	46056	27096	36960	13200	5904	6288	20148	14052	OK	OK	OK	OK	OK	OK
85	46032	25248	38064	23976	13512	13128	24612	11292	OK	OK	OK	OK	OK	OK
86	27744	25488	32040	23736	27288	24576	26388	1584	OK	OK	OK	OK	OK	OK
87	27744	25488	32040	23736	27288	24576	26388	1584	OK	OK	OK	OK	OK	OK
88	22056	24312	20064	15216	8064	10416	17640	5544	OK	OK	OK	OK	OK	OK
89	21576	23400	23736	15264	11832	11616	18420	5148	OK	OK	OK	OK	OK	OK
90	21552	28944	28728	40992	15504	14760	25140	6720	OK	OK	OK	OK	OK	OK
91	18936	34536	22176	34440	13968	14232	20556	6456	OK	OK	OK	OK	OK	OK
92	14736	15912	17784	23448	11640	11016	15324	3072	OK	OK	OK	OK	OK	OK
93	19584	19824	21600	25080	14136	13656	19704	3636	OK	OK	OK	OK	OK	OK
94	30768	35832	40104	34872	13992	14400	32820	5148	OK	OK	OK	OK	OK	OK
95	29328	30600	32376	29256	11760	12168	29292	2196	OK	OK	OK	OK	NOT OK	NOT OK
96	17352	18384	12312	10152	4632	4560	11232	6360	OK	OK	OK	OK	OK	OK
97	14880	11712	10464	11664			11688	2208	OK	OK	OK	OK	NOT OK	NOT OK
98	17664	23760	18456	9360	7176	7200	13512	5628	OK	OK	OK	OK	OK	OK
99	16800	11280	17928	2688	2376	2520	6984	4536	OK	OK	OK	OK	OK	OK
100	13560	14184	13536	12192	12408	11784	12972	684	OK	OK	OK	OK	OK	OK
101	8856	8088	7344	8256	35616	34056	8556	840	OK	OK	OK	OK	NOT OK	NOT OK
102	12864	13512	13824	12096	6888	7224	12480	1188	OK	OK	OK	OK	OK	OK
103	33960	35376	33576	32832	3384	2592	33204	1464	OK	OK	OK	OK	NOT OK	NOT OK
104	32400	24096	33408	22248	32976	31752	32076	1116	OK	NOT OK	OK	NOT OK	OK	OK
105	32400	24096	33408	22248	32976	31752	32076	1116	OK	NOT OK	OK	NOT OK	OK	OK
106	36864	37296	37584	34968	39672	29952	37080	1308	OK	OK	OK	OK	OK	NOT OK
107	36024	32832	38184	40368	22512	19992	34428	4848	OK	OK	OK	OK	OK	OK
108	38184	39072	36240	36672	9288	7584	36456	2172	OK	OK	OK	OK	NOT OK	NOT OK
109	9240	21936	5760	5184	8016	8712	8364	1740	OK	NOT OK	OK	OK	OK	OK
124	16344	18840	11016	19752	16800	17424	17112	1248	OK	OK	OK	OK	OK	OK
125	16344	18840	11016	19752	16800	17424	17112	1248	OK	OK	OK	OK	OK	OK
126	16344	18840	11016	19752	16800	17424	17112	1248	OK	OK	OK	OK	OK	OK
127	13776	20544	22944	17616	29208	27816	21744	5100	OK	OK	OK	OK	OK	OK
128	14112	18576	13368	9120	7512	7272	11244	3300	OK	OK	OK	OK	OK	OK
129	6384	5568	3672	7824	20640	20832	7104	2484	OK	OK	OK	OK	NOT OK	NOT OK
130	8208	6720	4752	21912	12864	16320	10536	4800	OK	OK	OK	OK	OK	OK
131	9192	12792	4752	26592	13200	11328	12060	2004	OK	OK	OK	NOT OK	OK	OK
132	20472	10992	15096	1848	18840	16008	15552	3924	OK	OK	OK	OK	OK	OK
133	20472	10992	15096	1848	18840	16008	15552	3924	OK	OK	OK	OK	OK	OK
134	26160	19848	17064	14376	29592	25008	22428	4548	OK	OK	OK	OK	OK	OK
135	28152	13032	23472	5688	22776	23568	23124	2736	OK	OK	OK	NOT OK	OK	OK

Section	AADT						Median	MAD	AADT					
	2011	2012	2013	2014	2015	2016			2011	2012	2013	2014	2015	2016
136	23760	6888	19872	5352	35136	34680	21816	13092	OK	OK	OK	OK	OK	OK
137	27240	29424	46248	20880	7344	7728	24060	10848	OK	OK	OK	OK	OK	OK
138	7320	22560	19608	22656	18048	20664	20136	2256	NOT OK	OK	OK	OK	OK	OK
139	7320	22560	19608	22656	18048	20664	20136	2256	NOT OK	OK	OK	OK	OK	OK
140	10800	16944	22464	18696	22488	25752	20580	2772	OK	OK	OK	OK	OK	OK
141	19032	16080	22704	18048	8136	7992	17064	3804	OK	OK	OK	OK	OK	OK
142	5520	13176	13728	24048	23520	22992	18360	5172	OK	OK	OK	OK	OK	OK
143	5520	13176	13728	24048	23520	22992	18360	5172	OK	OK	OK	OK	OK	OK
144	5520	13176	13728	24048	23520	22992	18360	5172	OK	OK	OK	OK	OK	OK
145	5520	13176	13728	24048	23520	22992	18360	5172	OK	OK	OK	OK	OK	OK
146	5520	13176	13728	24048	23520	22992	18360	5172	OK	OK	OK	OK	OK	OK
147	4656	12528	14640	14064	7320	6744	9924	3660	OK	OK	OK	OK	OK	OK
148	12792	18240	27840	45576			23040	16392	OK	OK	OK	OK	NOT OK	NOT OK
149	12792	18240	27840	45576			23040	16392	OK	OK	OK	OK	NOT OK	NOT OK
150	6336	8070	7968	13032	8616	9096	8856	1704	OK	OK	OK	OK	OK	OK

Appendix 2:

In this part, the result of the segmentation of the road network will be presented.

Table 0-2 Road Network

Section	Street Name	Crossing Street	Length[Km]
1	Via Guido Reni	Corso Orbassano	0.10
2	Via Guido Reni	Piazza Omero	0.24
3	Via Guido Reni	Via Monte Novegno	0.28
4	Via Guido Reni	Corso Cosenza	0.19
5	Via Guido Reni	Via Boston	0.32
6	Via Guido Reni	Via Filadelfia	0.17
7	Via Guido Reni	Via Baltimora	0.16
8	Via Guido Reni	Corso Sebastopoli	0.20
9	Via Guido Reni	Via Barletta	0.19
10	Corso Svizzera	Via Giacomo Medici	0.20
11	Corso Svizzera	Piazza Giusseppe	0.17
12	Corso Svizzera	Corso Appio Claudio	0.29
13	Corso Svizzera	Regina Margherita	0.14
14	Corso Svizzera	Corso Tassani	0.07
15	Corso Svizzera	Via Pianezza	0.25
16	Corso Svizzera	Ospedale Amedeo di Savoia	0.42
17	Corso Racconigi	Largo Tirreno	0.29
18	Corso Racconigi	Piazza Generale di Robilant	0.42
19	Via Reiss Remoli	Via Giambatista Lulli	0.25
20	Via Reiss Remoli	Via Arrigo Olivetti	0.23
21	Via Reiss Remoli	Via Enrico Fermi	0.40
22	Via Reiss Remoli	Via Leonardo Fea	0.16
23	Via Reiss Remoli	Via Paolo della Cella	0.44
24	Corso Sebastopoli	Via Guido Reni	0.21
25	Corso Sebastopoli	Via Giambatista Lulli	0.21
26	Corso Sebastopoli	Corso Siracusa	0.55
27	Corso Sebastopoli	Via Gorizia	0.33
28	Corso Moncalieri	Strada di Fioccardo	0.94
29	Corso Moncalieri	Starada Lucia	1.10
30	Corso Moncalieri	Alberoni	0.30
31	Corso Moncalieri	Via Sabauda	0.21
32	Corso Moncalieri	Piazza Zara	0.04
33	Corso Moncalieri	Piazza Zara	0.08
34	Corso Moncalieri	Via Salino	0.48
35	Corso Moncalieri	Corso Sicilia	0.13
36	Corso Moncalieri	Ponte Isabella	0.65
37	Corso Moncalieri	Via Febo	0.24
38	Corso Moncalieri	Corso Lanza	0.38

Section	Street Name	Crossing Street	Length[Km]
39	Corso Moncalieri	Via San Fermo	0.29
40	Corso Moncalieri	Corso Fiume	0.25
41	Corso Moncalieri	Via Sommacampagna	0.47
42	Corso Casale	Via Maria Bricca	0.27
43	Corso Casale	Corso Giuseppe Gabetti	0.16
44	Corso Casale	Via Bardassano	0.36
45	Corso Casale	Via Gassino	0.41
46	Corso Casale	Via Castiglione	0.25
47	Corso Casale	Piazza Francesco	0.25
48	Corso Casale	Corso Chieri	0.54
49	Corso Casale	Piazza Alberto Passini	0.31
50	Corso Traiano	Corso Unione Siovetica	0.42
51	Corso Traiano	Via Pietro Franceso	0.26
52	Corso Traiano	Corso Benedetto Croce	0.33
53	Corso Traiano	Via Pio VII	0.20
54	Corso Traiano	Via Luigi Palma	0.17
55	Corso Traiano	Via Sette Comuni	0.19
56	Via Filadelfia	Via Guido Reni	0.43
57	Via Filadelfia	Corso Siracusa	0.59
58	Via Filadelfia	Corso Orbassano	0.28
59	Via Filadelfia	Via Tripoli	0.29
60	Via Filadelfia	Corso Ferraris	0.24
61	Corso Massimo d'Azegli	Corso Rafaello	0.21
62	Corso Massimo d'Azeglio	Via Valperga Caluso	0.32
63	Corso Massimo d'Azeglio	Corso Marconi	0.24
64	Corso Massimo d'Azeglio	Silvio Pellico	0.36
65	Corso Regina Margherita	Corso Lecco	0.10
66	Corso Regina Margherita	Corso Lecco	0.10
67	Corso Regina Margherita	Corso Alessandro Tassoni	0.28
68	Corso Regina Margherita	Via Sondrio	0.23
69	Corso Regina Margherita	Via Avellino	0.23
70	Corso Regina Margherita	Via Aquila	0.17
71	Corso Regina Margherita	Via Livorno	0.21
72	Corso Regina Margherita	Via Macercita	0.63
73	Corso Regina Margherita	Rondo dell Forca	0.28
74	Corso Regina Margherita	Piazza Della Repubblica	0.26
75	Corso Regina Margherita	Via Gioachino Rossini	0.16
76	Corso Regina Margherita	Via Montebello	0.31
77	Corso Regina Margherita	Via Guastalla	0.25
78	Corso Regina Margherita	Via Antonio Fontanessi	0.19
79	Corso Francia	Corso Marche	0.40
80	Corso Francia	Via Pozzo Strada	0.53
81	Corso Francia	Corso Monte Grappa	0.61
82	Corso Francia	Corso Svizzera	0.61

Section	Street Name	Crossing Street	Length[Km]
83	Corso Francia	Via Pietro Palmieri	0.26
84	Corso Belgio	Corso Cralo Luigi Farini	0.35
85	Corso Belgio	Corso Cadore	0.19
86	Via Bologna	Corso Novara	0.32
87	Via Bologna	Via Giovanni Pacini	0.33
88	Via Bologna	Via Niccoolo Paganini	0.32
89	Via Bologna	Via Domenico Cimarosa	0.45
90	Via Bologna	Via Gottardo	0.27
91	Corso Giulio Cesare	Corso Brescia	0.22
92	Corso Giulio Cesare	Corso Novara	0.42
93	Corso Giulio Cesare	Via Alessamdro Scarlatti	0.18
94	Corso Giulio Cesare	Via Luigi Salvatore Cherubini	0.23
95	Corso Giulio Cesare	Via Gottardo	0.15
96	Corso Giulio Cesare	Via Luigi Boccherini	0.21
97	Via Pio VII	Corso Traiano	0.36
98	Via Pio VII	Via Passo Buole	0.33
99	Corso Orbssano	Piazza Pitagora	0.12
100	Corso Orbssano	Corso San Mario	0.15
101	Corso Orbssano	Via Boston	0.26
102	Corso Orbssano	Via Gorizia	0.23
103	Corso Orbssano	Via baltimore	0.18
104	Corso Orbassano	Corso Sepastopoli	0.22
105	Corso Orbassano	Via Romolo Gessi	0.13

Appendix 3:

In this part, the result of segments' crashes will be presented.

Table 0-3 Result of segments' crashes

Section	Street Name	Crossing Street	2012		2013		2014		2015		2016	
			INJ	FAT	INJ	FAT	INJ	FAT	INJ	FAT	INJ	FAT
1	Via Guido Reni	Corso Orbassano	0	0	0	0	0	0	0	0	0	0
2	Via Guido Reni	Piazza Omero	0	0	0	0	1	0	0	0	1	0
3	Via Guido Reni	Via Monte Novegno	0	0	0	0	0	0	0	0	0	0
4	Via Guido Reni	Corso Cosenza	0	0	0	0	1	0	0	0	0	0
5	Via Guido Reni	Via Boston	0	0	0	0	0	0	0	0	0	0
6	Via Guido Reni	Via Filadelfia	1	0	0	0	0	0	0	0	0	0
7	Via Guido Reni	Via Baltimora	0	0	0	0	0	0	0	0	0	0
8	Via Guido Reni	Corso Sebastopoli	0	0	0	0	0	0	1	0	0	0
9	Via Guido Reni	Via Barletta	0	0	0	0	0	0	0	0	3	0
10	Corso Svizzera	Via Giacomo Medici	0	0	1	0	0	0	1	0	1	0
11	Corso Svizzera	Piazza Giuseppe	0	0	0	0	0	0	0	0	0	0
12	Corso Svizzera	Corso Appio Claudio	0	0	1	0	1	0	0	0	0	0
13	Corso Svizzera	Regina Margherita	0	0	0	0	0	0	0	0	0	0
14	Corso Svizzera	Corso Tassani	0	0	0	0	0	0	0	0	0	0
15	Corso Svizzera	Via Pianezza	1	0	0	0	1	0	0	0	2	0
16	Corso Svizzera	Ospedale Amedeo di Savoia	0	0	0	0	0	0	1	0	0	0
17	Corso Racconigi	Largo Tirreno	1	0	0	0	0	0	0	0	0	0
18	Corso Racconigi	Piazza Generale di Robilant	1	0	1	0	3	0	1	0	3	0
19	Via Reiss Remoli	Via Giambatista Lulli	0	0	0	0	1	0	0	0	0	0
20	Via Reiss Remoli	Via Arrigo Olivetti	1	0	1	0	0	0	0	0	0	0
21	Via Reiss Remoli	Via Enrico Fermi	3	0	0	0	1	0	0	0	0	0
22	Via Reiss Remoli	Via Leonardo Fea	0	0	0	0	0	0	0	0	0	0
23	Via Reiss Remoli	Via Paolo della Cella	1	0	0	0	1	0	4	0	2	0
24	Corso Sebastopoli	Via Guido Reni	1	0	0	0	0	0	0	0	0	0
25	Corso Sebastopoli	Via Giambatista Lulli	1	0	0	0	0	0	0	0	0	0
26	Corso Sebastopoli	Corso Siracusa	6	0	4	0	3	0	5	0	4	0
27	Corso Sebastopoli	Via Gorizia	2	0	2	0	3	0	1	0	1	0
28	Corso Moncalieri	Strada di Fioccardo	6	0	1	0	2	0	0	0	1	0
29	Corso Moncalieri	Starada Lucia	2	1	3	0	5	1	2	0	5	0
30	Corso Moncalieri	Alberoni	1	0	1	0	0	0	0	0	1	0
31	Corso Moncalieri	Via Sabauda	0	0	2	0	0	0	1	0	0	0
32	Corso Moncalieri	Piazza Zara	0	0	0	0	0	0	0	0	0	0
33	Corso Moncalieri	Piazza Zara	0	0	0	0	0	0	0	0	0	0
34	Corso Moncalieri	Via Salino	2	0	1	0	2	0	1	0	5	0
35	Corso Moncalieri	Corso Sicilia	0	0	0	0	0	0	0	0	0	0
36	Corso Moncalieri	Ponte Isabella	2	0	0	0	2	0	2	0	1	0

Section	Street Name	Crossing Street	2012		2013		2014		2015		2016	
			INJ	FAT	INJ	FAT	INJ	FAT	INJ	FAT	INJ	FAT
37	Corso Moncalieri	Via Febo	0	0	0	0	0	0	0	0	0	0
38	Corso Moncalieri	Corso Lanza	2	0	0	0	2	0	3	0	2	0
39	Corso Moncalieri	Via San Fermo	0	0	1	0	1	0	3	0	2	0
40	Corso Moncalieri	Corso Fiume	2	0	0	0	1	0	4	0	4	0
41	Corso Moncalieri	Via Sommacampagna	4	0	1	0	2	0	0	0	0	0
42	Corso Casale	Via Maria Bricca	0	0	2	0	1	0	0	0	1	0
43	Corso Casale	Corso Giuseppe Gabetti	0	0	0	0	1	0	0	0	2	0
44	Corso Casale	Via Bardassano	1	0	3	0	2	0	2	0	3	0
45	Corso Casale	Via Gassino	2	0	1	0	0	0	3	0	0	0
46	Corso Casale	Via Castiglione	1	0	0	0	1	0	0	0	0	0
47	Corso Casale	Piazza Francesco	1	0	1	0	1	0	0	0	1	0
48	Corso Casale	Corso Chieri	1	0	3	0	2	0	3	0	2	0
49	Corso Casale	Piazza Alberto Passini	0	0	0	0	0	0	0	0	1	0
50	Corso Traiano	Corso Unione Siovetica	3	0	2	0	5	0	1	0	7	1
51	Corso Traiano	Via Pietro Franceso	0	0	1	0	0	0	0	0	0	0
52	Corso Traiano	Corso Benedetto Croce	1	0	1	0	2	0	1	0	0	0
53	Corso Traiano	Via Pio VII	0	0	0	0	0	0	0	0	0	0
54	Corso Traiano	Via Luigi Palma	1	0	0	0	0	0	0	0	0	0
55	Corso Traiano	Via Sette Comuni	0	0	0	0	1	0	0	0	0	0
56	Via Filadelfia	Via Guido Reni	1	0	2	0	3	0	3	0	0	0
57	Via Filadelfia	Corso Siracusa	1	0	0	0	2	0	1	0	1	0
58	Via Filadelfia	Corso Orbassano	0	0	0	0	4	0	2	0	1	0
59	Via Filadelfia	Via Tripoli	1	0	1	0	2	0	0	0	0	0
60	Via Filadelfia	Corso Ferraris	0	0	1	0	1	0	1	0	1	0
61	Corso Massimo d'Azeglio	Corso Rafaello	1	0	2	0	1	0	0	0	1	0
62	Corso Massimo d'Azeglio	Via Valperga Caluso	4	0	4	0	2	0	4	0	5	0
63	Corso Massimo d'Azeglio	Corso Marconi	1	0	0	0	2	0	0	0	2	0
64	Corso Massimo d'Azeglio	Silvio Pellico	2	0	5	0	1	0	4	0	0	0
65	Corso Regina Margherita	Corso Lecco	0	0	0	0	0	0	0	0	0	0
66	Corso Regina Margherita	Corso Lecco	0	0	0	0	0	0	0	0	1	0
67	Corso Regina Margherita	Corso Alessandro Tassoni	0	0	0	0	0	0	1	0	0	0
68	Corso Regina Margherita	Via Sondrio	1	0	2	0	0	0	0	0	0	0
69	Corso Regina Margherita	Via Avellino	1	0	0	0	0	0	0	0	0	0
70	Corso Regina Margherita	Via Aquila	0	0	1	0	0	0	0	0	0	0
71	Corso Regina Margherita	Via Livorno	0	0	0	0	1	0	1	0	0	0
72	Corso Regina Margherita	Via Macercita	2	0	0	0	1	0	1	0	1	0
73	Corso Regina Margherita	Rondo dell Forca	0	0	0	0	0	0	0	0	0	0

Section	Street Name	Crossing Street	2012		2013		2014		2015		2016	
			INJ	FAT	INJ	FAT	INJ	FAT	INJ	FAT	INJ	FAT
74	Corso Regina Margherita	Piazza Della Repubblica	0	0	0	0	0	0	0	0	0	0
75	Corso Regina Margherita	Via Gioachino Rossini	0	0	0	0	0	0	0	0	0	0
76	Corso Regina Margherita	Via Montebello	0	0	0	0	0	0	0	0	0	0
77	Corso Regina Margherita	Via Guastalla	0	0	0	0	0	0	0	0	0	0
78	Corso Regina Margherita	Via Antonio Fontanessi	0	0	0	0	0	0	0	0	0	0
79	Corso Francia	Corso Marche	0	0	0	0	0	0	1	0	0	0
80	Corso Francia	Via Pozzo Strada	0	0	0	0	0	0	3	0	1	0
81	Corso Francia	Corso Monte Grappa	0	0	0	0	1	0	0	0	1	0
82	Corso Francia	Corso Svizzera	0	0	0	0	0	0	2	0	1	0
83	Corso Francia	Via Pietro Palmieri	0	0	0	0	0	0	0	0	0	0
84	Corso Belgio	Corso Cralo Luigi Farini	1	0	0	0	0	0	1	0	0	0
85	Corso Belgio	Corso Cadore	0	0	0	0	0	0	1	0	0	0
86	Via Bologna	Corso Novara	1	0	2	0	1	0	0	0	0	0
87	Via Bologna	Via Giovanni Pacini	2	0	1	0	1	0	0	0	2	0
88	Via Bologna	Via Niccoolo Paganini	0	0	0	0	0	0	1	0	0	0
89	Via Bologna	Via Domenico Cimarosa	1	0	1	0	0	0	4	0	0	0
90	Via Bologna	Via Gottardo	1	0	1	0	3	0	1	0	0	0
91	Corso Giulio Cesare	Corso Brescia	3	0	0	0	1	0	0	0	0	0
92	Corso Giulio Cesare	Corso Novara	3	0	0	0	2	0	5	0	1	0
93	Corso Giulio Cesare	Via Alessamdro Scarlatti	1	0	2	0	2	0	2	0	0	0
94	Corso Giulio Cesare	Via Luigi Salvatore Cherubini	0	0	1	0	0	0	1	0	0	0
95	Corso Giulio Cesare	Via Gottardo	0	0	0	0	0	0	0	0	0	0
96	Corso Giulio Cesare	Via Luigi Boccherini	0	0	1	0	1	0	0	0	1	0
97	Via Pio VII	Corso Traiano	3	0	1	0	2	0	1	0	3	0
98	Via Pio VII	Via Passo Buole	1	0	1	0	0	0	1	0	3	0
99	Corso Orbssano	Piazza Pitagora	0	0	0	0	0	0	0	0	0	0
100	Corso Orbssano	Corso San Mario	0	0	0	0	1	0	0	0	0	0
101	Corso Orbssano	Via Boston	0	0	1	0	1	0	0	0	0	0
102	Corso Orbssano	Via Gorizia	0	0	1	0	0	0	0	0	0	0
103	Corso Orbssano	Via baltimore	0	0	0	0	0	0	0	0	0	0
104	Corso Orbassano	Corso Sepastopoli	0	0	0	0	0	0	0	0	0	0
105	Corso Orbassano	Via Romolo Gessi	0	0	0	0	0	0	0	0	0	0

Appendix 4:

In this part, the V85 and V50 estimation of the road segments results will be presented.

Table 0-4 V85 and V50 of segments

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	I/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Via Guido Reni																												
1	1	50	3	9	2	3	4.6	0	0	0	0	0	1	0	0.0	1	19.2	1	1	19.2	0	0	48.3	54.5	60.7	58.8	66.1	73.5
	1	50	3	9.6	2	3	4.6	0	1.2	0	0	0	0	0	0.0	1	19.2	1	1	19.2	0	0	26.6	32.8	39.0	35.3	42.7	50.0
2	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	16.8	1	21.0	1	1	12.6	1	0	15.3	21.5	27.7	22.6	30.0	37.3
	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	12.6	1	21.0	1	1	12.6	1	0	19.2	25.4	31.6	26.6	33.9	41.2
3	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	14.5	1	10.9	1	1	7.3	1	0	28.0	34.2	40.4	35.4	42.8	50.1
	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	10.9	1	10.9	1	1	7.3	1	0	31.4	37.6	43.8	38.8	46.1	53.5
4	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	20.9	1	10.5	1	1	10.5	1	0	20.4	26.6	32.8	27.7	35.1	42.4
	1	50	3	9	2	3	7.5	0	0	0	0	0	0	0	0.0	1	10.5	1	1	10.5	1	0	34.7	40.9	47.1	42.1	49.4	56.7
5	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	9.4	1	9.4	1	1	9.4	1	0	32.5	38.7	44.9	39.9	47.2	54.5
	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	6.3	1	9.4	1	1	9.4	1	0	35.4	41.6	47.8	42.8	50.1	57.4
6	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	11.5	1	11.5	1	1	11.5	1	0	27.8	34.0	40.2	35.1	42.5	49.8
	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	5.7	1	11.5	1	1	11.5	1	0	33.1	39.3	45.5	40.5	47.8	55.1
7	1	50	3	9	2	3	7.5	0	0	0	0	0	0	0	0.0	1	25.2	1	1	12.6	1	0	22.7	28.9	35.1	30.1	37.5	44.8
	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	12.6	1	25.2	1	1	12.6	1	0	16.2	22.4	28.6	23.6	30.9	38.3
8	1	50	3	9	2	3	7.5	0	0	0	0	0	0	0	0.0	1	15.2	1	1	10.1	1	0	31.5	37.7	43.9	38.9	46.3	53.6
	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	5.1	1	15.2	1	1	10.1	1	0	32.0	38.2	44.4	39.4	46.7	54.1
9	1	50	3	9	2	3	7.5	0	0	0	0	0	0	1	5.3	1	10.6	1	1	10.6	1	0	34.8	41.0	47.2	42.2	49.5	56.8
	1	50	3	9	2	3	7.5	0	0	0	0	0	0	0	0.0	1	10.6	1	1	10.6	1	0	34.5	40.7	46.9	41.9	49.2	56.6

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Svizzera																												
10	1	50	1	3	1	3	0	0	0	0	0	0	0	1	18.5	1	9.3	1	1	3.1	1	0	58.0			66.2		
	1	50	1	3	1	3	0	0	0	0	0	0	0	1	12.3	1	9.3	1	1	9.3	1	0	59.8			68.0		
11	1	50	1	3	1	3	0	0	0	0	0	0	0	1	5.1	1	20.4	1	1	10.2	1	0	57.9			66.1		
	1	50	1	3	1	3	0	0	0	0	0	0	0	1	20.4	1	20.4	1	1	10.2	1	0	43.7			51.8		
12	1	50	1	3	1	3	0	0	0	0	0	0	0	1	21.4	1	12.2	1	1	9.2	1	0	49.3			57.5		
	1	50	1	3	1	3	0	0	0	0	0	0	0	1	12.2	1	12.2	1	1	9.2	1	0	57.9			66.0		
13	1	50	1	3	1	3	0	0	0	0	0	0	0	1	5.9	1	23.7	1	1	11.8	1	0	53.8			61.9		
	1	50	1	3	1	3	0	0	0	0	0	0	0	1	5.9	1	23.7	1	1	11.8	1	0	53.8			61.9		
14	1	50	1	7	1	3.5	0	0	0	0	0	0	0	1	6.8	1	10.2	1	1	6.8	1	0	59.7			67.9		
	1	50	1	8	1	4	0	0	0	0	0	0	0	1	6.8	1	10.2	1	1	6.8	0	0	47.7			57.1		
15	1	50	2	7.5	1	3.75	0	0	0	0	0	0	0	0	0.0	1	14.0	1	1	14.0	1	0	45.0	51.2		53.4	60.7	
	1	50	2	8	1	4	0	0	0	0	0	0	0	1	7.0	1	14.0	1	1	14.0	1	0	41.5	47.7		50.1	57.4	
16	1	50	2	8	1	4	0	0	0	0	0	0	0	0	0.0	1	27.4	1	1	27.4	0	0	17.0	23.2		26.4	33.7	
	1	50	2	11	1	5.5	0	0	0	0	0	0	0	0	0.0	1	27.4	1	1	27.4	0	0	3.9	10.1		14.5	21.8	
17	1	50	2	8	1	4	0	0	0	0	0	0	0	1	8.1	1	12.1	1	1	12.1	1	0	43.0	49.2		51.5	58.9	
	1	50	2	8	1	4	0	0	0	0	0	0	0	1	16.2	1	12.1	1	1	12.1	1	0	35.5	41.7		44.0	51.3	
18	1	50	2	8	1	4	0	0	0	0	0	0	0	1	4.8	1	7.2	1	1	4.8	1	0	54.3	60.5		62.8	70.2	
	1	50	2	8	1	4	0	0	0	0	0	0	0	1	12.0	1	7.2	1	1	4.8	1	0	47.6	53.8		56.1	63.5	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Racconigi																												
19	1	50	2	6	1	3	0	0	0	0	0	0	0	1	3.5	1	7.0	1	1	10.5	1	0	60.7	66.9		68.5	75.8	
	1	50	2	6	1	3	0	0	0	0	0	0	0	0	0.0	1	7.0	1	1	10.5	1	0	58.8	65.0		66.6	73.9	
20	1	50	1	4.5	1	4.5	0	0	0	0	0	0	0	1	4.0	1	9.3	1	1	9.3	1	0	55.4			64.8		
	1	50	1	4.5	1	4.5	0	0	0	0	0	0	0	1	8.0	1	9.3	1	1	9.3	1	0	51.6			61.1		
21	1	50	2	6	1	3	0	0	0	0	0	0	0	1	12.0	1	16.7	1	1	7.2	1	0	48.0	54.2		55.7	63.1	
	1	50	2	6	1	3	0	0	0	0	0	0	0	1	19.1	1	16.7	1	1	7.2	1	0	41.3	47.5		49.1	56.4	
22	1	50	1	3	1	3	0	0	0	0	0	0	0	1	4.5	1	13.5	1	1	9.0	1	0	64.3			72.4		
	1	50	1	3	1	3	0	0	0	0	0	0	0	1	9.0	1	13.5	1	1	9.0	1	0	60.1			68.3		
23	1	50	1	3	1	3	0	0	0	0	0	0	0	1	10.2	1	12.2	1	1	6.1	1	0	61.8			69.9		
	1	50	1	3	1	3	0	0	0	0	0	0	0	1	10.2	1	12.2	1	1	6.1	1	0	61.8			69.9		
24	1	50	1	3	1	3	0	0	0	0	0	0	0	1	5.4	1	13.5	1	1	10.8	1	0	62.3			70.4		
	1	50	1	3	1	3	0	0	0	0	0	0	0	1	5.4	1	13.5	1	1	10.8	1	0	62.3			70.4		
25	1	50	1	3	1	3	0	0	0	0	0	0	0	1	17.9	1	8.9	1	1	8.9	1	0	55.2			63.3		
	1	50	1	3	1	3	0	0	0	0	0	0	0	1	13.4	1	8.9	1	1	8.9	1	0	59.3			67.4		

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Via Reiss Remoli																												
26	1	50	2	6.2	2	3.1	0	0	0	0	0	0	0	1	16.3	1	8.2	1	1	8.2	1	0	90.0	96.2		97.8	105.	
	1	50	2	6.2	2	3.1	0	0	0	0	0	0	0	1	16.3	1	8.2	1	1	8.2	1	0	90.0	96.2		97.8	105.	
27	1	50	2	6.4	2	3.2	0	0	0	0	0	0.00	0	1	13.2	1	8.8	1	1	8.8	1	0	85.2	91.4		93.1	100.	
	1	50	2	6.8	2	3.4	0	0	0	0	0	0.00	0	1	13.2	1	8.8	1	1	8.8	1	0	83.5	89.7		91.6	98.9	
28	1	50	2	6.4	2	3.2	0	0	0	0	0	0	0	1	19.9	1	10.0	1	1	5.0	1	0	86.5	92.7		94.5	101.	
	1	50	2	6.5	2	3.25	0	0	0	0	0	0	0	1	12.4	1	10.0	1	1	5.0	1	0	93.1	99.3		101.	108.	
29	1	50	2	6.2	2	3.1	0	0	0	0	0	0	0	0	0.0	1	12.7	1	1	12.7	1	0	93.8	100.		101.	108.	
	1	50	2	6.2	2	3.1	0	0	0	0	0	0	0	0	0.0	1	12.7	1	1	12.7	1	0	93.8	100.		101.	108.	
30	1	50	2	6	2	3	0	0	0	0	0	0.00	0	1	36.3	1	11.3	1	1	4.5	1	0	71.7	77.9		79.5	86.8	
	1	50	2	6	2	3	0	0	0	0	0	0.00	0	1	24.9	1	11.3	1	1	4.5	1	0	82.3	88.5		90.0	97.4	
31	1	50	2	6	2	3	0	0	0	0	0	0	0	1	4.9	1	9.8	1	1	9.8	1	0	99.2	105.		107.	114.	
	1	50	2	6	2	3	0	0	0	0	0	0	0	1	39.2	1	9.8	1	1	9.8	1	0	67.3	73.5		75.1	82.4	
32	1	50	2	6.4	2	3.2	0	0	0	0	0	0	0	0	0.0	1	15.5	1	1	15.5	1	0	89.2	95.4		97.1	104.	
	1	50	2	6	2	3	0	0	0	0	0	0	0	1	15.5	1	15.5	1	1	15.5	1	0	81.7	87.9		89.5	96.8	
33	1	50	2	6.4	2	3.2	0	0	0	0	0	0	0	1	5.5	1	27.5	1	1	11.0	1	0	83.5	89.7		91.4	98.7	
	1	50	2	6	2	3	0	0	0	0	0	0	0	1	27.5	1	27.5	1	1	11.0	1	0	64.8	71.0		72.5	79.9	
34	1	50	2	6	2	3	0	0	0	0	0	0	0	1	5.2	1	13.0	1	1	5.2	1	0	99.6	105.		107.	114.	
	1	50	2	6	2	3	0	0	0	0	0	0	0	1	18.2	1	13.0	1	1	5.2	1	0	87.6	93.8		95.3	102.	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Sebastopoli																												
35	1	50	2	6.4	1	3.2	0	0	0	0	0	0	0	1	9.5	1	9.5	1	1	9.5	1	0	52.3	58.5		60.2	67.5	
	1	50	2	6.6	1	3.3	0	0	0	0	0	0	0	1	9.5	1	9.5	1	1	9.5	1	0	51.4	57.6		59.4	66.8	
36	1	50	2	6.4	1	3.2	0	0	0	0	0	0	0	1	19.0	1	14.3	1	1	9.5	1	0	39.9	46.1		47.8	55.2	
	1	50	2	6.6	1	3.3	0	0	0	0	0	0	0	1	14.3	1	14.3	1	1	9.5	1	0	43.5	49.7		51.5	58.8	
37	1	50	2	8	1	4	0	0	0	0	0	0	0	1	12.8	1	14.6	1	1	7.3	1	0	40.0	46.2		48.6	55.9	
	1	50	2	8	1	4	0	0	0	0	0	0	0	1	10.9	1	14.6	1	1	7.3	1	0	41.7	47.9		50.3	57.6	
38	1	50	2	8	1	4	0	0	0	0	0	0	0	1	15.1	1	15.1	1	1	9.1	1	0	36.3	42.5		44.9	52.2	
	1	50	2	8	1	4	0	0	0	0	0	0	0	1	6.0	1	15.1	1	1	9.1	1	0	44.8	51.0		53.3	60.6	
39	1	50	1	4.5	1	4.5	0	0	0	1	1.2	0	0	1	9.8	1	19.6	1	1	19.6	1	0	21.3			30.7		
	1	50	1	3.5	1	3.5	0	0	0	1	1.2	0	0	0	0.0	1	19.6	1	1	19.6	1	0	33.3			41.9		
40	1	50	1	4.5	1	4.5	0	0	0	1	1.2	0	0	1	6.0	1	24.0	1	1	6.0	1	0	30.4			39.9		
	1	50	1	3.5	1	3.5	0	0	0	1	1.2	0	0	1	6.0	1	24.0	1	1	6.0	1	0	38.5			47.1		

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Moncalieri																												
41	1	50	1	2.75	2	2.75	0	0	0	0	0	0		1	9.6	1	8.5	1	1	7.5	1	0	107.			115.		
	1	50	1	2.75	2	2.75	0	0	0	0	0	0		1	9.6	1	8.5	1	1	7.5	1	0	107.			115.		
42	1	50	1	3.6	2	3.6	1.3	0	0	0	0	0	0	1	17.3	1	6.4	1	1	5.4	0	0	79.2			88.7		
	1	50	1	3.6	2	3.6	1.3	0	0	0	0	0	0	1	15.4	1	6.4	1	1	5.4	0	0	80.8			90.4		
43	1	50	1	3.6	2	3.6	1.3	0	0	0	0	0	0	1	1.0	1	13.2	1	1	9.9	1	0	94.2			102.		
	1	50	1	3.6	2	3.6	1.3	0	0	0	0	0	0	1	19.7	1	13.2	1	1	9.9	1	0	76.8			85.4		
44	1	50	1	3.6	2	3.6	1.3	0	0	0	0	0	0	1	19.3	1	14.5	1	1	9.7	1	0	76.3			85.0		
	1	50	1	3.6	2	3.6	1.3	0	0	0	0	0	0	1	24.2	1	14.5	1	1	9.7	1	0	71.8			80.5		
45	1	50	2	14.5	2	3.3	0	0	0	0	0	0	0	1	26.3	1	52.6	1	1	52.6	1	0	13.9	20.1		20.9	28.2	
	1	50	2	14.5	2	3.3	0	0	0	0	0	0	0	0	0.0	1	52.6	1	1	52.6	1	0	33.2	39.4		40.2	47.5	
46	1	50	1	3.6	2	3.6	1.3	0	0	0	0	0	0	0	0.0	1	26.7	1	1	26.7	1	0	69.5			78.1		
	1	50	1	3.6	2	3.6	1.3	0	0	0	0	0	0	0	0.0	1	26.7	1	1	26.7	1	0	69.5			78.1		
47	1	50	1	6	2	6	1.3	0	0	0	0	0	0	1	25.0	1	16.7	1	1	8.3	0	0	43.2			54.9		
	1	50	1	6	2	6	1.3	0	0	0	0	0	0	1	20.8	1	16.7	1	1	8.3	1	0	54.7			65.6		
48	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	0	0.0	1	15.6	1	1	15.6	0	0	73.2	79.4		81.4	88.7	
	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	0	0.0	1	15.6	1	1	15.6	0	0	73.2	79.4		81.4	88.7	
49	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	1	18.4	1	4.6	1	1	3.1	0	0	77.2	83.4		85.4	92.7	
	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	0	0.0	1	4.6	1	1	3.1	0	0	89.2	95.4		97.4	104.	
50	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	1	20.7	1	8.3	1	1	8.3	0	0	69.2	75.4		77.4	84.7	
	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	0	0.0	1	8.3	1	1	8.3	0	0	83.2	89.4		91.4	98.7	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Moncalieri																												
51	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	1	13.2	1	15.8	1	1	13.2	0	0	67.6	73.8		75.8	83.1	
	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	1	7.9	1	15.8	1	1	13.2	0	0	72.5	78.7		80.7	88.0	
52	1	50	1	10.9	2	3.65	0	0	0	0	0	0	0	1	7.0	1	13.9	1	1	7.0	1	0	94.8			102.		
	1	50	2	10.9	2	3.65	0	0	0	0	0	0	0	1	10.5	1	13.9	1	1	7.0	0	0	77.5	83.7		86.2	93.5	
53	1	50	1	10.9	2	3.65	0	0	0	0	0	0	0	1	11.9	1	15.8	1	1	11.9	1	0	85.8			93.6		
	1	50	2	10.9	2	3.65	0	0	0	0	0	0	0	1	4.0	1	15.8	1	1	11.9	0	0	79.1	85.3		87.7	95.1	
54	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	1	6.4	1	6.4	1	1	4.2	0	0	86.4	92.6		94.6	101.	
	1	50	2	14.6	2	3.65	0	0	0	0	0	0	0	1	2.1	1	6.4	1	1	4.2	0	0	90.3	96.5		98.5	105.	

Corso Casale

V853		88.4		104.		73.4		100.													
V852	98.5	81.1	114.	97.0	83.5	66.1	110.	92.7	106.	82.8					87.5	97.1						
V851	91.1	73.8	107.	89.6	76.1	58.8	102.	85.4	98.8	75.5	96.9	86.4	92.3	92.3	80.2	89.7	76.0	94.4	105.	87.1	91.5	80.2
V503		77.9		93.8		62.9		89.5														
V502	88.7	71.7	104.	87.6	73.7	56.7	100.	83.3	98.0	74.6					78.5	88.1						
V501	82.5	65.5	98.4	81.4	67.5	50.5	94.1	77.1	91.8	68.4	88.3	77.9	83.0	83.0	72.3	81.9	66.7	85.1	97.2	77.6	79.8	70.8
TCD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PKL	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0
PedD[No./km]	6.6	6.6	6.3	6.3	29.0	29.0	7.4	7.4	12.3	12.3	8.4	8.4	7.4	7.4	11.9	11.9	7.9	7.9	9.3	9.3	6.4	6.4
Ped	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S	0	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ID	9.9	9.9	6.3	6.3	29.0	29.0	11.2	11.2	12.3	12.3	11.2	11.2	9.8	9.8	15.8	15.8	11.9	11.9	7.4	7.4	16.0	16.0
I	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DD[No./km]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.7	14.0	25.3	12.3	12.3	15.8	0.0	27.8	7.9	7.4	20.4	25.6	22.4
D	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1
PUB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
1/R	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RSW[m]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MW[m]	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LW[m]	3	3	3	3	3	3	3	3	3	3	4	4	5	5	3	3	5	5	3	4	4	4
NT	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
TWW[m]	6	9	6	9	6	9	6	9	12	12	8	8	10	10	12	12	10	10	7	7	8	8
NL	2	3	2	3	2	3	2	3	2	2	1	1	1	1	2	2	1	1	1	1	1	1
PSL[km/h]	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
LP	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Section	55		56		57		58		59		60		61		62		63		64		65	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Traiano																												
66	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	13.0	1	1	13.0	1	0	8.5	14.7		18.8	26.1	
	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	13.0	1	1	13.0	1	0	8.5	14.7		18.8	26.1	
67	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	11.9	1	1	7.2	1	0	13.0	19.2		23.3	30.6	
	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	11.9	0	1	7.2	1	0	21.8	28.0		32.1	39.4	
68	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	19.2	0	1	7.7	1	0	16.2	22.4		26.5	33.8	
	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	19.2	0	1	7.7	1	0	16.2	22.4		26.5	33.8	
69	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	15.0	0	1	6.0	1	0	20.4	26.6		30.7	38.0	
	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	15.0	0	1	6.0	1	0	20.4	26.6		30.7	38.0	
70	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	19.8	0	1	9.9	1	0	14.4	20.6		24.7	32.0	
	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	19.8	0	1	9.9	1	0	14.4	20.6		24.7	32.0	
71	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	18.0	0	1	12.0	1	0	14.4	20.6		24.7	32.0	
	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	18.0	0	1	12.0	1	0	14.4	20.6		24.7	32.0	
72	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	10.3	0	1	10.3	1	0	21.0	27.2		31.3	38.6	
	1	50	2	6.6	2	3.3	13	0	0	0	0	0	1	0	0.0	1	10.3	0	1	10.3	1	0	21.0	27.2		31.3	38.6	

V853	**Via Filadelfia**														
V852															
V851		97.6	95.4	102.	104.	94.1	92.8	89.7	99.2	115.	110.	82.4	94.0	90.1	82.4
V503															
V502															
V501		88.7	86.6	94.2	95.8	85.6	84.2	81.0	90.5	107.	102.	73.9	85.5	81.7	73.9
TCD		0	0	0	0	0	0	0	0	1	1	0	0	0	0
PKL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
PedD[No./km]		9.4	9.4	6.7	6.7	10.6	10.6	10.2	10.2	3.8	3.8	8.3	8.3	8.3	8.3
Ped		1	1	1	1	1	1	1	1	1	1	1	1	1	1
S		1	1	1	1	1	1	1	1	1	1	1	1	1	1
ID		14.1	14.1	8.4	8.4	17.6	17.6	13.6	13.6	7.6	7.6	29.2	29.2	29.2	29.2
I		1	1	1	1	1	1	1	1	1	1	1	1	1	1
DD[No./km]		7.0	9.4	10.1	8.4	10.6	17.6	17.0	6.8	7.6	13.3	16.7	4.2	8.3	16.7
D		1	1	1	1	1	2	1	1	1	1	1	1	1	1
PUB		0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/R		0	0	0	0	0	0	0	0	0	0	0	0	0	0
LSW		0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS		0	0	0	0	0	0	0	0	0	0	0	0	0	0
RSW[m]		0	0	0	0	0	0	0	0	0	0	0	0	0	0
RS		0	0	0	0	0	0	0	0	0	0	0	0	0	0
MW[m]		0	0	0	0	0	0	0	0	0	0	0	0	0	0
LW[m]		4.4	4.4	4.1	4.1	4	4	4.2	4.2	3.8	3.8	3.9	3.9	3.9	3.9
NT		2	2	2	2	2	2	2	2	2	2	2	2	2	2
TWW[m]		8.8	8.8	8.2	8.2	8	8	8.4	8.4	7.6	7.6	7.8	7.8	7.8	7.8
NL		1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSL[km/h]		50	50	50	50	50	50	50	50	50	50	50	50	50	50
LP		1	1	1	1	1	1	1	1	1	1	1	1	1	1
Section		73		74		75		76		77		78		79	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Massimo d'Azeglio																												
80	1	50	3	9	2	3	2	0	0	0	0	0	0	0	0.0	1	12.2	0	1	8.1	0	0	76.4	82.6	88.8	84.6	91.9	99.3
	1	50	3	9	2	3	2	0	0	0	0	0	0	0	0.0	1	12.2	0	1	8.1	0	0	76.4	82.6	88.8	84.6	91.9	99.3
81	1	50	3	9	2	3	1.6	0	0	0	0	0	0	0	0.0	1	14.9	0	1	7.4	0	0	77.8	84.0	90.2	86.1	93.4	100.
	1	50	3	9	2	3	1.6	0	0	0	0	0	0	0	0.0	1	14.9	0	1	7.4	1	0	85.5	91.7	97.9	92.9	100.	107.
82	1	50	2	8	2	4	5	0	0	0	0	0	0	0	0.0	1	14.3	0	1	9.5	0	0	51.5	57.7		60.9	68.2	
	1	50	2	6.6	2	3.3	5	0	0	0	0	0	0	1	9.5	1	14.3	1	1	9.5	1	0	52.7	58.9		60.7	68.0	
83	1	50	2	7.8	2	3.9	5	0	0	0	0	0	0	0	0.0	1	15.5	0	1	9.3	1	0	59.2	65.4		67.7	75.0	
	1	50	2	6.6	2	3.3	5	0	0	0	0	0	0	1	12.4	1	15.5	1	1	9.3	1	0	49.2	55.4		57.2	64.6	
84	1	50	2	7.4	2	3.7	5	0	0	0	0	0	0	0	0.0	1	16.8	0	1	8.4	1	0	60.6	66.8		68.9	76.3	
	1	50	2	8	2	4	5	0	0	0	0	0	0	1	12.6	1	16.8	1	1	8.4	1	0	42.6	48.8		51.2	58.5	
85	1	50	2	7	2	3.5	4.6	0	0	0	0	0	0	0	0.0	1	13.9	0	1	5.6	1	0	69.2	75.4		77.4	84.7	
	1	50	2	8	2	4	4.6	0	0	0	0	0	0	1	16.7	1	13.9	1	1	5.6	1	0	45.7	51.9		54.2	61.6	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Regina Margherita																												
86	1	50	2	6.4	2	3.2	1.9	0	0	0	0	0	1	0	0.0	1	20.0	0	1	20.0	0	0	82.3	88.5		93.3	100.	
	1	50	3	9.3	2	3.1	1.9	0	0	0	0	0	0	0	0.0	1	20.0	0	1	20.0	0	0	63.0	69.2	75.4	71.3	78.6	85.9
87	1	50	2	6.4	2	3.2	1.9	0	0	0	0	0	1	0	0.0	1	20.0	0	1	20.0	0	0	82.3	88.5		93.3	100.	
	1	50	3	9.3	2	3.1	1.9	0	0	0	0	0	0	0	0.0	1	20.0	0	1	20.0	0	0	63.0	69.2	75.4	71.3	78.6	85.9
88	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	7.1	0	1	7.1	0	0	103.	110.		111.	118.	
	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	7.1	0	1	7.1	0	0	103.	110.		111.	118.	
89	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	8.8	0	1	8.8	0	0	101.	107.		109.	116.	
	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	8.8	0	1	8.8	0	0	101.	107.		109.	116.	
90	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	8.7	0	1	8.7	0	0	101.	108.		109.	116.	
	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	8.7	0	1	8.7	0	0	101.	108.		109.	116.	
91	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	11.6	0	1	11.6	0	0	97.8	104.		105.	112.	
	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	11.6	0	1	11.6	0	0	97.8	104.		105.	112.	
92	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	9.7	0	1	9.7	0	0	100.	106.		108.	115.	
	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	9.7	0	1	9.7	0	0	100.	106.		108.	115.	
93	1	50	2	9.6	2	2.4	0	0	0	0	0	0	1	0	0.0	1	4.8	0	1	3.2	0	0	122.	128.		131.	139.	
	1	50	2	9.6	2	2.4	0	0	0	0	0	0	1	0	0.0	1	4.8	0	1	3.2	0	0	122.	128.		131.	139.	
94	1	50	2	9.6	2	2.4	0	0	0	0	0	0	1	0	0.0	1	7.1	0	1	7.1	0	0	117.	124.		127.	135.	
	1	50	2	9.6	2	2.4	0	0	0	0	0	0	1	0	0.0	1	7.1	0	1	7.1	0	0	117.	124.		127.	135.	
95	1	50	1	3.4	2	3.4	1.2	1	0.2	0	0	0	0	0	0.0	1	2.3	1	1	2.3	0	0	92.6			102.		
	1	50	1	3.4	2	3.4	1.2	1	0.2	0	0	0	0	0	0.0	1	2.3	1	1	2.3	0	0	92.6			102.		

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Regina Margherita																												
96	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	7.8	0	1	7.8	0	0	99.3	105.		107.	114.	
	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	7.8	0	1	7.8	0	0	99.3	105.		107.	114.	
97	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	18.3	0	1	18.3	0	0	84.9	91.1		92.6	100.	
	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	18.3	0	1	18.3	0	0	84.9	91.1		92.6	100.	
98	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	12.8	0	1	12.8	0	0	92.4	98.6		100.	107.	
	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	12.8	0	1	12.8	0	0	92.4	98.6		100.	107.	
99	1	50	2	9.6	2	2.4	0	1	0.2	0	0	0	0	0	0.0	1	6.5	0	1	6.5	0	0	102.	108.		109.	117.	
	1	50	2	9.6	2	2.4	0	1	0.2	0	0	0	0	0	0.0	1	6.5	0	1	6.5	0	0	102.	108.		109.	117.	
100	1	50	2	9.6	2	2.4	0	1	0.2	0	0	0	0	0	0.0	1	7.9	0	1	7.9	0	0	100.	106.		107.	115.	
	1	50	2	9.6	2	2.4	0	1	0.2	0	0	0	0	0	0.0	1	7.9	0	1	7.9	0	0	100.	106.		107.	115.	
101	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	10.3	0	1	10.3	0	0	95.9	102.		103.	111.	
	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	10.3	0	1	10.3	0	0	95.9	102.		103.	111.	
102	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	10.3	0	1	10.3	0	0	95.9	102.		103.	110.	
	1	50	2	10	2	2.5	0	1	0.2	0	0	0	0	0	0.0	1	10.3	0	1	10.3	0	0	95.9	102.		103.	110.	
103	1	50	3	9	2	3	11	0	0	0	0	0	0	0	0.0	1	9.6	1	1	9.6	0	0	2.6	8.8	15.0	10.8	18.1	25.5
	1	50	3	9	2	3	11	0	0	0	0	0	0	0	0.0	1	9.6	1	1	9.6	0	0	2.6	8.8	15.0	10.8	18.1	25.5

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Francia																												
104	1	50	3	9	2	3	2.5	0	0	0	0	0	0	0	0.0	1	20.4	0	1	20.4	0	0	58.9	65.1	71.3	67.2	74.5	81.8
	1	50	3	9	2	3	2.5	0	0	0	0	0	0	0	0.0	1	20.4	0	1	20.4	1	0	66.6	72.8	79.0	74.0	81.3	88.6
105	1	50	3	9.6	2	3.2	2.5	0	0	0	0	0	0	0	0.0	1	20.0	0	1	20.0	0	0	57.6	63.8	70.0	66.0	73.3	80.7
	1	50	3	9	2	3	2.5	0	0	0	0	0	0	0	0.0	1	20.0	0	1	20.0	0	0	59.5	65.7	71.9	67.7	75.1	82.4
106	1	50	3	9.6	2	3.2	2.5	0	0	0	0	0	0	0	0.0	1	9.5	0	1	4.8	0	0	75.0	81.2	87.4	83.3	90.7	98.0
	1	50	3	9.6	2	3.2	2.5	0	0	0	0	0	0	0	0.0	1	9.5	0	1	4.8	0	0	75.0	81.2	87.4	83.3	90.7	98.0
107	1	50	3	10.2	2	3.4	2.5	0	0	0	0	0	0	0	0.0	1	7.5	0	1	5.0	0	0	74.4	80.6	86.8	82.9	90.2	97.5
	1	50	3	9	2	3	2.5	0	0	0	0	0	0	0	0.0	1	7.5	0	1	5.0	0	0	78.1	84.3	90.5	86.3	93.6	101.
108	1	50	2	6	2	3	4	0	0	0	0	0	0	0	0.0	1	8.3	0	1	8.3	1	0	80.3	86.5		88.0	95.4	
	1	50	2	6	2	3	4	0	0	0	0	0	0	0	0.0	1	8.3	0	1	8.3	1	0	80.3	86.5		88.0	95.4	
109	1	50	2	6	2	3	3.5	0	0	0	0	0	0	0	0.0	1	5.3	0	1	8.0	0	0	78.6	84.8		87.2	94.5	
	1	50	2	6	2	3	3.5	0	0	0	0	0	0	0	0.0	1	5.3	0	1	8.0	0	0	78.6	84.8		87.2	94.5	
110	1	50	2	6	2	3	4.6	0	0	0	0	0	0	0	0.0	1	5.7	0	1	5.7	0	0	71.8	78.0		80.4	87.7	
	1	50	2	6	2	3	4.6	0	0	0	0	0	0	0	0.0	1	5.7	0	1	5.7	0	0	71.8	78.0		80.4	87.7	
111	1	50	2	6.8	2	3.4	4.8	0	0	0	0	0	0	0	0.0	1	5.0	0	1	5.0	0	0	67.8	74.0		76.7	84.1	
	1	50	2	5.5	2	2.75	4.8	0	0	0	0	0	0	0	0.0	1	5.0	0	1	5.0	0	0	73.5	79.7		81.9	89.2	
112	1	50	2	6.4	2	3.2	4.5	0	0	0	0	0	0	0	0.0	1	4.8	0	1	4.8	0	0	71.9	78.1		80.7	88.0	
	1	50	2	6.7	2	3.35	4.5	0	0	0	0	0	0	0	0.0	1	4.8	0	1	4.8	0	0	70.6	76.8		79.5	86.8	
113	1	50	2	6	2	3	4.7	0	0	0	0	0	0	0	0.0	1	4.9	0	1	4.9	0	0	72.1	78.3		80.7	88.0	
	1	50	2	6.6	2	3.3	4.7	0	0	0	0	0	0	0	0.0	1	4.9	0	1	4.9	0	0	69.4	75.6		78.3	85.6	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Francia																												
114	1	50	2	6.4	2	3.2	4.5	0	0	0	0	0	0	0	0.0	1	5.1	0	1	5.1	0	0	71.5	77.7		80.3	87.6	
	1	50	2	6	2	3	4.5	0	0	0	0	0	0	0	0.0	1	5.1	0	1	5.1	0	0	73.2	79.4		81.8	89.2	
115	1	50	2	6.2	2	3.1	4.5	0	0	0	0	0	0	0	0.0	1	7.7	0	1	7.7	0	0	68.9	75.1		77.6	84.9	
	1	50	2	6.2	2	3.1	4.5	0	0	0	0	0	0	0	0.0	1	7.7	0	1	7.7	0	0	68.9	75.1		77.6	84.9	
116	1	50	2	6.2	2	3.1	4.5	0	0	0	0	0	0	0	0.0	1	7.3	0	1	7.3	0	0	69.4	75.6		78.1	85.4	
	1	50	2	6.2	2	3.1	4.5	0	0	0	0	0	0	0	0.0	1	7.3	0	1	7.3	0	0	69.4	75.6		78.1	85.4	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Belgio																												
117	1	50	2	5	2	2.5	1.5	0	0	0	0	0	0	1	8.5	1	8.5	0	1	8.5	1	0	99.9	106.		107.	114.	
	1	50	2	5.4	2	2.7	1.5	0	0	0	0	0	1	0	0.0	1	8.5	1	1	8.5	0	0	96.3	102.		107.	114.	
118	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	25.4	1	16.9	1	1	8.5	1	0	83.1			94.0		
	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	21.2	1	16.9	1	1	8.5	1	0	87.1			97.9		
119	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	26.4	1	15.1	1	1	7.5	1	0	84.1			95.0		
	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	15.1	1	15.1	1	1	7.5	1	0	94.7			105.		
120	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	8.2	1	13.7	1	1	8.2	1	0	101.			112.		
	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	21.9	1	13.7	1	1	8.2	1	0	89.0			99.9		
121	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	49.8	1	11.5	1	1	7.7	1	0	64.9			75.8		
	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	11.5	1	11.5	1	1	7.7	1	0	100.			111.		
122	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	31.8	1	12.7	1	1	12.7	1	0	77.5			88.3		
	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	25.5	1	12.7	1	1	12.7	1	0	83.4			94.3		
123	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	5.3	1	15.9	1	1	10.6	1	0	101.			112.		
	1	50	1	3.5	2	3.5	1.2	0	0	0	0	0	1	1	15.9	1	15.9	1	1	10.6	1	0	91.4			102.		

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Via Bologna																												
124	1	50	1	7	2	3.5	0	0	0	0	0	0	1	1	9.4	1	12.5	1	1	6.3	0	0	101.			113.		
	1	50	1	7	2	3.5	0	0	0	0	0	0	1	1	18.8	1	12.5	1	1	6.3	1	0	100.			111.		
125	1	50	1	7	2	3.5	0	0	0	0	0	0	1	1	12.0	1	12.0	1	1	6.0	0	0	99.9			111.		
	1	50	1	7	2	3.5	0	0	0	0	0	0	1	1	6.0	1	12.0	1	1	6.0	1	0	113.			123.		
126	1	50	1	7	2	3.5	0	0	0	0	0	0	1	1	9.5	1	12.6	1	1	6.3	1	0	109.			119.		
	1	50	1	7	2	3.5	0	0	0	0	0	0	1	1	6.3	1	12.6	1	1	6.3	0	0	104.			115.		
127	1	50	1	7	2	3.5	0	0	0	0	0	0	1	1	2.2	1	8.8	1	1	6.6	0	0	110.			122.		
	1	50	1	7	2	3.5	0	0	0	0	0	0	1	1	13.2	1	8.8	1	1	6.6	1	0	108.			118.		
128	1	50	2	5.6	2	2.8	1.5	0	0	0	0	0	1	1	11.0	1	18.4	1	1	11.0	0	0	81.6	87.8		92.4	99.7	
	1	50	2	5.6	2	2.8	1.5	0	0	0	0	0	1	1	11.0	1	18.4	1	1	11.0	0	0	81.6	87.8		92.4	99.7	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Giulio Cesare																												
129	1	50	2	6.2	1	3.1	0	0	0	0	0	0	0	1	16.2	1	10.8	1	1	10.8	1	0	45.1	51.3		52.9	60.3	
	1	50	2	6.2	1	3.1	0	0	0	0	0	0	0	0	0.0	1	10.8	1	1	10.8	1	0	55.0	61.2		62.8	70.2	
130	1	50	1	4	2	4	0	0	0	0	0	0	1	1	4.7	1	9.3	1	1	9.3	1	0	112.			123.		
	1	50	1	4	2	4	0	0	0	0	0	0	1	1	9.3	1	14.0	1	1	9.3	1	0	104.			115.		
131	1	50	1	4	2	4	0	0	0	0	0	0	1	0	0.0	1	13.4	1	1	10.7	1	0	107.			118.		
	1	50	1	4	2	4	0	0	0	0	0	0	1	1	18.7	1	13.4	1	1	10.7	1	0	95.3			106.		
132	1	50	1	4	2	4	0	0	0	0	0	0	1	1	14.3	1	11.9	1	1	14.3	1	0	98.1			109.		
	1	50	1	4	2	4	0	0	0	0	0	0	1	1	7.2	1	11.9	1	1	14.3	1	0	104.			116.		
133	1	50	1	4.5	2	4.5	0	0	0	0	0	0	1	0	0.0	1	17.1	1	1	11.4	1	0	100.			112.		
	1	50	2	5.8	2	2.9	0	0	0	0	0	0	1	0	0.0	1	17.1	1	1	11.4	1	0	105.	111.		115.	122.	
134	1	50	1	4	2	4	0	0	0	0	0	0	1	1	26.3	1	8.8	1	1	8.8	1	0	92.7			104.		
	1	50	1	4	2	4	0	0	0	0	0	0	1	1	39.5	1	8.8	1	1	8.8	1	0	80.5			91.8		
135	1	50	1	4.5	2	4.5	0	0	0	0	0	0	1	1	42.1	1	13.2	1	1	13.2	1	0	68.0			79.8		
	1	50	1	4.5	2	4.5	0	0	0	0	0	0	1	1	23.7	1	10.5	1	1	13.2	1	0	87.1			98.8		
136	1	50	2	5	2	2.5	0	0	0	0	0	0	1	1	46.4	1	13.2	1	1	39.7	0	0	47.7	53.9		58.2	65.6	
	1	50	1	4.5	2	4.5	0	0	0	0	0	0	1	1	46.4	1	13.2	1	1	39.7	1	0	47.0			58.8		
137	1	50	2	5.1	2	2.55	0	0	0	0	0	0	1	1	4.9	1	9.7	1	1	9.7	1	0	115.	121.		125.	132.	
	1	50	2	5.1	2	2.55	0	0	0	0	0	0	1	1	4.9	1	9.7	1	1	9.7	0	0	107.	113.		118.	125.	

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	1/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Via Pio VII																												
138	1	50	3	17.4	2	2.9	0	0	0	0	0	0	0	1	24.7	1	12.3	1	1	8.2	1	0	67.7	73.9	80.1	74.0	81.3	88.6
	1	50	3	17.4	2	2.9	0	0	0	0	0	0	0	1	24.7	1	12.3	1	1	8.2	1	0	67.7	73.9	80.1	74.0	81.3	88.6
139	1	50	3	17.4	2	2.9	0	0	0	0	0	0	0	1	11.3	1	11.3	1	1	7.5	1	0	81.4	87.6	93.8	87.6	94.9	102.
	1	50	3	17.4	2	2.9	0	0	0	0	0	0	0	1	7.5	1	11.3	1	1	7.5	1	0	84.9	91.1	97.3	91.1	98.4	105.
140	1	50	3	17.7	2	2.9	0	0	0	0	0	0	0	1	22.4	1	8.4	1	1	11.2	1	0	70.6	76.8	83.0	76.8	84.2	91.5
	1	50	3	17.7	2	3	0	0	0	0	0	0	0	1	14.0	1	8.4	1	1	11.2	1	0	77.7	83.9	90.1	84.0	91.3	98.7
141	1	50	3	17.7	2	2.9	0	0	0	0	0	0	0	1	6.1	1	9.1	1	1	6.1	1	0	88.6	94.8	101.	94.8	102.	109.
	1	50	3	17.7	2	3	0	0	0	0	0	0	0	1	6.1	1	9.1	1	1	6.1	1	0	87.9	94.1	100.	94.2	101.	108.

Section	LP	PSL[km/h]	NL	TWW[m]	NT	LW[m]	MW[m]	RS	RSW[m]	LS	LSW	I/R	PUB	D	DD[No./km]	I	ID	S	Ped	PedD[No./km]	PKL	TCD	V501	V502	V503	V851	V852	V853
Corso Orbssano																												
142	1	50	2	14	2	3.5	0	0	0	0	0	0	0	1	8.7	1	17.4	1	1	17.4	1	0	77.0	83.2		84.3	91.6	
	1	50	2	14	2	3.5	0	0	0	0	0	0	0	0	0.0	1	17.4	1	1	17.4	1	0	79.9	86.1		87.2	94.5	
143	1	50	2	14	2	3.5	0	0	0	0	0	0	0	1	6.5	1	19.6	1	1	13.1	1	0	80.2	86.4		87.4	94.8	
	1	50	2	14	2	3.5	0	0	0	0	0	0	0	1	6.5	1	19.6	1	1	13.1	1	0	80.2	86.4		87.4	94.8	
144	1	50	2	14.5	2	3.75	0	0	0	0	0	0	0	1	3.9	1	11.8	1	1	11.8	1	0	86.9	93.1		94.4	101.	
	1	50	2	14.5	2	3.5	0	0	0	0	0	0	0	1	7.8	1	11.8	1	1	11.8	1	0	85.2	91.4		92.4	99.7	
145	1	50	2	14	2	3.5	0	0	0	0	0	0	0	1	17.4	1	13.0	1	1	8.7	1	0	77.6	83.8		84.9	92.2	
	1	50	2	14	2	3.5	0	0	0	0	0	0	0	1	4.3	1	13.0	1	1	8.7	1	0	89.7	95.9		97.0	104.	
146	1	50	2	14	2	3.5	0	0	0	0	0	0	0	1	11.3	1	11.3	1	1	11.3	1	0	82.9	89.1		90.1	97.5	
	1	50	2	14	2	3.5	0	0	0	0	0	0	0	1	16.9	1	11.3	1	1	11.3	1	0	77.6	83.8		84.9	92.2	
147	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	1	4.5	1	13.6	1	1	9.0	1	0	97.8	104.		104.	112.	
	1	50	2	10.4	2	2.6	0	0	0	0	0	0	0	0	0.0	1	13.6	1	1	9.0	1	0	96.9	103.		103.	111.	
148	1	50	1	8.5	2	3.5	0	0	0	0	0	0	0	1	10.0	1	10.0	1	1	5.0	0	0	91.0			99.8		
	1	50	1	8.5	2	5	0	0	0	0	0	0	0	1	2.5	1	10.0	1	1	5.0	1	0	94.3			103.		
149	1	50	1	8.5	2	3.5	0	0	0	0	0	0	0	1	19.9	1	15.9	1	1	12.0	0	0	73.0			81.9		
	1	50	1	8.5	2	5	0	0	0	0	0	0	0	1	4.0	1	15.9	1	1	12.0	0	0	76.6			86.9		
150	1	50	1	8.5	2	3.5	0	0	0	0	0	0	0	1	14.9	1	14.9	1	1	14.9	1	0	84.2			92.1		
	1	50	1	8.5	2	5	0	0	0	0	0	0	0	1	14.9	1	14.9	1	1	14.9	0	0	65.2			75.5		