Personal Injury by Auto motors Colombia 2010 to 2020

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Abstract

Logistics services are frequently provided with the use of means of transport on public roads where this road is shared with a wide variety of transport vehicles and road actors with pedestrians. Failures in vehicular and pedestrian management lead to accidents with tragic balances at times, such circumstances can be considered as sources of risk in logistics and transport activity. This work characterizes the Homicide caused by this accident for Colombia since 2010 to 2020 based on available public information identifies the evolution and cyclicality of the accident rate for both motor vehicles and motorcycles. Her we can find the periodic components using Categorical Linear Regression.

Keywords
Personal Injury, Motor Vehicles, Justice Services, Logistics Management, Public Policy

1. Introduction
The provision of logistics services is within the social environment in Colombia. The logistics services use motor vehicles and motorcycles to transport this cargo. The loss or impairment of functionalities of motor vehicles and motorcycles affects the provision of the logistics service. The National Police of Colombia has public databases with the registry of personal injuries, homicides due to traffic accidents; Information available for the period 2010 to 2020. This text describes the cyclicality of personal injuries, due to motor vehicles and motorcycles. For this it uses the public information available; then an ANOVA model is implemented using as a factor the year, the week of the year, the day of the week. In this way, methods are available to describe the evolution of the accident rate associated with personal injuries by motor vehicles and motorcycles and to anticipate possible changes in the road accident rate and the performance of the logistics systems used by these vehicles, as well as in each of selected country departments.

1.1 Objectives
Identify the weight of the temporal components in the behavior of personal injuries in Colombia from public information and describe the details for some territorial units, both for cars and motorcycles.

2. Literature Review

Since the road accident rate is an event that occurs within the field of transport and in public spaces, it should be remembered that the accident rate is the effective realization of risk options widely modeled and studied for public transport (Rojas Sánchez et al. 2019), (Hidalgo et al. 2013) of cargo and transport (Malagón Acosta et al. 2012), (Samba et al. 2011)

The techniques used to model and predict road accidents are summarized and studied extensively, some studies find that the best forecasting method includes two or more groups of techniques in order to obtain accident forecasts (Gutierrez-Osorio & Pedraza 2020), techniques that include simulation (Huang et al. 2016), (F. Gómez & Bocarejo, 2015), (Otero-Niño et al. 2019), techniques that in turn make use of behavior and modeling from the claims, previous data collected and the stability or variation of the data in the generation of vehicular traffic (Holguín-Veras et al., 2011) technologies separate from the data collection (Silva et al. 2015), and used to the allocation of resources in the management of claims risks (Adler et al. 2014), (Gallison & Andresen 2017), (Giacopassi & Forde 2000).

In Colombia, the development of different models for different cities in the country for various purposes is verified (Quintero 2015); (García et al. 2016).

The modeling of accidents in Colombia includes the description of the factors for urban areas (Cantillo et al. 2016), (Wilches, Avila, et al., 2020), (Wilches et al. 2020), (Victoria & Galvis 2014), (Aristizábal et al. 2012), (Restrepo Betancur & Angulo Arizala 2016), topographic conditions associated with civil works (Wilches et al. 2020), or for specific road sections (Mayorga Mogollón 2003); (MC Gómez et al. 2017); (Rivera & Echaveguren 2014); (Cerquera Escobar 2015); (Romero et al. 2017) using a single urban area. And the consequences of the accident rate for specific age groups (Seijas-Bermúdez et al. 2019), (Roncancio et al. 2015); by logistics cargo activity (Forigua & Lyons 2016), its comparison with the accident rate in other countries (Domingo Alarcón et al. 2018), (Escanés et al. 2015), the implementation of studies as the basis of the policy public (Fernando & Roa 2014). From the above, proposals for the selection of traffic rules are obtained (Rueda Villar et al. 2019); (Lota 2020).

3. Methods

First, the personal injury data available as public information is obtained and refined if necessary in terms of its quality of information. After the frequency and availability of the data is identified, in case of including the time record of the event, they will be included in the study. Then the system of dichotomous variables will be implemented for the date attribute. Subsequently, the linear regressions of a general linear model with dichotomous variables will be run for both the national total and for the selected departments with the highest incidence of personal injuries associated with Motorcycles and Automobiles. Given the decomposition of variance in each of the types of variables and will describe the participation based on the Analysis of Variance, ANOVA, for the regressions with the categorical variables. From there it concludes.

4. Data Collection

Table 1 has the personal injury records for the years 2013 to 2020 and finds the total for the period 2010 to 2020. For the entire national territory of Colombia. This list is ordered from highest to lowest in terms of the number of times the weapon or medium is used for the total of the records, this list includes the detail for 20 categories from short stab weapons and groups the following 24 categories in the header "others"; The categories grouped there are: fireworks, knife, toxic substances, tapes / belt, gases, medicine, explosive potato syringe, direct, bomb pack, incendiary, clothing, hallucinogens, poison, pillow, food, adulterated liquor, plastic bag , bomb pot, bladed weapons, sharps, bomb cylinder, bomb belt. The sum of the others and the subtotal are the total of records; the percentage relationship between the subtotal and the total is the last row and in any case fluctuates between 99.97% to 99.84% of the annual records or of each column.

Table 2 breaks down the total injured for the 5 territories with the most total events: Cundinamarca, Valle, Antioquia, Santander, Tolima. Another 27 territorial divisions are grouped under the column heading "other"; The 27 territories in order of number of records are: Atlántico, Risaralda, Boyacá, Huila, Nariño, Bolívar, Meta, Norte de Santander, Caldas, Cauca, Córdoba, Quindío, Magdalena, Sucre, Cesar, Casanare, Guajira, Caquetá, Arauca , Chocó, Putumayo, San Andrés, Amazonas, Guaviare, Vichada, Guainía, Vaupés. The column "Total 2010 - 2020" has the data for that period and the column "% subtotal" has the percentage of data contained by the 5 selected territories with respect to the national total for each of the 20 types of weapons or means with which what causes the injury.

Table 1. Records of Media Type Personal Injuries, Colombia 2010 to 2020

Weapons/year	2.013	2.014	2.015	2.016	2.017	2.018	2.019	2020	Total P.
Overwhelming	59.436	58.257	63.616	10.627	10.510	59.746	75.021	44.442	512.604
Sharp short	13.951	15.314	15.534	111.790	114.860	52.892	17.866	28.322	406.829
Vehicle	25.466	24.750	24.418	29.942	27.311	24.260	22.209	762	249.923
Motorcycle	15.534	15.148	16.993	19.059	15.431	16.631	11.996	1.029	150.940
Without weapons	34	289	348	27.043	24.345	2.494	1.109	3.360	59.082
Does not report	1.202	1.043	1.556	805	2.342	20.948	24.433	-	56.926
Firearm	6.116	5.667	5.082	577	539	2.753	4.546	4.786	49.727
Acid	43	78	79	3.671	3.950	6.466	814	234	15.401
Stabbing	943	631	682	36	-	-	-	-	5.388
Bike	195	184	212	284	268	354	314	34	2.604
Dynamite charge	390	239	106	21	-	53	180	136	1.976
Dog	194	202	201	42	33	217	270	214	1.709
Hand grenade	214	150	96	24	13	47	65	34	1.299
Antipersonnel Mine	116	81	49	15	1	10	38	28	766
Chemical Submi.	28	30	51	203	166	33	37	28	696
Fuel	-	-	-	-	-	-	-	489	489
Not reported	21	21	42	17	29	137	156	94	557
Hot water	48	62	47	9	10	23	62	42	415
Bomb car	16	82	29	4	-	-	62	1	282
Others	43	89	42	68	88	63	74	136	734
Subtotal	123.990	122.260	129.172	204.169	199.815	187.088	159.196	84.057	1.517.887
Total	124.033	122.349	129.214	204.237	199.903	187.151	159.270	84.193	1.518.621
Sub / Total , %	99,97	99,93	99,97	99,97	99,96	99,97	99,95	99,84	99,95

Table 2. Records of Media Type Personal Injuries by territories Colombia 2010 to 2020

Weapons/year	Cundi.	Valle	Antioquia	Santander	Tolima	Others	Total P	% subtotal
Overwhelming	99.778	59.299	39.868	41.585	20.931	251.143	512.604	67,1
Sharp short	106.235	46.235	35.148	24.574	21.004	173.633	406.829	70,1
Vehicle	29.791	42.359	27.328	25.513	13.313	111.619	249.923	69,1
Motorcycle	11.204	23.513	17.360	16.136	7.154	75.573	150.940	66,6
Without weapons	25.910	2.396	4.132	1.237	3.417	21.990	59.082	72,9
Does not report	25.445	712	4.173	1.230	3.034	22.332	56.926	71,8
Firearm	4.549	13.243	5.392	2.056	1.401	23.086	49.727	68,3
Acid	460	52	8.958	544	72	5.315	15.401	74,3
Stabbing	512	532	279	500	251	3.314	5.388	61,9
Bike	464	328	300	190	72	1.250	2.604	67,6
Dynamite charge	42	109	261	3	66	1.495	1.976	56,9
Dog	628	141	126	144	36	634	1.709	72,9
Hand grenade	31	162	270	24	15	797	1.299	62,0
Antipersonnel Mine	2	23	101	1	9	630	766	54,9
Chemical Submis.	223	36	67	17	60	293	696	70,4
Fuel	140	41	57	25	32	262	557	68,0
Not reported	120	8	120	102	5	134	489	78,5
Hot water	72	35	30	38	13	227	415	64,6
Bomb car	103	7	9	13	2	148	282	65,6
Others	302	236	236	178	83	856	1.653	65,9
Total	306.050	189.503	144.258	114.136	70.984	694.847	1.519.540	68,6
% subtotal	99,90	99,88	99,84	99,84	99,88	99,88	99,89	

Table 3 contains the descriptive statistics for the 20 weapons or objects with the highest count of involvement in the crime of personal injury, for this, all the civil calendar days from 2010 to 2011 are taken as a unit of count, with 4,018 days for the period. . Two types of objects were used every day of the period: blunt and short sharp. Each column contains a statistic relevant to the description of the behavior as a time series: the number of records without zeros, "No zeros"; "Max" or the maximum value within one day for the use of this weapon; "Min" or minimum; "Average" or average value; "Desvest" is the standard deviation; and the coefficients of: "C. Corr " Correlation with date and events," C. Asim. " Asymmetry and "C. Curt. " Kurtosis

Table 4 presents the use of motor vehicles with one or more axles in personal injury situations between the years 2010 to 2020. For 32 departmental territorial divisions of Colombia, their departments; this adds up to 249,923 claims records. The department of Valle del Cauca has the highest number of records with 42,359 records, followed by the department of Antioquia with 29,791. The departments with the most records are. Valle del Cauca, Antioquia, Santander, Risaralda, Cundinamarca, Huila and Tolima; Bogotá is included within Cundinamarca. The year with the most registrations is 2,017 with 27,311 registrations, during 2020 the lowest number of this type of incidents was obtained with 762.

Table 5 presents the table of the use of motorcycles in personal injury situations between the years 2010 to 2020. For 32 departmental territorial divisions of Colombia, their departments; this adds up to 150,940 claims records. With the department of Valle del Cauca with 23,513 records, followed by the department of Antioquia with 17,360. The departments with the most records are. Valle del Cauca, Antioquia, Santander, Risaralda, Cundinamarca, Huila and Tolima; Bogotá is included within Cundinamarca. The year with the most registrations is 2,019 with 19,059 registrations, during 2020 the lowest number of this type of incidents is obtained with 1,029.

A detailed description of the accident rate by time, geographical section and type of weapon is available. The sum of these registries is close to 400,000 registries, with the affectation that this implies in the social, commercial, transport and individual aspects of the people involved here. Therefore, it seems pertinent to try to identify the existence of regular or cyclical behaviors so that they can be included in the management of motor traffic.

These equations are obtained for the national total and for the behavior of these injuries over time for the selected departments at the level of daily detail.

Table 3. Personal Injury Records Type of Daily Media Colombia 2010 to 2020

Stat/Weapon	Sum	Non Zeros	Max	Min	Average	Desvest	C Corr	C As.	C Cu.
Overwhelming	512.604	4.018	890	8	127,58	83,93	0,05	1,69	8,00
Sharp short	406.829	4.018	1.421	6	101,25	125,12	0,32	2,39	8,95
Vehicle	249.923	3.931	169	-	62,20	24,98	(0,35)	(0,79)	1,12
Motorcycle	150.940	3.974	135	-	37,57	17,57	(0,23)	0,15	1,02
No use of weapons	59.082	1.859	247	-	14,70	29,26	0,28	2,04	4,01
Does not report	56.926	3.160	221	-	14,17	26,92	0,44	2,75	8,35
Firearm	49.727	3.765	94	-	12,38	8,88	(0,39)	1,21	5,06
Acid	15.401	1.653	168	-	3,83	9,29	0,28	4,86	40,79
Stabbing	5.388	1.752	34	-	1,34	2,41	(0,48)	3,92	29,73
Bike	2.604	1.548	9	-	0,65	1,03	(0,03)	2,06	5,55
Dynamite charge	1.976	625	30	-	0,49	1,66	(0,12)	5,77	50,77
Dog	1.709	1.269	8	-	0,43	0,74	0,11	2,30	8,05
Hand grenade	1.299	389	38	-	0,32	1,49	(0,13)	9,60	150,62
Antipersonnel Mine	766	446	11	-	0,19	0,71	(0,20)	6,49	61,38
Chemical Subm.	696	513	9	-	0,17	0,54	0,05	4,94	39,91
Fuel	557	407	10	-	0,14	0,50	0,22	6,72	80,36
Not reported	489	224	9	-	0,12	0,62	0,31	7,13	63,59
Hot water	415	362	5	-	0,10	0,36	(0,00)	4,32	26,22
Bomb car	282	115	60	-	0,07	1,14	(0,01)	42,33	2.054

Table 4. Registry of Personal Injuries by Motor Vehicles by Departments of Colombia 2010 to 2020

Vehicles	2.011	2.012	2.013	2.014	2.015	2.016	2.017	2.018	2.019	2.020	Total
Valle	3.743	3.582	4.159	4.117	4.459	4.732	5.122	4.664	4.323	57	42.359
Antioquia	3.525	2.976	2.704	2.516	2.363	2.749	2.684	3.494	2.937	58	29.791
Santander	1.739	1.629	1.787	2.639	2.726	3.146	3.725	4.339	4.254	353	27.328
Risaralda	2.811	2.853	3.250	2.719	2.771	2.704	1.938	1.899	1.823	28	25.513
Cundinamarca	1.548	1.710	1.735	1.523	1.493	2.543	2.311	1.620	1.666	1	17.849
Huila	1.337	1.210	1.018	904	803	2.164	1.919	1.082	1.420	3	13.313
Tolima	1.440	1.750	1.712	1.659	1.549	1.670	957	371	346	73	12.949
Nariño	1.061	1.449	1.398	982	849	678	724	282	121	8	8.518
Bolívar	794	798	762	634	759	1.019	1.180	814	966	3	8.355
Norte d S.	527	641	917	887	992	1.197	674	663	526	10	7.612
Córdoba	847	1.011	851	724	516	1.159	577	547	313	13	7.529
Caldas	686	700	641	709	566	1.179	925	560	266	11	6.943
Atlántico	389	367	442	671	843	979	826	673	607	18	6.181
Quindío	407	240	822	919	632	605	819	723	488	31	6.084
Meta	744	445	582	679	403	597	358	163	173	5	4.955
Cauca	239	182	672	438	717	616	586	622	490	5	4.722
Cesar	265	202	191	334	414	801	465	539	403	2	3.994
Sucre	344	368	373	319	225	274	378	399	320	12	3.410
Casanare	284	350	420	404	451	145	139	14	16	-	2.404
Caquetá	254	266	319	248	207	184	259	164	160	6	2.304
Boyacá	301	238	168	182	148	298	205	97	109	3	2.048
Arauca	257	156	160	124	163	179	267	219	188	43	2.031
Magdalena	143	171	148	152	128	119	81	151	91	2	1.333
San Andrés	194	133	130	141	108	76	70	60	50	1	1.148
Guajira	9	53	34	79	60	56	30	26	57	7	446
Putumayo	66	36	27	13	24	16	35	19	40	1	324
Chocó	9	7	20	-	36	46	41	48	36	-	247
Guaviare	11	15	4	11	4	4	1	4	13	6	86
Amazonas	19	7	11	16	6	1	-	-	-	-	72
Vichada	8	5	8	6	2	6	14	2	7	2	61
Guainía	1	-	1	-	1	-	-	2	-	-	12
Vaupés	-	-	-	1	-	-	1	-	-	-	2
Total	24.002	23.550	25.466	24.750	24.418	29.942	27.311	24.260	22.209	762	249.923

5. Results and Discussion

5.1 Numerical Results

Table 6 has the statistical contrasts of the categorical factors in motorcycle personal injuries for 5 regions: Total Nacional, Antioquia, Cundinamarca, Santander, Valle del Cauca, in the first Column. The second contains the sources of the Dates model: Year, "DYY"; week of the year, "DWoY"; day of the month, "DDoM"; day of the week, "DDoW"; These elements of the date decompose the total sum of modeled information, "Model"; the total information is in the source "Total C." what is total information. The average of modeled squares is in "Mean Squares"; the test statistic is column "F"; the probability of the statistical test is in column "Pr> F", this is the p-value of each F test on each type of variable.

The percentage of information that explains each group of variables with respect to the model is in the column: "% of Model". The percentage of information that explains each group of variables with respect to the total information is in the column: "% of Total".

Table 6 contains the statistical contrasts of the relevance of the categorical factors in automobile personal injuries for 5 regions. The explanation is the same as for Table 6. For Table 5 all the models are statistically significant, since the

p-values have significance lower than $p = 0.05$. However, not all sets of variables are significant, being the day of the month "DDoM" the least significant.

Table 5. Registry of Personal Injuries by Motorcycles by Departments of Colombia 2010 to 2020

Motorcycle	2.011	2.012	2.013	2.014	2.015	2.016	2.017	2.018	2.019	2.020	Total
Valle	1.768	1.795	2.291	2.361	2.858	3.021	3.007	2.567	2.116	145	23.513
Antioquia	1.606	2.185	1.689	1.558	2.215	1.648	1.466	1.673	1.415	278	17.360
Santander	1.498	1.859	1.824	1.768	1.795	1.876	1.098	1.226	1.244	89	16.136
Risaralda	972	816	1.178	1.074	1.785	1.871	1.369	933	839	50	11.885
Cundinamarca	827	741	728	697	725	1.187	1.017	3.316	1.129	104	11.204
Huila	1.058	1.056	1.032	724	675	754	690	497	506	14	7.995
Tolima	414	414	571	828	509	1.251	1.113	786	838	10	7.154
Nariño	249	144	491	597	935	925	995	839	923	17	6.293
Bolívar	444	795	734	495	647	657	468	350	80	3	5.123
Norte de S. r	262	319	597	737	725	872	368	477	378	7	4.965
Córdoba	119	96	583	465	699	765	681	692	617	8	4.944
Caldas	491	653	536	476	376	758	488	338	193	55	4.861
Atlántico	393	484	553	529	442	498	260	439	185	43	4.090
Quindío	336	386	546	462	352	228	261	293	145	31	3.380
Meta	289	306	306	393	306	458	302	471	159	32	3.339
Cauca	245	339	278	276	284	518	270	365	227	2	2.994
Cesar	379	278	215	353	266	193	216	196	134	12	2.368
Sucre	196	201	146	215	188	258	210	227	219	77	2.233
Casanare	195	172	250	243	369	401	324	47	9	-	2.161
Caquetá	184	186	214	196	199	193	88	187	117	1	1.712
Boyacá	101	155	145	151	146	154	247	236	197	-	1.681
Arauca	180	159	131	149	99	100	131	111	29	3	1.283
Magdalena	134	105	94	101	65	176	85	56	60	6	987
San Andrés	147	117	138	93	69	43	56	41	57	-	931
Guajira	56	55	82	89	75	40	70	49	14	2	589
Putumayo	27	54	46	59	64	63	61	99	63	31	579
Chocó	25	51	69	10	61	76	62	93	63	1	515
Guaviare	36	20	13	10	32	38	10	19	33	3	242
Amazonas	22	45	25	14	10	18	3	1	4	3	179
Vichada	26	22	23	21	18	17	9	2	-	-	150
Guainía	18	9	6	4	4	-	4	5	3	2	87
Vaupés	-	2	-	-	-	2	2	-	-	-	7
Total	12.697	14.019	15.534	15.148	16.993	19.059	15.431	16.631	11.996	1.029	150.940

Table 6 identifies what explains 46.51% of the total information for personal injuries with a motorcycle for Colombia based on the date; in the same way, there are the percentages of explanation, as follows: Antioquia 17.89; Cundinamarca 31.14%; Santander 20.70%; Valley 32.61%.

Table 7 identifies what explains 51.20% of the total information for personal injuries with a motor vehicle for Colombia based on the date; in the same way, the explanation percentages are obtained, as follows: Antioquia 39.19%; Cundinamarca 21.11%; Santander 27.40%; Valley 26.16%.

For the above. In any case, the cyclical components associated with the calendar explain in any case at least 21.1%. The effect of the year for motorcycle personal injuries is between 65% to 75% of the modeled data. The effect of the year for personal injuries associated with motor vehicles is higher for all departments at 80%. Therefore, those for motorcycles are presented in Table 8 are the normal and standardized coefficients for the effect of the year; and the coefficients of categorical linear regression models for each year are presented in Table 9. Since the coefficients are all significant for the years.

Table 6. Significance of cyclicality in Personal Injury by Motorcycle Colombia 2010 to 2020

Region	Source	GL	Sum of Squares	Mean Squares	F	Pr>F	% of Model	% of Total
Total	DYY	10	143.366	14.336,62	245,23	0,00E+00	72,57	33,94
	DWoY	53	24.351	459,46	7,86	2,20E-54	12,33	5,76
	DDoM	30	4.623	154,11	2,64	3,17E-06	2,34	1,09
	DDoW	6	24.152	4.025,28	68,85	1,08E-81	12,23	5,72
	Model	99	197.550	1.995,45	34,13	0,00E+00	99,46	46,51
	Total C.	3946	422.453					
Antioquia	DYY	10	5.730	573,03	55,79	1,09E-105	65,75	11,88
	DWoY	53	1.182	22,29	2,17	2,28E-06	13,56	2,45
	DDoM	30	399	13,32	1,30	1,29E-01	4,58	0,83
	DDoW	6	1.318	219,59	21,38	7,88E-25	15,12	2,73
	Model	99	8.716	88,04	8,57	1,27E-105	99,00	17,89
	Total C.	3946	48.226					
Cundinamarca	DYY	10	17.665	1.766,46	141,03	3,70E-252	81,59	25,29
	DWoY	53	3.777	71,26	5,69	8,55E-35	17,44	5,41
	DDoM	30	203	6,76	0,54	9,81E-01	0,94	0,29
	DDoW	6	105	17,55	1,40	2,10E-01	0,49	0,15
	Model	99	21.651	218,70	17,46	9,02E-238	100,00	31,14
	Total C.	3946	69.836					
Santander	DYY	10	6.972	697,22	82,11	1,39E-153	81,46	16,91
	DWoY	53	444	8,38	0,99	5,03E-01	5,19	1,08
	DDoM	30	296	9,87	1,16	2,48E-01	3,46	0,72
	DDoW	6	821	136,76	16,11	2,19E-18	9,59	1,99
	Model	99	8.559	86,46	10,18	1,40E-130	99,69	20,70
	Total C.	3946	41.227					
Valle	DYY	10	16.475	1.647,52	139,54	8,57E-250	74,50	24,39
	DWoY	53	1.735	32,74	2,77	1,64E-10	7,85	2,57
	DDoM	30	612	20,41	1,73	8,19E-03	2,77	0,91
	DDoW	6	3.198	533,07	45,15	1,16E-53	14,46	4,74
	Model	99	22.114	223,37	18,92	5,74E-258	99,58	32,61
	Total C.	3946	67.536					

5.2 Graphical Results

Figure 1 shows the coefficients of the categorical variables of the effect for each of the years for personal injuries by motorcycle and automobile. All the coefficients are significant from the beginning, but no clear trend can be identified for the behavior from the beginning of the period to the end of the period 2010 to 2020.

Figure 2 presents the Linear Regression Normal Coefficients for Personal Injuries by Week of Year. A slight decreasing trend can be identified towards the end of the year for both the automotive and motorcycle coefficients.
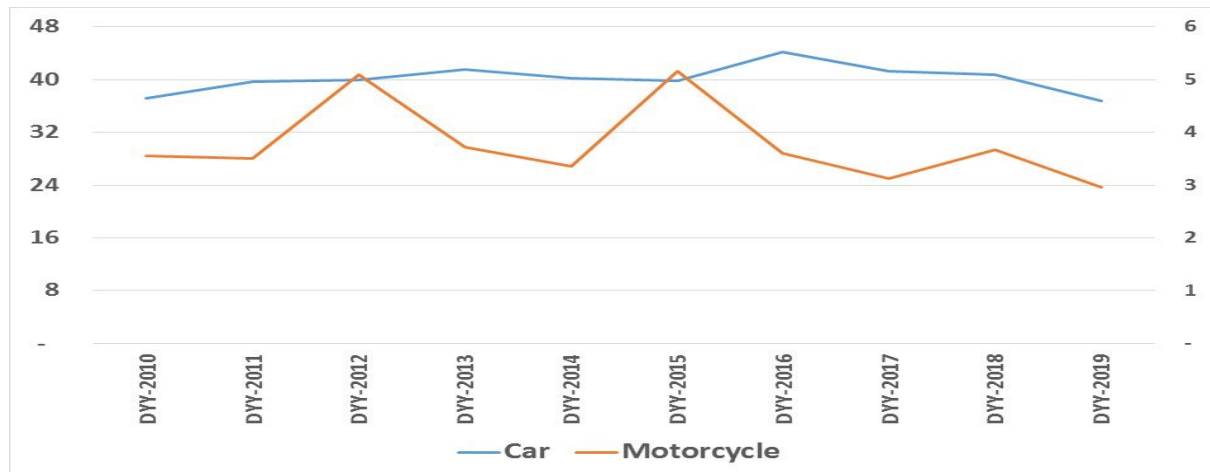
Figure 1. Linear Regression Normal Coefficients for Personal Injuries by Year
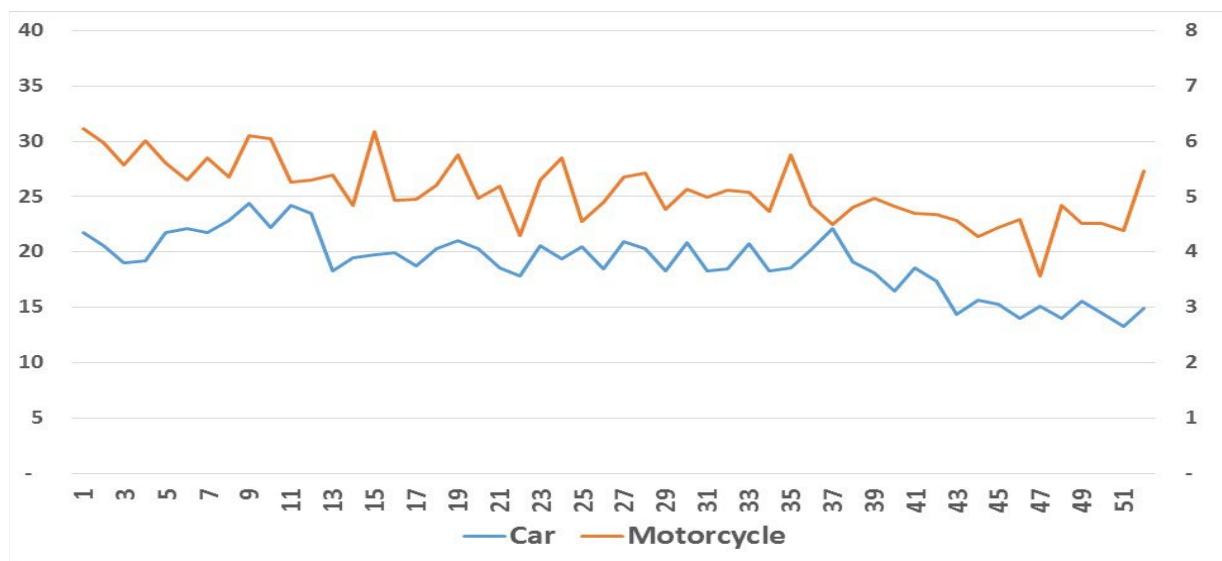

Figure 2. Linear Regression Normal Coefficients for Personal Injuries by Week of Year

5.3 Proposed Improvements

The effect of the year on accidents with personal injuries has been identified for the territories and the cyclical behavior between weeks of the year in such a way that it is possible to define control and improvement points around the calendar dates for the national total and in a similar way use the coefficients for each of the departments. On the other hand, the cyclicality could be at the time level or for certain specific risk regions, thus managing certain hours and place either by redesigning the automotive flow, or by the implementation of other types of measures.

5.4 Validation

Table 10 has the validation statistics for the linear regression models with categorical variables for personal injuries due to automobiles, and Table 11 for personal injuries due to motorcycles. In most cases and in all models, the degrees of freedom are 3804 based on 4108 daily records. For both tables, the DW is the Durbin Watson statistic for the search for first-order serial correlations in the data. In any case, they are higher than 1.75 in Automobiles and with a serial correlation in Motorcycles for the department of Cundinamarca. The coefficients of determination adjusted in any case are greater than 0.17 reaching up to 0.51. The p-value for all models is less than $p = 0.01$

Table 7. Significance of cyclicality in Personal Injuries by Automobile Colombia 2010 to 2020

Region	Source	GL	Sum of Squares	Mean Squares	F	Pr>F	% of Model	% of Total
Total	DYY	10	390.888	39.088,79	345,64	0,00E+00	85,66	44,09
	DWoY	53	28.689	541,31	4,79	7,38E-27	6,29	3,24
	DDoM	30	8.149	271,62	2,40	2,92E-05	1,79	0,92
	DDoW	6	26.205	4.367,50	38,62	8,72E-46	5,74	2,96
	Model	99	456.319	4.609,29	40,76	0,00E+00	100,00	51,20
	Total C.	3946	886.519					
Antioquia	DYY	10	41.923	4.192,30	226,96	0,00E+00	91,02	36,04
	DWoY	53	2.511	47,38	2,57	5,10E-09	5,45	2,16
	DDoM	30	653	21,76	1,18	2,32E-01	1,42	0,56
	DDoW	6	494	82,41	4,46	1,66E-04	1,07	0,43
	Model	99	46.059	465,24	25,19	0,00E+00	100,00	39,19
	Total C.	3946	116.324					
Cundinamarca	DYY	10	20.691	2.069,10	80,78	4,51E-151	80,63	16,81
	DWoY	53	2.100	39,63	1,55	6,93E-03	8,19	1,71
	DDoM	30	877	29,25	1,14	2,72E-01	3,42	0,71
	DDoW	6	2.312	385,32	15,04	4,33E-17	9,01	1,88
	Model	99	25.661	259,20	10,12	1,95E-129	100,00	21,11
	Total C.	3946	123.097					
Santander	DYY	10	16.940	1.694,02	123,40	1,64E-223	85,55	23,52
	DWoY	53	953	17,98	1,31	6,61E-02	4,81	1,32
	DDoM	30	541	18,04	1,31	1,18E-01	2,73	0,75
	DDoW	6	1.297	216,21	15,75	5,97E-18	6,55	1,80
	Model	99	19.802	200,02	14,57	4,32E-196	100,00	27,40
	Total C.	3946	72.021					
Valle	DYY	10	37.935	3.793,49	116,24	9,24E-212	85,88	22,54
	DWoY	53	3.455	65,20	2,00	2,68E-05	7,82	2,05
	DDoM	30	737	24,58	0,75	8,31E-01	1,67	0,44
	DDoW	6	1.901	316,88	9,71	1,23E-10	4,30	1,13
	Model	99	44.174	446,20	13,67	6,01E-183	100,00	26,16
	Total C.	3946	168.317					

Table 10. Statistics of the regressions in Personal Injuries by Automobile Colombia 2010 to 2020

Automovil.	Total	Antioquia	Bolívar	Cundina marca	Santan der	Valle
R²	0,51	0,40	0,22	0,21	0,27	0,26
R²Adj.	0,50	0,38	0,20	0,19	0,26	0,24
MEC	113,09	18,47	7,08	25,61	13,73	32,64
DW	1,79	1,76	1,75	1,88	2,00	1,79
F	40,76	25,19	10,69	10,12	14,57	13,67
P(F)	0	0	3,267E-138	1,9462E-129	4,315E-196	6,054E-183

Table 11. Statistics of the regressions in Personal Injuries by Motorcycle Colombia 2010 to 2020

Motorcycle	Total	Antioquia	Bolívar	Cundinamarca	Santander	Valle
R²	0,47	0,18	0,19	0,31	0,21	0,33
R² Adj	0,45	0,16	0,17	0,29	0,19	0,31
MEC	58,46	10,27	3,20	12,53	8,49	11,81

DW	1,44	1,50	1,80	0,83	1,90	1,87
F	34,133	8,57223	8,997	17,4609	10,1887	18,918
P(F)	**0,0E+00**	1,3E-105	**3,1E-112**	9,0E-238	1,4E-130	**5,7E-258**

6. Conclusion

This work uses the public information and a regression model is implemented using as a factor the year, the week of the year, the day of the week. In this way, the evolution of the accident rate associated with personal injuries by motor vehicles and motorcycles are find.

The linear regression model with categorical variables is used for each year and each month within each language, so the statistics are presented in both Table 10 and Table 11. From there it is identified that the models capture between 19% and 45% of the variability total information this in the adjusted coefficient of determination.

It is identifying that 46.51% and 51.2% of the total information for personal injuries with a motorcycle and vehicle for Colombia can be based on the date; in the same way, we can observe that the explanation of the date depends of the region. On the other hand, always higher values of the Bayesian Information Criterion, SBC, are obtained with respect to the Aikake Information Criterion, which indicates a good fit of the proposed models. As they are categorical unsaturated models, a quasi-orthogonal design matrix is obtained, with which there are no multicollinearity effects, given the selection of the data, implying an adaptation of the estimators by ordinary least squares, which is the model used.

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