

## Title: In-depth crash investigation setup in Campinas, São Paulo, Brazil

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### Motivation

Brazil is one of the major emerging countries and is increasingly becoming a very modern society. Although road infrastructure is developed extensively Brazil is still one of the countries with the most dangerous roads in the world. According to the official statistics by ministry of health more than 43.000 traffic fatalities were reported in 2014. The trend of the last decade shows an increase of 23 percent.



Figure 1: traffic accident fatalities in Brazil, 2004 – 2014 [1]

Users of motorized 2- or 3- wheelers (28%) are at highest risk. This group is followed by car occupants (23%) and pedestrians (20%). Also a high number of fatalities is registered in road user category “others” (23%).

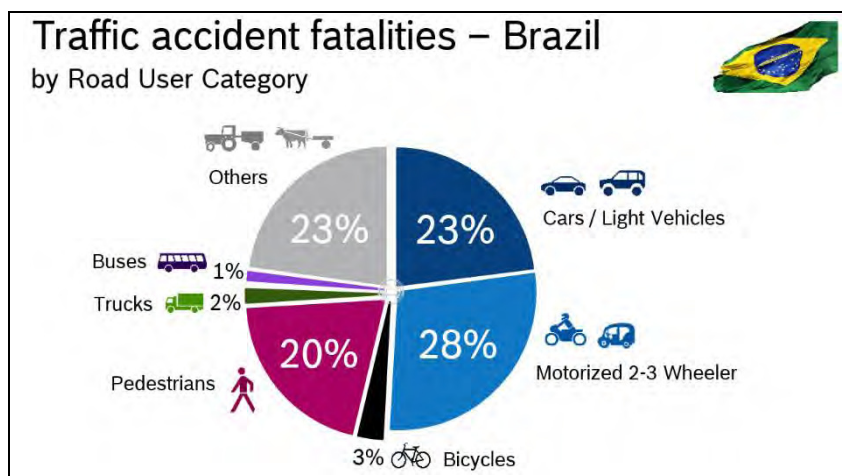


Figure 2: traffic accident fatalities in Brazil by road user category, 2013 [2]

These figures show that in Brazil around 9.900 car occupants, 12.100 riders of 2- or 3- wheelers and 8.600 pedestrians die each year. The number of registered injured road users increased significantly by 67% in the last 10 years.

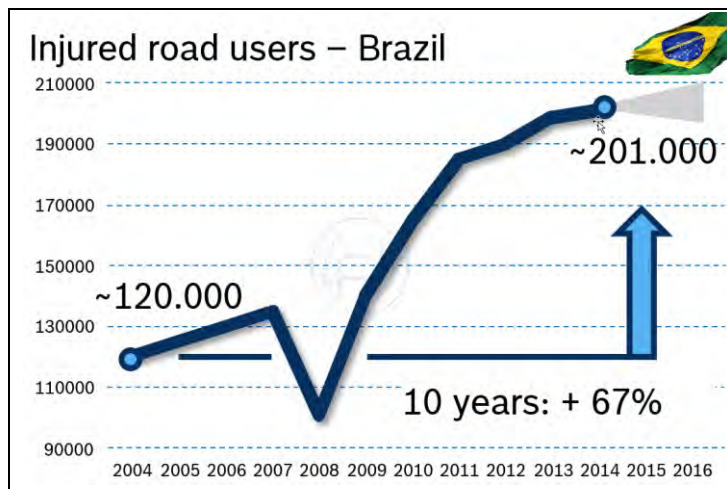


Figure 3: injured road users in Brazil, 2004 – 2014 [1]

In order to stop the increasing trend of the last few years and to improve traffic safety on Brazilian roads effective activities are necessary. Finding efficient solutions for increasing road traffic safety presumes an understanding of the Brazilian accident situation first. Using comparisons with other countries exclusively is not enough because of big differences in behavior of transport, climate conditions, vehicle fleet and infrastructure.

To identify accident root causes and to derive measures for improving traffic safety further investigations are necessary. Therefore, Robert Bosch Latin America and Corporate Research of Bosch initiated a pilot study on behalf of SAE Brazil started in March 2016 with the goal to lay the foundations for a long-term research activity. This allows then scientific studies regarding traffic safety with internationally known methods in Brazil.

### Approach with local partner

Piloting for an in-depth accident investigation the city of Campinas, São Paulo was chosen. Campinas is roughly 100 km north of São Paulo with approximately 1.024 million inhabitants – thereof are 2.8 million within the center of Campinas city. Thus the infrastructure covers either urbanized as well as rural areas which is a good baseline for a representative investigation area in Brazil. Furthermore a well-established traffic safety management is available.

This area is observed by the *Empresa Municipal de Desenvolvimento de Campinas (EMDEC)*. The *EMDEC* organization supports the city of Campinas in terms of traffic observation, regulation and handling damaged vehicles. Furthermore, *EMDEC* takes care of traffic education and driver licensing. For the pilot study an investigation area of 3.5 km around the *EMDEC* headquarter was defined in which different types of roads are covered e.g. highway, multilane main roads and roads in residential areas.

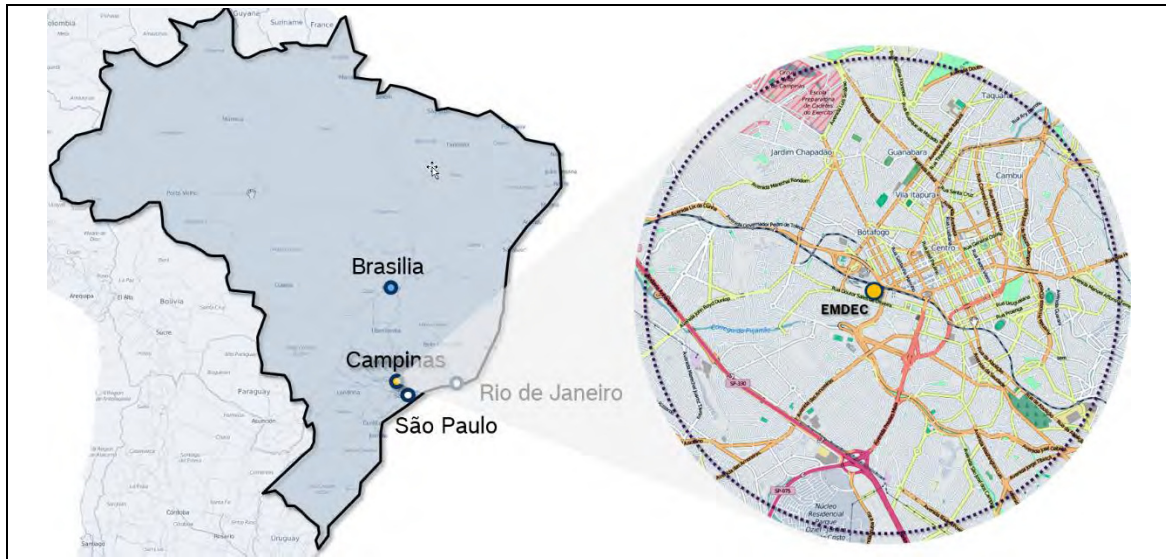


Figure 4: Investigation Area in Campinas SP, Map: © OpenStreetMap, CC-BY-SA 2.0 [3]

Because of *EMDEC*'s expertise it is an ideal partner for accident investigations on the spot. Their existing infrastructure, network and knowhow enabled a quick start. Due to the fact that *EMDEC* is part of the official traffic management in Campinas city a quick access to the accident site is possible. Their operation vehicles and their role as traffic agents (traffic management, traffic control, safeguarding) allow a safe and secure data collection and measurements on the spot.



Figure 5: *EMDEC* Travel Agent during safeguarding of accident scene

### Initial Training

In-depth accident investigation was not in scope of *EMDEC*'s work as of now, thus a short intensive training was necessary in order to start the on spot crash investigation.

The training of evidence based accident data collection on-spot was conducted by Bosch Accident Research. Further support was given by *Takata Corporation* and *Applus IDIADA Group*. This training covered an intensive theory part followed by practical training.

The theoretical part aimed to give an understanding how accident causal factors can be determined at the accident site. Furthermore it gave a general guideline how to behave at the accident

spot dealing with authorities and accident participants. By using accident information from already investigated crashes out from other investigations the team from *EMDEC* was trained intensively. Overall following topics were covered

- Safety and behavior at the accident site
- Trace identification and type of traces
- Determination of the collision point
- Type and kind of accident
- Types of crash configurations and their specific characteristics i.e. truck crashes
- Basics of crash documentation

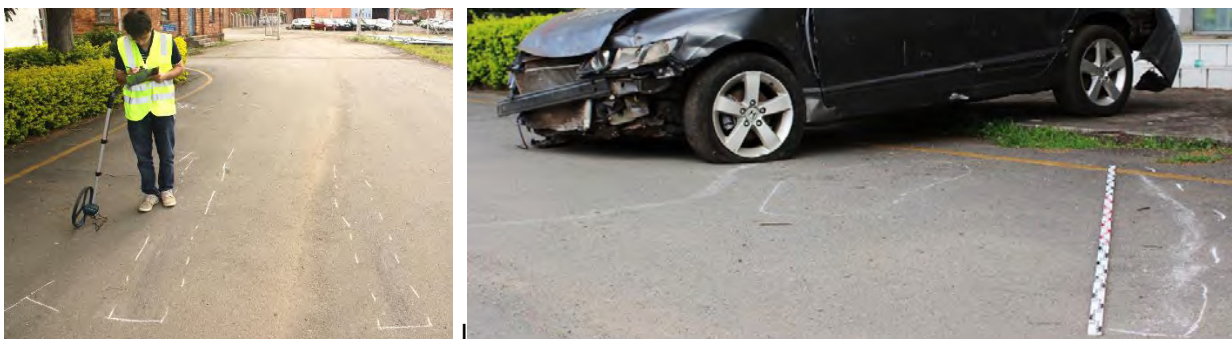
To underlie the theory a practical part was assessed including:

- Picture reporting (detailed documentation of vehicle damages)
- Documentation of accident details using investigation forms and database
- Trace interpretation, identification of collision
- Measurement and drawing of scaled sketch of the accident site
- Save work on accident spot

The practical part contained the simulation of an accident using damaged vehicles available at the *EMDEC* facility. *Figure 6* shows a simulated head-on collision between two vehicles. Here the team was able to learn how to document an accident effectively under different circumstances. Besides, picture reporting and measurement of the accident site a focus was set on how to use the provided investigation forms for accident site documentation. The results were discussed in the office, afterwards.



*Figure 6: Training by using crashed vehicles at EMDEC facilities*



*Figure 7a and 7b: Training of making scaled sketches and identifying of brake/scratch marks*

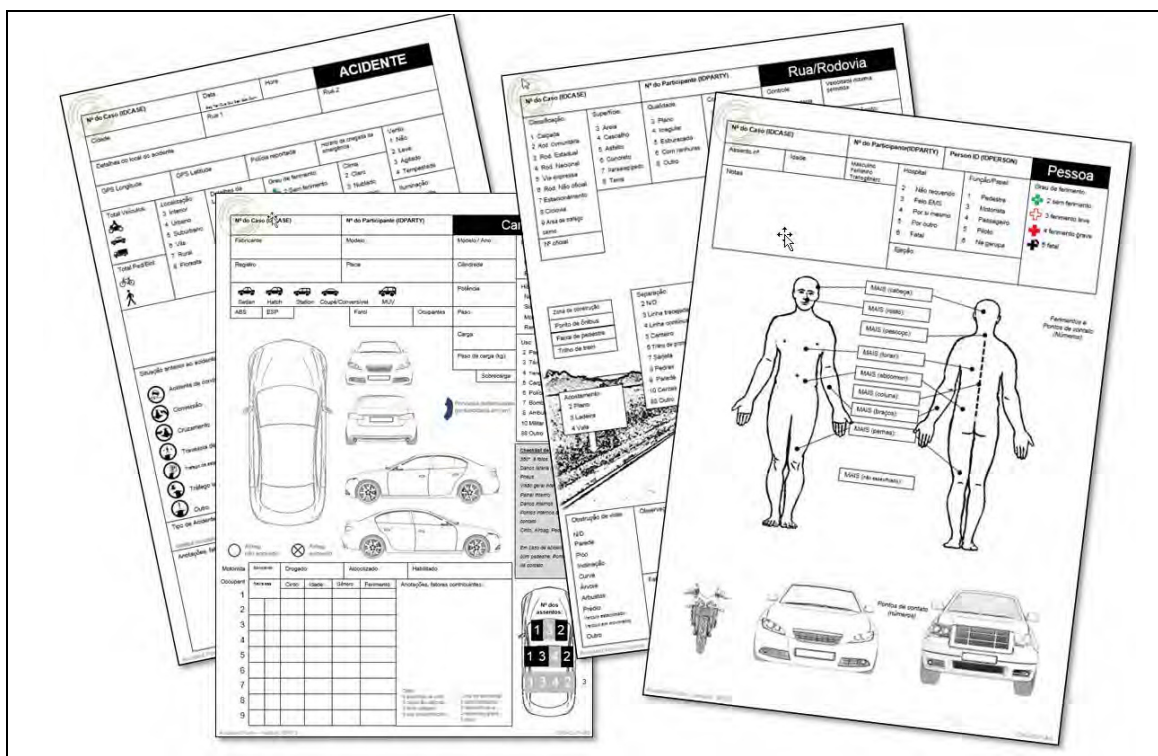
In analogy to other international studies like *GIDAS*, *RASSI* or *CIDAS*, a scientific photo documentation and a scalable CAD accident sketch are also content of each case in the Brazilian

accident investigation. *Figure 8* shows the training of scientific photo documentation in the simulated case at the *EMDEC* facilities.



*Figure 8a, 8b and 8c: Training documentation vehicle details*

For effective on-spot data collection a Brazil related investigation form was developed which was in use during the pilot study. The forms (see *figure 9*) were optimized on quick data collection and translated in Portuguese language.



*Figure 9: On-spot investigation forms*

Injuries are recorded, too and will be expanded in cooperation with the emergency services and hospitals in the future.

## Database

In addition to the training of data collection a new Brazilian adapted system of data storage was developed. This new digital database includes 12 records with 400 variables<sup>1</sup> and approximately 3.000 detailing specifications options for each accident. The database structure and content allows international comparison of study results and supports the harmonization with other accident databases like *iGlad*.

In addition to the accident pictures and scaled accident sketch the digital database of the pilot study includes detailed information about:

- Accident scene (traffic control, traffic signs, location details, ...)
- Weather information (climate, visibility, ...)
- Street conditions (constitution, number of lanes, infrastructure details, ...)
- Participant details (role, causes of accident, ...)
- Vehicle details (body type, features, usage, active & passive safety, ...)
- Vehicle damage (location, deformation, description, ...)
- Accident reconstruction (event and vehicle wise details, speed, collision partner, ...)
- Person information (role, usage of safety features, ...)
- Injury coding (Injury details, location, classification, ...)
- Police and rescue service relevant details

The clear structure and consistent key and link variables (see *figure 10*) allow the implementation of further details and comparisons with other in-depth accident databases.

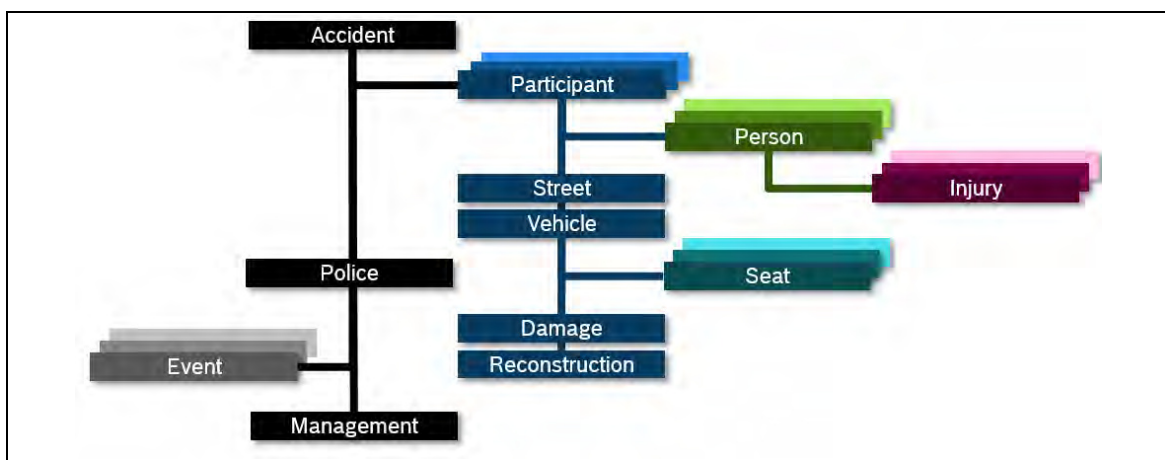


Figure 10: Database structure

In the pilot study the data input method is realized with a GUI based on Microsoft Access. To avoid problems with wrong data format and values and to make an easy coding possible nearly all variables are labeled and can be coded with drop down lists. This method allows the automatic generation of the coding manual, too. The database is available in Portuguese and English.

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<sup>1</sup> Accident with two participants

Figure 11: User interface of pilot study accident database (screenshot)

In case of a long term activity following on the pilot study an enhanced database can be used easily because the structure and data can be transferred to other systems with low effort. The applied structure allows the integration of automatic plausibility checks and flexible administration.

### Data collection

After the intensive training and the supply of the database by the accident research specialists, the educated on-spot team was fast effective in doing on-spot data collection.

Relevant accidents in the investigation area are notified by using *EMDEC* internal communication. If an accident happens the *EMDEC* traffic agents will be informed by rescue services, police or participants in order to secure the accident spot and to manage the traffic.

With this short notification chain the accident spot was reached within 15 till 20 minutes. During the first cases of data collection the on spot investigation was intensively supported by accident experts of Bosch. After the theoretical and practical training inside the *EMDEC* facilities, the accident collection started with parallel practical training on real accident spots documentation in the database system.

For good cooperation and official acceptance, firefighters and police were involved during the complete training period, too.

The first documented accidents were very different and ideal for the intensification of training. Different vehicle types (motorcycles, cars and trucks), different accident situations like “rear-end collisions”, “pedestrian crossing” or “loss of control” were investigated.

The following example (case 552016010005) shows a driving accident in the first week of the accident research activity in Campina, SP.

*The driver of the white car turned at the intersection (controlled by traffic lights) to the left. Possibly due to high speed the vehicle crashed with its tires/rim in the curbs on the right-hand side during turning maneuver. After collision the driver lost control and the car ran over both lanes and curbs on the left-hand side till colliding with a pole. Driver and front-seat passenger were injured.*



Figure 12a: Vehicle end position



Figure 12b: marking of tire marks



Figure 13a, 13b and 13c: Part of 360° picture documentation



Figure 14: Accident scene in driving direction



## First results

After a few weeks of accident investigation, the database is now filled with more and more accidents. At this time the results are not representative for Campinas or Brazilian cities (to less number of cases) but this data gives an impression of the different accident situations which have to be investigated. The first analysis of the database shows a mix of different vehicle types (see *figure 15*). As suspected, the database also contains a high proportion of motorcycles which corresponds to the typical street scene.

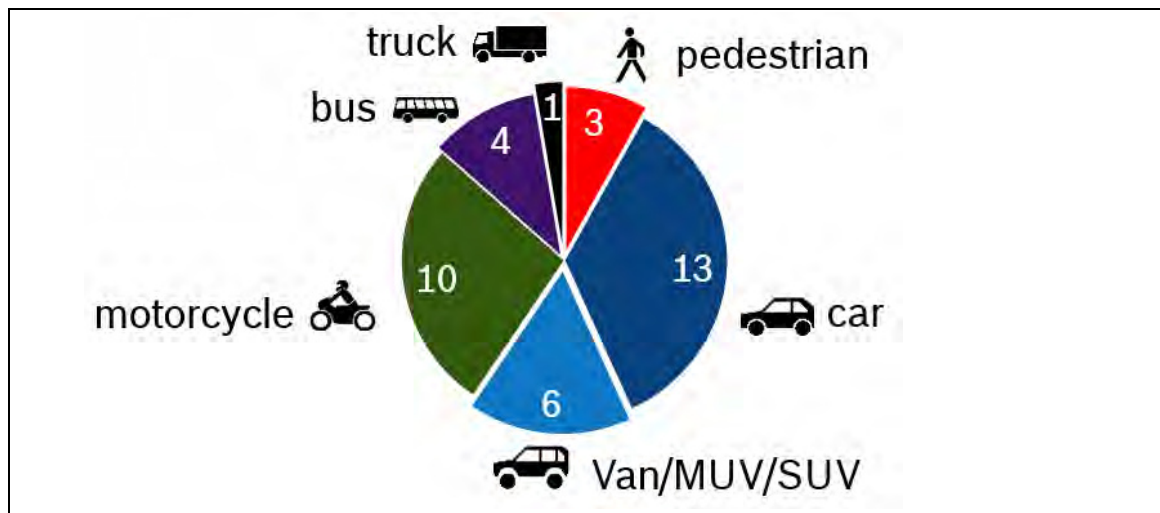


Figure 15: Participants involved in documented accidents (status May 2016 n=37)

Also the distribution of “Accident Type” looks typical for urban area (*figure 16*). Accidents in lateral traffic (especially rear end conflicts) dominates the dataset of the pilot study.

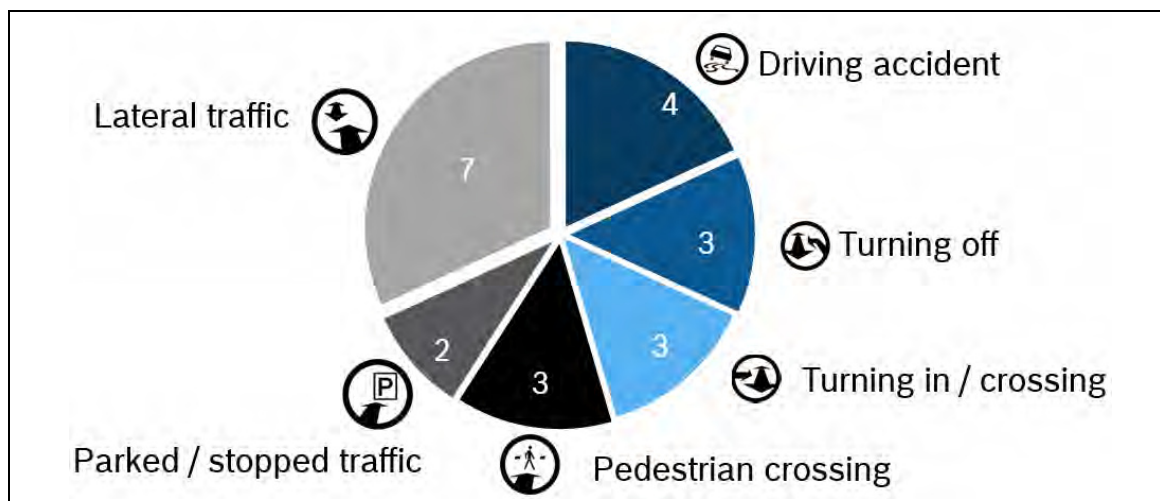


Figure 16: Distribution of accident type (status May 2016, n=22)

Accident with initial critical situation in lateral traffic often ends in collision with a vehicle moving ahead or waiting in front. This can also be recognized in distribution of Variable “Accident Kind” (*figure 17*).

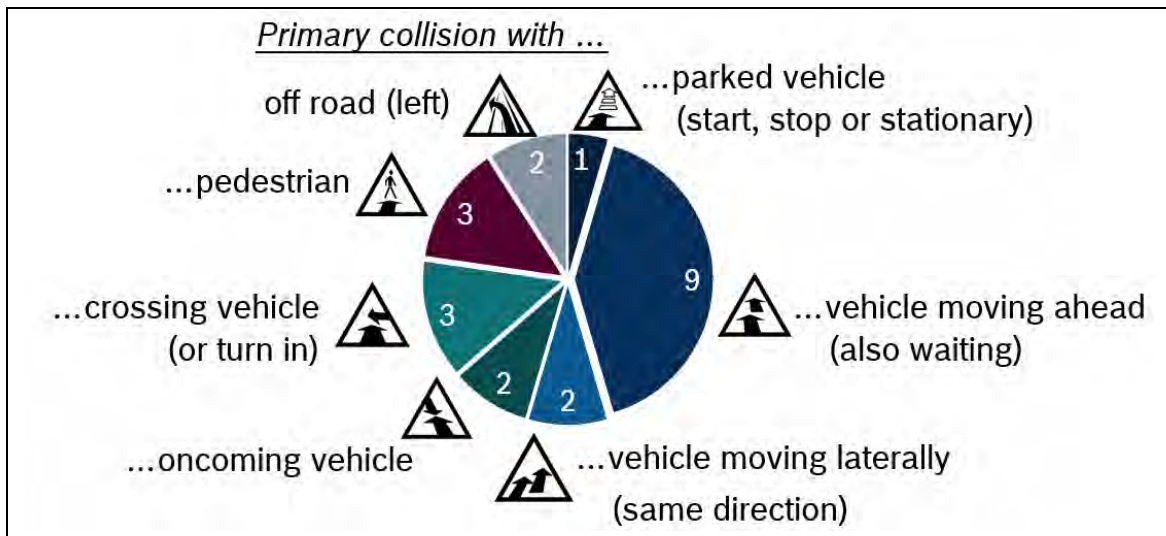


Figure 17: Distribution accident kind (status May 2016, n=22)

Reasons of the documented accidents were mainly “disregarding traffic rules” like “give way”, “lack of safety distance” and “speeding”.

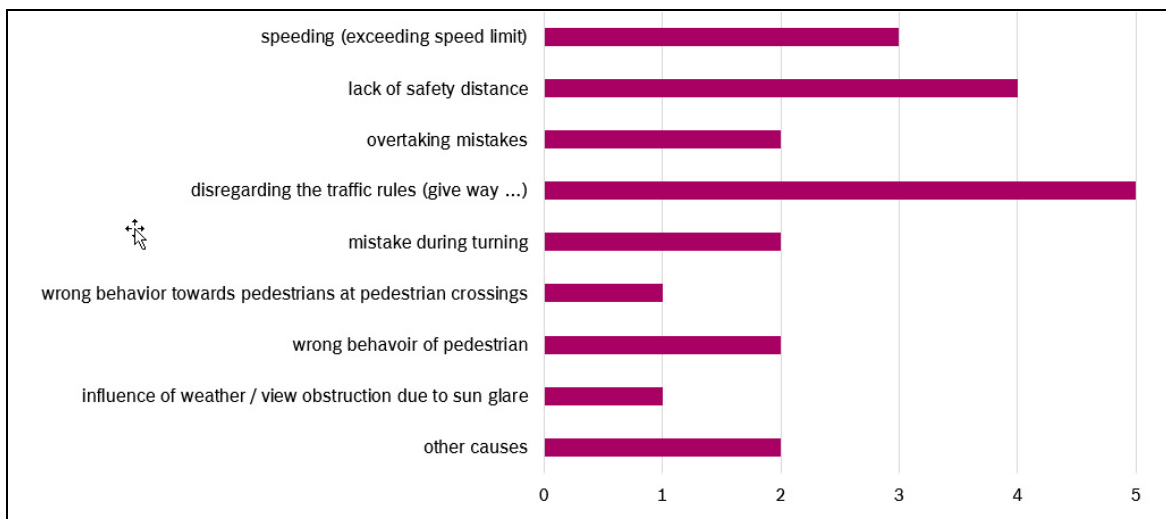


Figure 18: Documented root causes of accidents (status May 2016, n=22)

At this point of time the results are just a glimpse of the pilot study and the low number of collected accidents is not qualified for statistical analysis. Nevertheless first results such as type and kind of shows the potential for Brazilian related analysis. Furthermore such data enables an international comparison in near future.

## Outlook

The experience after few weeks of running accident collection shows that a baseline has been laid to build up a long term activity regarding in-depth accident research in Brazil. By end of 2016 the results will show that such investigation is more than required to improve traffic safety hence it is more likely that the investigation will be continued in 2017. Therefore a next step is to find further stakeholders like vehicle manufactures, supplier, safety-, infrastructure- or governmental related organizations which are willing to support this activity in future as a long-term investigation.

The investigation area should be expanded to rural area to increase representativeness. Therefore other authorities has to be taken into account hence further discussions to be made to get permission to access the accident site.

The implementation of automatic plausibility checks and development and usage of easy administrable database has to be done in advanced to reach high quality standards. Existing experience in other international activities like *GIDAS*, *RASSI*, *CIDAS* and *iGlad* is very beneficial to bring the Brazil project to a comparable level in short time.

First results of such long-term accident study can be used for comparison of real accident situation against Latin-NCAP results. Moreover results will lead to further traffic safety measures to improve traffic safety in Brazil. It will then also be possible to determined benefits from existing active and passive vehicle safety solutions in Brazil in future. Results can also be used for future campaigns with the goal to increase safety awareness in general.

- [1] Ministry of Health – Brazil - DATASUS database Update 02/2016  
Brazilian association for the prevention of traffic accidents  
[http://www.vias-seguras.com/os\\_acidentes/estatisticas/estatisticas\\_nacionais/estatisticas\\_do\\_ministerio\\_da\\_saude](http://www.vias-seguras.com/os_acidentes/estatisticas/estatisticas_nacionais/estatisticas_do_ministerio_da_saude)  
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World Health Organization  
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