Road safety in Antananarivo, capital of Madagascar: a naturalistic observation study of road users and motorcycle helmet use rates

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Introduction and Background

Road safety has become a public health problem of global proportions. The World Health Organization (WHO) estimates that road deaths are the 8th most frequent cause of death globally and the leading cause of death for children and young adults between 5 and 29 years old (WHO 2018). In the context of the United Nations Sustainable Development Goals (SDGs)[1], road safety targets are included in SDG 3 (Good Health and Well-being) and SDG 11 (Sustainable Cities and Communities):

- **SDG 3, Target 3.6:** By 2020, halve the number of global deaths and injuries from road traffic accidents;
- **SDG 11, Target 11.2:** By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

In Antananarivo, Madagascar's capital city, socio-economic activities are appealing and, as a result, the number of inhabitants in the city is increasing. According to the latest data from the National Institute of Statistics (INSTAT 2019), Antananarivo is the most populated city in Madagascar, with 1.2 million inhabitants, compared to 326,000 in Toliary, 245,000 in Antsirabe, and 244,000 in Mahajanga. Antananarivo is also the Malagasy city which has seen a greater increase in its population, an increase of more than 500 thousand inhabitants between 1993 and 2018; the Analamanga region, where Antananarivo is located, has 3.6 million inhabitants (14% of the Malagasy population). Furthermore, between 2011 and 2019, an average of 1,285 vehicles per month were registered in Antananarivo[2]. Traffic in the Antananarivo area is thus becoming more and more complex, and the existing road infrastructure cannot meet the requirements of increased traffic flow and new mobility demands (e.g. sufficient parking space, cycle lanes, public transport lanes, etc.).

As a result of the increased motorization, articles reporting on road crashes are frequently published in local newspapers.[3] The majority of victims mentioned in these articles are pedestrians and especially motorcyclists. However, official data on road safety in the Antananarivo area and in Madagascar in general is still limited. WHO's latest road safety report estimates that road deaths in Madagascar in 2016 were 7,108, but data from the Malagasy Gendarmerie reported only 340 deaths, indicating a high level of underreporting (WHO 2018). WHO data estimates a death rate of 28.6 per 100,000 inhabitants for the country, which puts Madagascar among the average of low-income countries, an average three times higher than that of high-income countries. Since a large share of motorized traffic in Madagascar consists of motorcycle and scooter riders, special focus has to be given to their safety. Despite this importance, and the existing law for mandatory motorcycle helmet use, no data is available on actual motorcycle helmet use in the country (WHO 2018).

[1] https://www.un.org/sustainabledevelopment/fr/objectifs-de-developpement-durable/
[2] https://tradingeconomics.com/madagascar/car-registrations (source: INSTAT Madagascar)
[3] https://www.newsmada.com/2020/07/10/soanierana-un-scooteriste-se-retrouve-sous-un-poids-lourd/; http://www.midi-madagasikara.mg/faits-divers/2019/12/30/ambohitrarahaba-et-ivato-3-morts-dont-un-ressortissant-etranger-dans-des-accidents-de-moto/

In this context, data collection and management must be improved so that we can understand the true dimension of the problem and thus ONG Lalana, through a partnership with Dr. Felix Siebert, researcher at the Friedrich Schiller University Jena, Germany and Paolo Perego, researcher at the Università Cattolica del Sacro Cuore di Milano, Italy, took the initiative to carry out a naturalistic observation study of the users of the main roads in the capital. The goal was to register the movement of two-wheeled vehicles travelling on one of these main roads (the ring road, *Route Circulaire*) and to produce data on the number of powered two-wheeler (PTW) drivers and passengers wearing helmets for their safety. The importance of helmet use while riding a PTW has been reported by scientific research: it has been estimated that helmets can reduce the risk of head injury by 69% and the risk of death by 42% (Liu et al. 2008). With our initiative we aim to generate new knowledge that will contribute to improving the national road safety strategy and, in the long term, bring about positive change for road users in Madagascar.

1. Choosing the observation sites

In order to facilitate the camera installation and to better manage the recordings, ONG Lalana's office was chosen as an observation site. ONG Lalana's office is located in the South-eastern part of Antananarivo's ring road (*Route Circulaire*). The *Route Circulaire* is one of the main roads in the capital, used by road users coming from the Southern and Eastern areas of Antananarivo on their way to the city centre and serving schools, offices, and local businesses located in the South-eastern area of the capital. The road is on average 8m wide, plus 1m to 2m on each side used as pavements for pedestrians. The following map shows the observation point in relation to the city centre (Picture 1).

Picture 1: Map showing the observation site in relation to the city centre

2. Observation method

A camera was installed on the office balcony and the traffic was recorded every day for one week. Compared to other research methods (for example, direct observation or survey research), video observations are particularly useful for this kind of study, as they allow researchers to slow down the image and observe all the details, not only regarding the type of road users but also regarding road user behaviour. In addition, video recording allows the data and observations to be reviewed by other researchers and relevant stakeholders. For our study, the team made observations on the type of road users and helmet use among two-wheeler riders (drivers and their passengers). The observations were carried out from **7am to 5pm,** from Tuesday 25 February until Monday 2 March 2020, i.e. a duration of 10 hours per day, without interruption, covering the 7 days of the week. The team was unable to carry out the observations beyond this time slot since the camera was unable to distinguish the helmets in the absence of daylight. However, the chosen time slot represents the highest traffic volume of the day. The team used the software BORIS to register the observations on the video recordings.

3. Observations on road users

3.1. Observed road user categories

To analyse the share of different road users on traffic, all road user categories observed at the observation site were registered for three days, Tuesday, Thursday, and Sunday. The three days were selected to represent those days with the highest (Tuesday) and lowest (Sunday) traffic, as well as average traffic (Thursday). Table 1 shows the percentage of different road user categories observed at the study site on three days.

Table 1: Observed types of road users.

Road user category	Tuesday	Thursday	Sunday	Total	Percentage
Pedestrians	3,595	2,686	1,806	8,087	25.4%
Two-wheelers	2,889	3,123	1,492	7,504	23.5%
Private cars	3,054	3,649	2,186	8,889	27.9%
Taxis	742	841	656	2,239	7.0%
Buxis*	1,699	1,486	1,337	4,522	14.2%
Other (tricycles, vans)	129	119	46	294	0.9%
Trucks	157	156	31	344	1.1%
Total	**12,265**	**12,060**	**7,554**		
			Grand total	**31,879**	**100.0%**

*Minibuses with 15 to 20 seats used as public transport.

Two-wheeled vehicles alone make up approximately one fourth (23.5%) of all road users.

3.2. Two-wheeler traffic

The number of two-wheeled vehicles (motorised and non-motorised) passing by the observation site is presented in Table 2.

Table 2: Number of two-wheeled vehicles counted during the 7 days of observations.

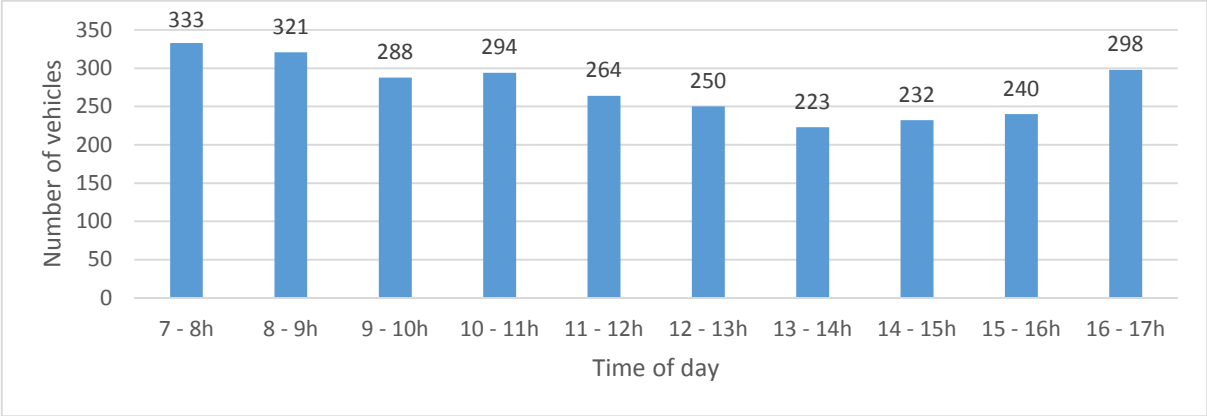
Day :	Tuesday 25/02/2020	Wednesday 26/02/2020	Thursday 27/02/2020	Friday 28/02/2020	Saturday 29/02/2020	Sunday 01/03/2020	Monday 02/03/2020	**Total**
Number :	2,889	3,031	3,123	3,025	2,439	1,492	3,206	**19,205**

A total of 19,205 two-wheeled vehicles were observed during the whole week. Approximately half (53.3%) were heading toward the city centre. The number of two-wheeled vehicles varies from 2,889 to 3,206 on working days, and is reduced to 1,492 on Sunday, which is usually a resting day.

While the observed traffic flow is relatively constant, the number of observed two-wheelers is highest on Monday, the first day of the working week, and Thursday, which could be explained by the Mahamasina market day – on this day, riders might prefer to take this South-eastern ring road to avoid traffic jams on the major western axis (boulevard Ratsimandrava - RN 7).

Throughout the day, observed two-wheeler traffic is lowest between 1pm and 2pm, and highest between 7am and 8am, the first hour of observation (Figure 1)[4].

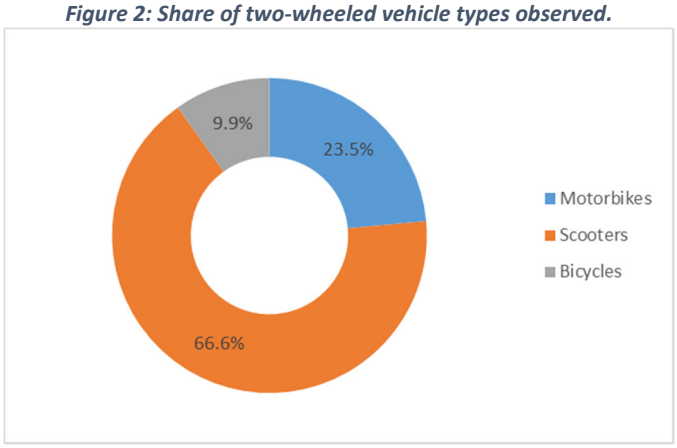
Figure 1: Average number of two-wheeled vehicles per time of day during the 7 days of observations.



3.3. Types of two-wheeled vehicles

Scooters are the most frequently used two-wheeled vehicles, accounting for 66% of the two-wheeled vehicles observed, while motorcycles have a share of 23.5%. Bicycles are observed less frequently with a share of 9.9% throughout the 7 days of observations. The figure below represents the distribution of the types of two-wheeled vehicles wheels observed.

Figure 2: Share of two-wheeled vehicle types observed.



3.4. Two-wheeler drivers by gender

Only 1.5% of the two-wheeler drivers were observed to be female (table 3).

Table 3: Number of two-wheeler drivers observed by gender.

Gender[5] :	Female	Male	**Total**
Number :	288	18,892	**19,180**
%	1.5%	98.5%	

Figures 3 and 4 summarise the type of two-wheeler vehicles according to gender of the driver. Women drive scooters much more than men, almost 88% compared to 66%, and very few women were observed driving bicycles.

[4] Although this data is not presented in Figure 1, Sundays do not comply with this rule, since the drop in traffic at this time of day is not very distinctive compared to other times of day.

[5] During the observations, gender could not be identified for 25 people.

Figure 3: Two-wheeled vehicle type, female drivers (N=288).

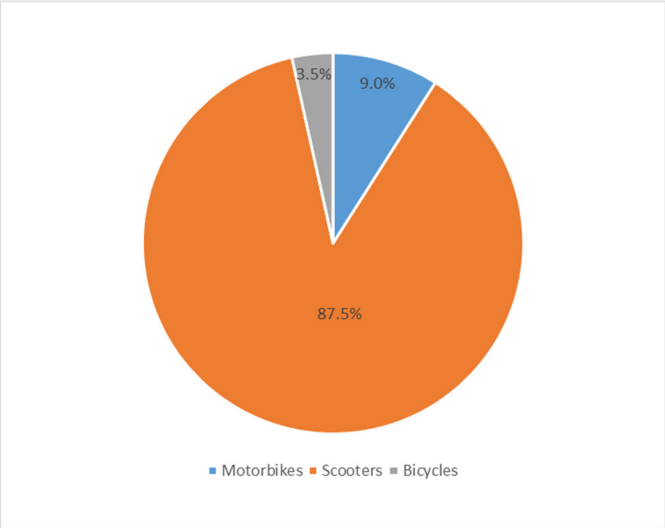
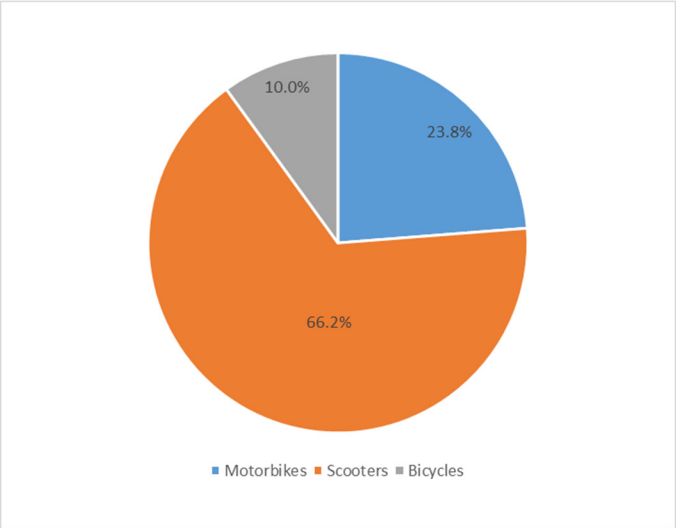


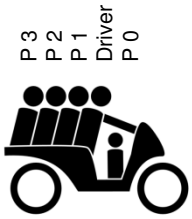
Figure 4: Two-wheeled vehicle type, male drivers (N=18,892).



3.5. Passengers

The position of the passengers in relation to the drivers was coded according to the following scheme during the observations.

Picture 2 Passenger position (coded)



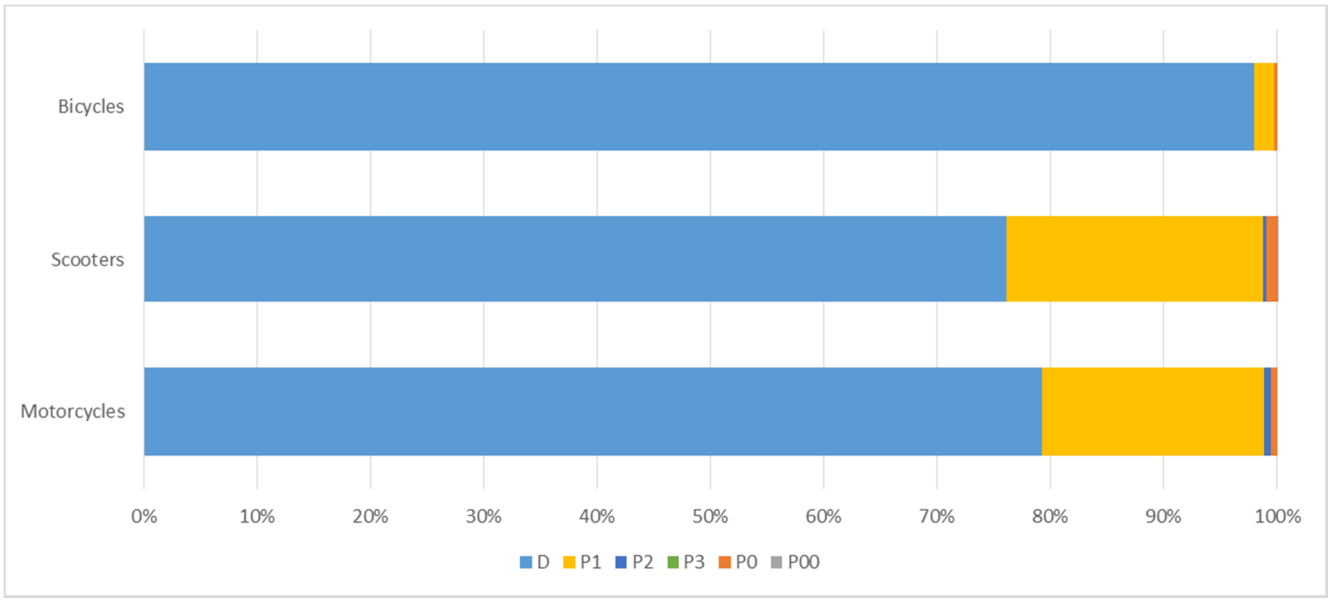
If the driver (*Driver* in picture 2) carries a second passenger in front of him/her, the coding of this passenger would be P00. The number and distribution of the passenger position observed is shown in Table 4. A total of 5,237 passengers were counted during the 7 days of observations (in comparison with 19,205 drivers) and it is mainly scooters that carry passengers (4,011 passengers observed in scooters).

Table 4: Passengers observed according to their location

Position	Motorcycles	Scooters	Bikes	Total
Driver	4,521	12,784	1,900	**19,205**
P0	33	163	6	**202**
P00		2		**2**
P1	1,123	3,796	33	**4,952**
P2	30	49		**79**
P3	1	1		**2**
Total Passengers	**1,187**	**4,011**	**39**	**5,237**
Total (all)	**5,708**	**16,795**	**1,939**	**24,442**

Figure 5 shows the distribution of drivers and passengers per vehicle type. It can be observed that while riders on scooters and motorcycles consist of approximately 20% passengers, they only constitute 1.7% on bicycles. Almost all of the observed passengers are at the P1 position (yellow bar) and there are only a small number of P2, P3, or P0 passengers, i.e. most vehicles only carry one additional passenger.

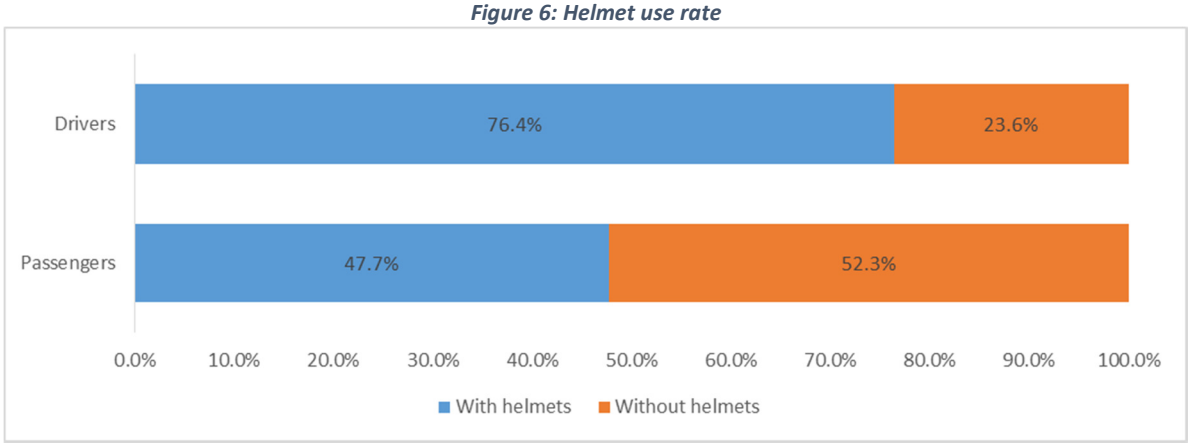
Figure 5: Distribution of passengers on two-wheeled vehicles.



4. Observations on the use of helmets among PTW riders

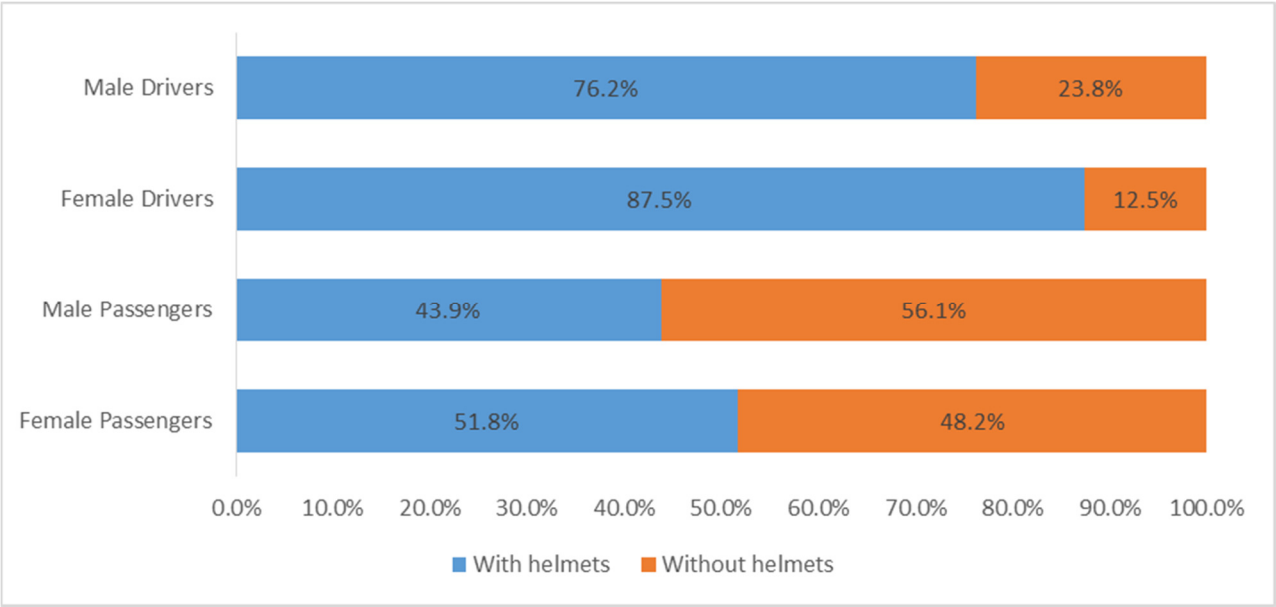
Helmet use rate for PTW drivers and their passengers observed is presented in Figure 6. We found that 76% of PTW riders were wearing helmets, while more than half of their passengers were not.

Figure 6: Helmet use rate



Furthermore, for helmet use according to observed gender, we found that women have a higher helmet use rate than men, where 87% of female drivers use a helmet, compared to 76% of male drivers. Similarly, female passengers use a helmet in 52% of observed occurrences compared to 44% helmet use in male passengers (figure 7).

Figure 7: Helmet use rate according to gender.



5. Comparing the results with data from other countries in Africa and the Indian Ocean

It is not easy to compare the results of our study with other countries in the region, due to a lack of detailed data. The WHO Global Status Report on Road Safety (2018) lists PTW helmet use data for only two other member countries of the Southern Africa Development Community (SADC), of which Madagascar is a member. Angola, with 40% helmet use among drivers and 15% among passengers; and Lesotho, with a rate of 75% for drivers and 3% for passengers. Other data from survey research[6] conducted by the UK-based NGO Transaid in five African countries (Ghana, Kenya, Tanzania, Uganda and the Democratic Republic of Congo (DRC)) show relatively low rates of self-declared helmet use by riders, at an average of 35%, with the highest rate reported in Tanzania (81%) and the lowest in DRC (5%), as shown in figure 8.

Compared to existing data from SADC countries, the helmet use rate of PTW drivers and passengers in Madagascar's capital Antananarivo is well above the average for the SADC region and even for other African countries for which recent data is available. This is despite WHO experts' estimates that the enforcement of the mandatory helmet use law in Madagascar is comparatively low, rated as only 2 out of 10. However, for a more comprehensive analysis and for conclusions that apply nationwide, geographically representative observations should be made in other Malagasy cities, national roads, and rural areas.

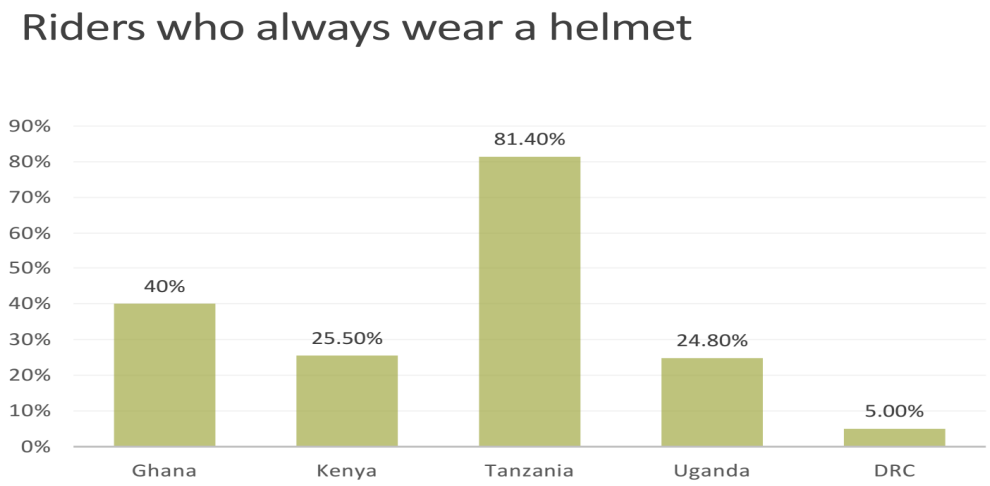
[6] It should be noted that data collected by questionnaire from riders is not directly comparable to data collected by naturalistic observation. An article by Siebert et al. with data collected in Tanzania showed that the self-reported helmet use rate by riders is significantly higher than the rate produced by observing the video recordings of roadside cameras (Siebert et al. 2018).

*Table 5: Helmet use data in the SADC countries**

SADC member country	Is there a national motorcycle helmet use law for riders and their passengers?	Level of enforcement (0-10)	Helmet use rate
Angola	Yes	7	40% Drivers / 15% Passengers
Botswana	Yes	8	No data
Comoros	Yes	No data	No data
Democratic Republic of Congo	Yes	4	No data
Eswatini	Yes	5	No data
Lesotho	Yes	8	75% Drivers / 3% Passengers
Madagascar	***Yes***	***2***	***No data***
Malawi	Yes	2	No data
Mauritius	Yes	10	No data
Namibia	Yes	7	No data
Seychelles	Yes	7	No data
South Africa	Yes	8	No data
Tanzania	Yes (but only for drivers)	6	No data
Zambia	No data	No data	No data
Zimbabwe	Yes	8	No data

* Source: Country fact sheets in the *Global status report on road safety 2018* (WHO 2018).

Figure 8: Helmet use by riders in Ghana, Kenya, Tanzania, Uganda and DRC (survey results)*



* Source : Transaid webinar "Insights on motorcycles and motorised three-wheelers before and during COVID-19", 30/06/2020[7]

[7] available here: https://www.youtube.com/watch?v=ZJvMUs7djjE.

Conclusion and Next Steps

This first naturalistic observation study allowed us to draw a first picture of road users in Madagascar's capital and most populated city, Antananarivo:

- Two-wheeled vehicles account for 23.5% of the vehicles in circulation observed, of which **powered two-wheelers (PTW – scooters and motorcycles) represent 90%**;
- We observed that **76% of PTW riders** registered during this observation on this south-eastern part of Antananarivo's ring road **were wearing a helmet**;
- However, **more than half of their passengers were not wearing a helmet (52%).**

Thus, awareness and enforcement actions will have to be strengthened so that all PTW riders and passengers are aware of the road safety imperative of wearing a helmet while riding their vehicles.

Other questions also deserve to be raised: do the helmets worn by these users using two-wheeled vehicles meet the required standard? Do they effectively protect their heads in the event of a crash? We observed that some helmets worn by riders did not provide full coverage and protection for the head, hence further analysis through other research methodologies (e.g. questionnaire surveys) is needed to better understand this reality.

Wearing a helmet is not enough to ensure the safety of PTW drivers and their passengers. It is also essential to make drivers aware of the importance of good driving practices and respect for speed limits, as moving at high speed in the city is often the cause of road crashes. Finally, it is also important to consider the road conditions, which could disturb the stability of two-wheeled vehicles. In fact, coordinated action is needed to improve road safety. Initiatives need to be taken at different levels, using a systems approach, and the United Nations have identified five pillars to guide government intervention for road safety: 1) building road safety management capacity; 2) improving the safety of road infrastructure and wider transport networks; 3) further developing vehicle safety; 4) improving road user behaviour; and 5) improving post-crash response. In any case, having reliable data is the first step towards taking concrete and effective action based on evidence.

Another important point not to be overlooked is the presence of pedestrians - our observations have noted that pedestrians represent 25.4% of road users at the observation site and recent figures estimate that 47% of deaths on Malagasy roads are pedestrians (WHO 2018). A study carried out by ONG Lalana among 1,150 pupils of Public Primary Schools in Antananarivo, Antsirabe, and other schools along National Road 7 found that **94% of those students walk to and from school, usually in groups with other children (ONG Lalana 2019)**.

As a follow-up to this first naturalistic observation study, the NGO Lalana will continue its research and actions in this field, with a view to sharing information and data with the national authorities and other relevant stakeholders, in order to support them in improving Madagascar's strategies for safer roads. Thus, in the coming months we will plan activities to follow up on this research, including:

- Choosing other geographical areas as observation points to increase the scope of this research: another major axis in the Capital, National Roads, and rural roads, taking into account the urban, semi-urban or rural contexts;
- Collaborating with our university partners in the writing of a scientific article on helmet use in Madagascar;
- Other surveys to deepen existing knowledge on this topic in Madagascar will be developed.

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Photo Credit : Cover photos by ONG Lalana, showing traffic congestion examples in Antananarivo. The first photo shows this study's observation site.