HOW STREET PARKING IMPACTS ON ROAD SAFETY

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ABSTRACT

The effect of road parking practices on road safety has been under researched. The aim of this paper is to identify and to analyze risk situations caused by the presence of on-street parking in urban environments. In this research we selected seven urban scenarios located in Bogotá where road parking is frequent. These areas have a variety of characteristics in terms of main activities, land use, vehicular volume, traffic composition, pedestrian density, infrastructure type, and parking configuration. We did field surveys and video documentation in these urban scenarios to identify specific risk situations that may influence the occurrence of road accidents. We defined a set of nineteen hazardous situations that were described and classified in function of two categories of difficulty found: (1) obstruction of visibility when users undertake some action in their trajectory, and (2) increased conflict between road users, in some cases with improper maneuvers associated with parking. As a final contribution, we made recommendations for the regulatory framework and design of on street facilities.

Keywords: Road safety, On-Street parking, Risk situations

I. INTRODUCTION

Very few studies look specifically on the effect of parking pathways on road safety and the probability of crash occurrences. In our research, we analyse the ways in which on street parking is an accident factor that triggers a set of risk situations for road users. First, we will describe the methodology used to collect field data. Second, we present the risk situations identified in an urban environment such as Bogota. Finally, we recommend formulations for the design and regulation of parking zones. Analyses were done through direct in-field observations and using in-depth analysis methodologies because on-street parking effects on road safety are not identifiable from accident data and statistics. We sensed that there are risk situations but it is necessary to base it on real observations from a research.

1.1. Background

We carried out a reference consultation about two main topics: the relation between on-street parking and road crashes, and the urban parking zones configurations and features.

The main highlights from the literature state that parking could raise accident frequency. Actually, factors like road parking, wide lanes, number of lanes, vehicles per lane, and lanes for bus circulation have direct effects on accident risk (Chimba D., 2010). Furthermore, difficulties emerge when parked vehicles reduce visibility or obstruct movement (London Road Safety Plan, 2001), two aspects that we discuss at length in this paper. Thus, obstruction of visibility, speeding and on-road parking raise the probability of suffering serious injuries in road crashes (Das A., 2009). In the same way, research has demonstrated that on-street parking and parking on the sidewalk increase accident risk for pedestrians, for parked vehicles and for circulating vehicles in secondary roads (Greibe P., 2001). Another factor that may augment accident rate is the overburden on street generated by multiple vehicles parked. It is argued that reaction time for a driver when a pedestrian appears crossing the road in a scenario with 90% of occupation of road parking is approximately twice that for the case without parking. This fact due to the mental brain charge that overburden implies for the driver (Edquist J., 2011). In the same way, research has shown that road parking could increase the severity of crashes when there is a final collision with a parked vehicle posterior to a crash or a loss of control. Roads with on-street parking are associated with serious accidents. However, a significant relation between road parking and road accidents deaths is not really deduced (Marshall W., 2010). In general the absence of on-road parking reduces probability of a serious injury after a crash (Das A., 2011). Another risky situation is the collision between a cyclist and an opening car door on the road, particularly if it is one-way road. Parking zone are more frequent in roads with one-way traffic where there is a major probability that this kind of accident could happen to cyclists (Pai C., 2011). Some studies conclude that banning road parking in road with narrow lanes or one-way traffic contributes to reduce accidents, if it is accompanied with measures related with lighting and appropriate demarcation of lanes (Retting R., 1994). Several studies focus on the augmentation of accident risk due to road parking.

In contrast, research has proved that parking could have positive effects on road safety considering that it discourages speed, thus frequency of accidents caused by speeding would diminish. In this case when speed is usually low, parking zones present low risk of injuries and fatalities (Rifaat S., 2010). Other research has showed that on-street parking zones are more common near downtown cities and less frequent in commercial areas. From this point of view road parking does not affect injuries severity when a road crash occurs (Zajac S., 2002). Other experiments have developed models for estimating waiting times when looking for an empty place. Calculations have considered road parking and the implementation of a new area assigned for parking (Benenson I, 2008). In addition, some investigations aimed to identify maneuvers for diagonal and parallel parking, and to determine optimal maneuvers for a combination between different parking configurations (Gomez-Bravo, 2000). For parking configurations, typologies were defined in function of the angle of parking. It was found that in one space in which it is possible to park four vehicles parallel to the road, we can park five vehicles with a 30° angle, seven vehicles with a 45° angle and ten vehicles with a 90° angle

(Escruceria de la Aspriella C., 2009). Furthermore, parking including road parking should be classified in function of localization, user type, land use, and mobility polices (Arnau Esteller A., 2007). For parking typologies there are few regulated configurations: perpendicular to the road, parallel to the road and diagonal orientation with angles of 35° and 50°. For the cases studied we found that these configurations tend to be combined forming mixture of typologies for one parking area.

Many studies treat several aspects related with on-street parking but no one is focused on the impacts that it generates in terms of road safety. This research aims to fill this gap.

1.2. Context

This research was done in Bogotá where one of the priorities of the current government is to regulate on-street parking areas. Bogotá is the capital of Colombia and its population is nearly 8 million people (DANE, 2010). In 2010, fatality rate for Bogotá as a consequence of road crashes was of 6.6 deaths per 100,000 people (Uniandes, FPV, 2011). Inside the format filled out by traffic officers for accident field surveys, there is one space to indicate the possible presence of a parked vehicle near the crash scene. However completion of this information is not so rigorous and it stills unsuitable for deep studies. On the other hand, in Bogotá there is a regulation for on-street parking that forbids it in some circumstances and places, but there is low control to assure the obedience of those rules. Doing this study, we remarked that there are difficulties in many zones due to the lack of information for people about regulations regarding road parking. Additionally, there is an absence of control forces. Conversely, the augment of the number of vehicles raises the demand for parking in the city. It is a problem that may be solved by implementing multiples parking zones, which must be designed, adapted and regulated with road safety criteria.

II. METHOD

2.1 Places selection

To select places for the study we followed a procedure. First, a set of relevant variables were included in the analysis as for instance type of vehicle parked, type of road-users affected, flow conditions, road and traffic characteristics, pedestrian density, existence of a special establishment and presence of loading activities. Once we defined a preliminary list of appropriate places, we visited the site and took photographs (figure 1), to choose the best places to record parking scenes and its environment. To analyze videos we designed specialized tools that describe the content of the observations, beginning and end times, and comments associated with drivers and pedestrians behavior. From the videos we identified a group of repetitive risk situations that we described in detail. The last step of the work was the proposition of recommendations to improve safety conditions.

Figure 1 – Photographic registers form preliminary visit

In order to find interesting situations, we took into account main criteria that we considered important to select definitive places for recording videos: (1) high presence of pedestrians, (2) high traffic density, (3) mixture of configurations for parking, (4) variety of land use, (5) places that we thought were problematic, and (6) places that we discovered interesting during the preliminary visit. After this step the working group recorded videos in seven places (Table 1 and Figure 2).

Table I – Selected places

	Neighborhood / place and description
1	***Plaza de Mercado Restrepo (Carrera 19 - Calle 19 Sur)***: It is a commercial zone with high presence of people. Many vehicles arrive to this place such as trucks for food transport. Parking maneuvers are strongly disorganized.
2	***San Andresito de la 38 (Carrera 39 – Calle 9)***: It is a commercial zone characterized by informal merchants. It is usually overcrowded with a high density of people and informal sellers on street.
3	***Venecia (Carrera 51 – Calle 46 Sur)***: It is a commercial area near two main road axes, and a popular zone with a high density of pedestrian.
4	***Zona T (Carrera 13 – Calle 82)***: It is a commercial zone with many restaurants and activities during the day and at night.
5	***Restrepo (Carrera 17 – Calle 20 Sur)***: It is a residential and commercial zone, very traditional in Bogota.
6	***Spring (Carrera 45- Calle 134A)***: It is a residential and a commercial zone, with some trucks waiting for removal service; some commercial establishments are also installed.
7	***Zona Industrial - Puente Aranda (Carrera 41 - Calle 9)***: It is an industrial zone where factories are located. There is a high presence of big trucks, and in contrast a low presence of pedestrians.

Figure 2 – Location places in Bogotá city

2.2 Recording and analysis process

The documentation team recorded videos during approximately two continuous hours in each of the places previously selected. Recordings were done in periods of time in which we found

more influx of people, like Friday afternoon and Saturday day. We tried to capture general scenes with multiplicity of elements. Seven videos were recorded for a total of 13 hours, 11 minutes and 36 seconds. For the video analysis we designed three formats: one to differentiate the kind of situation minute by minute and its duration calculated from beginning and end time. In this format we described the risk situation, the people's behaviours and the manoeuvres performed. A second format contains detailed description for each one of the seven places, and regroups observation videos for each zone. A third format was designed to describe risk situation, with a general scheme, photographs, information summarized from observations, and proposals to measure risk. Some risk situations were proposed at the beginning as intuitive situations. Others were initially proposed based on a French study that defines accidental configurations (Van Eslande, 2008). Initial situations were confirmed and complemented after, and others new situations were added from video information.

III. MAIN RESULTS

We classified risk situations in two main groups: (1) Obstruction of visibility: when a user needs to make a decision for crossing a roadway or for continuing a path and he can not take fully information due to the presence of parked vehicles on the road. (2) Increased conflict between road users: when a user is obligated to change its trajectory or to wait for a time due to the presence of parked vehicles on road. This fact raises the interaction with other users.

We determined nineteen risk situations that we describe in this section; five situations belong to the first group and fourteen to the second group.

3.1 Situations associated with obstruction of visibility

1–A: **A pedestrian crosses a roadway**: A pedestrian wants to cross a roadway under limited conditions of visibility when one or several vehicles are parked on the road. In front of parked vehicles, the pedestrian usually occupies part of the road, trying to improve his visibility. When the pedestrian decides to cross, he or she can be surprised by a vehicle that appears behind parked vehicles.

1–B: **A driver circulates in straight line and a pedestrian appears**: A driver circulates in straight line on a roadway with limited conditions of visibility, in one or in two sides of the road due to the presence of parked vehicles. When the driver continues the path, a pedestrian suddenly appears in front the parked vehicles.

1–C: **A driver circulates in straight line and a motorcyclist appears**: A driver circulates in straight line on a roadway with limited conditions of visibility, in one or in two sides of the road due to the presence of parked vehicles. When the driver continues on the path, a motorcyclist suddenly appears from a secondary road.

1–D: **A driver that circulates near an intersection**: A driver that circulates with limited conditions of visibility due to the presence of parked vehicles in a corner continues his path

to cross an intersection, when a vehicle appears from the perpendicular road.

1-E: **A driver that circulates in straight line and a cyclist appears**: A driver circulates in straight line on a roadway with limited conditions of visibility, in one or in two sides of the road due to the presence of parked vehicles. When the driver continues the path, a cyclist suddenly appears from a sidewalk, often near an intersection or in a central divisor, where cycle exclusive ways are located in the city.

3.2 Situations associated with conflict increase

2–A: **A driver overtakes a parked vehicle in a congested road in one-way traffic**: A driver makes a lane change to overtake a parked vehicle. This maneuver generates conflicts with vehicles that move in the contiguous lane, and reduces usable width. Drivers could become stressed for this situation and often the conflict expands to more than two lanes.

2–B: **A driver overtakes a parked vehicle in a two-way road traffic**: A driver uses a lane for opposite traffic to overtake a parked vehicle on a road commonly not so wide. This maneuver generates conflicts with vehicles that circulate in opposite way, increasing the probability of a frontal collision.

2–C: **A driver brakes on road to get a parking place**: A driver brakes unexpectedly to get a parking space or to park on road. Vehicles behind must brake too to avoid a rear collision or may cause pile up.

2–D: **A driver waits for an empty place for parking**: A driver waits for an empty place for parking at one side of the road or in a parking zone. This wait generates conflict situations with other vehicles that move on the road. Frequently the wait creates a second line of parked vehicles.

2–E: **A parked driver makes an inserting maneuver in main flow**: A driver that is parked on street or in a parking zone makes an insertion maneuver in vehicular flow. Its maneuver generates conflicts with vehicles and with pedestrians. When it goes in reverse visibility is more limited.

2–F: **An occupant car opens the door in side road**: A driver or a passenger of a parked vehicle opens the door in side of the road, interrupting motorcyclist´s, cyclist´s or other driver´s trajectory. It is more common at right side but it could happen at left. When it occurs at left it is more hazardous because speed should be highest. The danger is for the occupant and also for the other user that passes. This situation has been studied for the implementation of a special mirror for detecting vehicles coming (TRSI, Spain, 2012).

2–G: **A parked vehicle entering sidewalk**: One vehicle is parked on sidewalk obstructing partial or totally pedestrian passage, obligating them to walk on the road while they can overtake the vehicle.

2–H: **A person performs a work on the road**: On street parking, commonly a van or a truck is sometimes associated with presence of workers on road performing loading activities. Another people like informal sellers, repairmen, or maneuver guides remain in exposition on the road for prolonged periods of time.

2–I: **A driver suddenly makes a lane change for occupying a parking space**: A driver is circulating in a two or more lanes road; he or she perceives an empty space distant to the lane in which it moves. Then, the driver makes an unexpectedly maneuver interrupting other users trajectory.

2–J: **A pedestrian waits for a bus on the road**: One or more pedestrians wait for a taxi o for a bus on the road, or passengers get off a public vehicle on the road, due to the presence of parked vehicles in one side of an avenue.

2–K: **A big vehicle turns in an intersection**: One big vehicle, bus or truck, makes a turn in an intersection with limited curvature. The maneuver is difficult due to the presence of parked vehicles near the corner. This situation also implies risk for pedestrians and cyclists that result trapped between vehicles.

2–L: **A driver makes a parking maneuver**: A driver undertakes a maneuver to park on street. Sometimes when space is limited, it is necessary to maneuver many times in order to park properly. During these maneuvers the driver interacts with other vehicles circulating on the road or with pedestrians.

2–M: **A pedestrian tries to get into sidewalk after crossing a road**: A pedestrian that crosses a road affronts difficulties to get into sidewalk because there is a line of parked vehicles. He must walk on the road until he can be able to use sidewalk.

2–N: **A driver turns in an intersection where a vehicle is parked near the corner**: A driver of a car or a motorcyclist turns in an intersection and he is surprised by a parked vehicle near the corner, obstructing his trajectory. The driver brakes and tries to pass despite the restricted wide road, or attempts to make a lane change interacting with other vehicles.

Once we characterized the set of situations, we constructed a risk situation matrix in order to differentiate situations involving vulnerable users from situations involving only car drivers, and distinguishing between the two categories showed before (Figure 3).

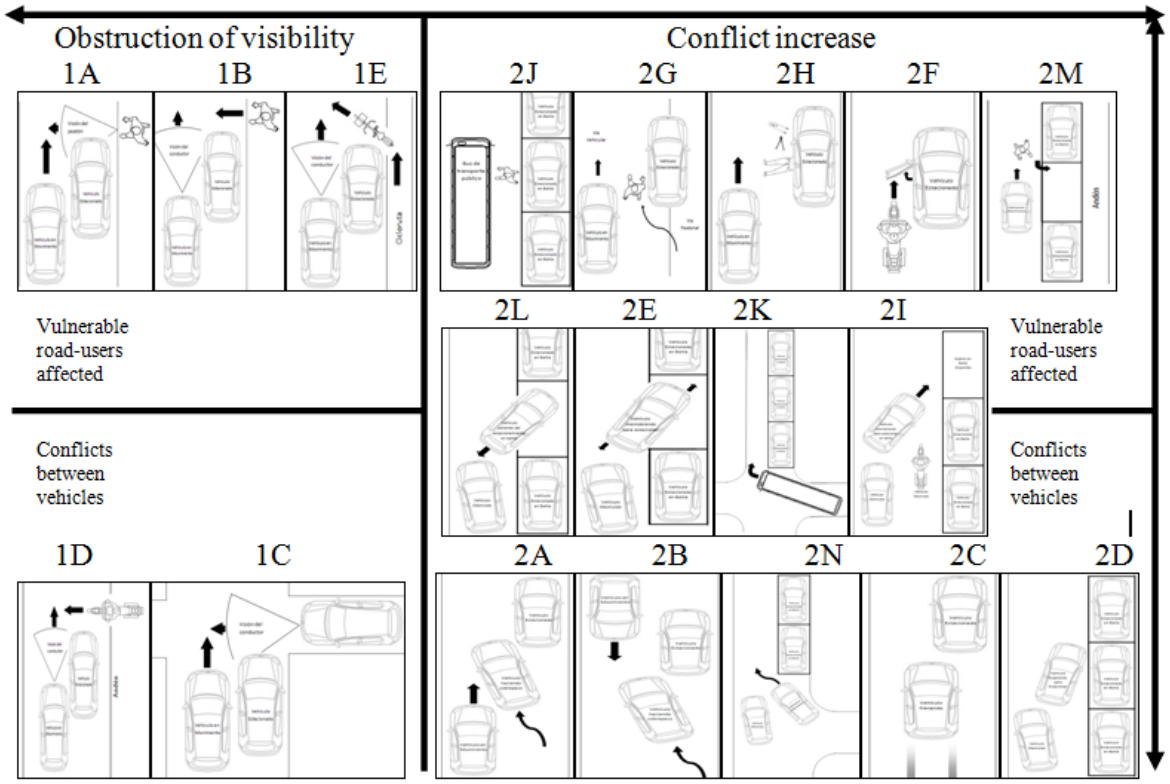

Figure 3 – Risk situation matrix

IV. ANALYSIS OF RESULTS

4.1 General observations

On-street parking done in a disorder way without regulations, originates hazardous situations and risky behaviors. Also it generates a negative image of the city and its environment. Moreover given that the majority of the situations occur under no legal conditions, for instance a pedestrian that crosses the road distant to an intersection or outside a protecting passage, or the driver that waits for an empty place on the road. Beyond that, in several places despite signs indicating forbidden parking, on-street parking was repeatedly. In general there are mixtures of parking configurations, we observed places where there were at the same time vehicles parked in diagonal and others in parallel to the road, blocking their exit. Some micro-congestions appear inside chaotic parking zones, involving pedestrians, sellers and cyclists who move between cars and motorcycles. Issues related with road parking are not positive from a safety point of view.

4.2 Frequency and duration per risk situation

For each situation we obtained a frequency, a total duration and an average duration (table 2).

Table 2 – Frequency and duration for each situation

Risk Situation	Frequency Observations	Duration (seconds)	Average duration (seconds)
1–A	60	524	8,73
1–B	22	101	4,59
1–C	5	79	15,80
1–D	1	7	7,00
1-E	0	0	0,00
2–A	49	389	7,94
2–B	1	5	5,00
2–C	9	97	10,78
2–D	43	3.744	87,07
2–E	202	4.332	21,45

Risk Situation	Frequency Observations	Duration (seconds)	Average duration (seconds)
2–F	50	512	10,24
2–G	86	1.352	15,72
2–H	25	5.826	233,04
2–I	13	170	13,08
2–J	96	1.454	15,15
2–K	22	212	9,64
2–L	194	4.379	22,57
2–M	16	164	10,25
2–N	2	14	7,00
-			

Form the seven videos we found 896 risk situations caused by on-street parking. The total duration of risk was 6 hours, 29 minutes, 24 seconds; some risks occur on the same interval of time. Actually, when we analyzed videos there were multiple risk situations simultaneously so we needed to observe several times the same video to capture all situations.

Results between zones are different. There are risk situations that occur in some places and not in others, devolving on the predominant activities. Frequency is also variable and depends on the proper characteristics of each place, for example with wide sidewalk, wide road, presence of public transport and parking typology.

Situations related with entry and exit parking were more frequent and constitute maneuvers that usually interfere with pedestrians and vehicular circulation. However, the most frequent situations are not necessarily the most time consuming. For example the average time for entry is 83 second, in comparison to situation 2H that takes 233 seconds in average. The wait for one empty place (situation 2D) becomes so long, that it often corresponds by itself to one on-street parking situation.

Some activities are directly related with on-street parking as for example such who guides vehicles to park in a restaurant entry. This activity is not regulated and sometimes it generates external negative consequences as: (1) An additional time for insertion on the flow while driver arranges gratuity, (2) The wait on the road for a place that will be free in response to guide signs, raising traffic (3) Stop vehicular flow by the guide to allow exit vehicle, increasing congestion, (4) Lack of accountability of the guide; in some cases it allows maneuvers without looking the conflict they could generate.

V. RECOMMENDATIONS AND DISCUSSION

5.1 Recommendations

In order to formulate adequate recommendations it is important to distinguish properties associated with parking configurations: (1) Diagonal and perpendicular parking

configurations require more cross section to ensure a sidewalk enough wide for pedestrians. This kind of parking encourages drivers to make improper manoeuvres to occupy quickly and in a frontal direction one empty space. Exit manoeuvres from these spots, especially in reverse, present difficulties in terms of visibility and handling. (2) Parallel parking configuration: This type of parking diminishes road width for circulating vehicles. When vehicles are too close handling becomes hard. It is important that this kind of parking does not interfere with a crossing pedestrian which means that vehicles cannot park on pedestrian lines, on a corner, or near intersections. All these aspects must be considered when improving design and establishing regulation laws.

From engineering, it is suitable to demarcate on the road the places for vehicles, taking into account the different sizes of vehicles that will be authorized to park. Also it is important to indicate with demarcation areas where parking is not allowed, for instance stop buses areas. Additionally it is advisable to fit out parking zones for loading activities, indicating hours and duration authorized, especially in commercial and industrial areas. Near to intersection it is important to forbid parking and to indicate clearly with demarcation from what distance it is forbidden, depending on the curvature radius necessary for vehicles to turn. On-street parking parallel to the road only should been allowed on secondary roads with a flow no superior to nine vehicles per minute. Otherwise conflicts between vehicles could raise substantially.

In places where road parking will be allowed the priority must be for pedestrians and cyclists, peculiarly in limited spaces. For lanes designated to cyclists´ circulation, road parking cannot interfere with them. On the contrary, on-street parking can benefit cyclist forming a barrier that segregates and protects them from vehicular flow. For pedestrians it is recommendable to establish exclusive areas for their mobilization, and planning peripheral parking zones particularly in commercial zones, like San Andresito and Restrepo.

From an enforcement standpoint, it is necessary to improve controls and to reinforce the presence of policy forces, especially in certain zones that are more conflictive in terms of on-street parking. For the surveillance one measure that increases significantly control capacity is the installation of cameras accompanied by an efficient cash mechanism. For this purpose there are yet cameras installed in Bogotá.

From educational aspects, it is required the diffusion of information about parking zones allowed and rules governing them. It is convenient to develop campaigns and road safety messages emphasized on road safety in parking zones. We propose also to create and to diffuse a manual of good practices from all road users inside parking zones.

5.2 Discussion

Video documentation provides valuable information to identify risk situations, recurrence and durations of these situations, and to recognize frequent and unexpected users' behaviours.

When on-street parking is performed on a disorder way without regulation, it originates hazardous situations and risky behaviors. As we distinguish in description of situations,

parking limits the correct use of sidewalks, and obligates pedestrians to walk on road along the road edge, especially when sidewalks are narrow as it happens in many roads in Bogota. In some cases the vehicle occupies partially the space of the sidewalk but some pedestrians prefer walking on the road. Furthermore, there is a tendency in pedestrians to deteriorate their behaviour because they tend to continue to walk on road after overtaking the obstacle. To conclude in this aspect, more research has to be developed, but apparently, on-street parking triggers bad behaviors from people. Additionally, road users coexist with bad behaviors; in collected information we observed adaptation to unsuitable situations from people.

On-street parking impacts on road safety depend greatly on users´ behaviours; consequently it differs between cities and places where we emphasized analysis. Results have a strong local component. The generalization for different contexts needs to be carefully reviewed.

More research about this topic is needed, for example regarding procedures to measure risk. In addition, to have deep results it is advisable to analysis situation following in-depth analysis, for instance collecting elements from interviews to better understand behaviours and people perception of risk.

ACKNOWLEDGEMENTS

This research was conducted in cooperation with the Corporación *Fondo de Prevención Vial CFPV*. We appreciate the valuable dedication of the working group belonging to the research group *SUR – Uniandes*.

REFERENCES

Arnau Esteller Alberto (2007), Los aparcamientos en el subsuelo municipal urbano. Capítulo 1. Sección 3: tipologías de aparcamiento.

Benenson Itzhak, Martens Karel, Birfir Slava, (2008), PARKAGENT: An agent-based model of parking in the city, Computers, Environment and Urban Systems 32, 431–439.

Chimba Deo, Sando Thobias, Kwigizile Valerian (2010), Effect of bus size and operation to crash occurrences, Accident Analysis and Prevention Volume: 42 Issue: 6 Pages: 2063-2067.

DANE, Departamento Administrativo Nacional de Estadística, Información estadística, (2010) Bogotá, Indicadores demográficos 2005 - 2020.

Das Abhishek, Abdel-Aty Mohamed A, (2009), A genetic programming approach to explore the crash severity on multi-lane roads, Accident Analysis and Prevention Volume: 42 Issue: 2 Pages: 548-557.

Das Abhishek, Abdel-Aty Mohamed A. (2011), A combined frequency–severity approach for the analysis of rear-end crashes on urban arterials, Safety Science Volume: 49 Issue: 8-9 Pages: 1156-1163.

Edquist Jessica, Rudin-Brown Christina M., Lenne Michael G. (2011), The effects of on-street parking and road environment visual complexity on travel speed and reaction time, Accident Analysis and Prevention Volume: 45 Pages: 759-765.

Escruceria De La Aspriella Carlos Andrés (2009), Caracterización de parqueaderos públicos de Bogotá y revisión bibliográfica de estos. Aproximación desde la problemática de congestión vehicular, Uniandes, 2009.

Gomez-Bravo F., Cuesta F., Ollero A. (2000), Parallel and diagonal parking in nonholonomic autonomous vehicles, Engineering Applications of Artificial Intelligence Volume: 14 Issue: 4 Pages: 419-434.

Greibe Poul (2001), Accident prediction models for urban roads, Accident Analysis and Prevention Volume: 35 Issue: 2 Pages: 273-285.

Marshall Wesley Earl, Garrickb Norman W. (2010), Does street network design affect traffic safety?, Accident Analysis and Prevention Volume: 43 Issue: 3 Pages: 769-781.

Pai, Chih-Wei (2011), Overtaking, rear-end, and door crashes involving bicycles: An empirical investigation, Accident Analysis and Prevention, Volume: 43 Issue: 3 Pages: 1228-1235.

Retting Richard A., Williams Allan F., Preusser David F., Weinstein Helen B. (1995), Classifying urban crashes for countermeasure development, Accident Analysis & Prevention Volume 27, Issue 3, Pages 283–294

Rifaat Shakil Mohammad, Tay Richard, De Barros Alexandre (2010), Effect of street pattern on the severity of crashes involving vulnerable road users, Accident Analysis and Prevention Volume: 43 Issue: 1 Pages: 276-283.

Universidad de los Andes, Corporación Fondo de Prevención Vial (CFPV), (2010). Anuario Estadístico de Accidentalidad vial en Colombia, en redacción.

Transport for London Street Management, Mayor of London, London's Road Safety Plan, November 2001.

Van Elslande Pierre, Fournier Jean-Yves, Vincensini Mathieu, Roynard Mathieu, Nussbaum Fanny, Clabaux Nicolas (2008), Analyse comparative de procédures d'accidents mortels et non mortels, Rapport scientifique Tâche 3 (R3), ANR / Predit / Projet "2RM" 2006-2008: Accidentologie, Usage et Représentation des Deux - Roues Motorisés, août 2008.

Zajac Sylvia S., Ivan John N. (2002), Factors influencing injury severity of motor vehicle–crossing pedestrian crashes in rural Connecticut, Accident Analysis and Prevention Volume: 35 Issue: 3 Pages: 369-379.

ONLINE REFERENCES

TRSI, Todos con Retrovisor de Seguridad Integrado, Barcelona, Spain, http://www.trsi.es/.