ESTIMATION OF THE ECONOMIC LOSSES DUE TO THE LACK OF ROADS IN ANTANANARIVO IN 2016

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Abstract

The purpose of this study is to highlight the lost opportunities in road congestion, which dwellers Antananarivo live on a daily basis. The present research serves as a basis for reflection on Antananarivo urban development. It can also be exploited by political leaders to streamline their policies and decisions on the future of the agglomeration of Antananarivo.
According to the calculations and hypothesis used in the modeling, in 2016, Antananarivians have 868,760,556 fuel loss Ariary per day.

Keywords: Antananarivo, economic losses, traffic, speed.

1- INTRODUCTION

The car is the means transport of a large number of Antananarivo. The tracks are the infrastructures that allow economic exchange and movement of population in the City of Thousands, for activities such as work, study ... Thus, the tracks are infrastructure promoters for economic development. However, in the case of Antananarivo, the movement and transport on roads lead to economic losses via traffic congestion.

This raises the following issue: "What is the estimated economic and opportunity loss associated with bottling?"

The objective of this study is to evaluate the traffic speed in the City of Thousands and the losses related thereto. To achieve this overall objective, the methodology is to study successively: the difference between the speed of the current traffic and the speed of the "fluid traffic", the calculation of the total traveled distances during time intervals, and finally, the calculation of the time and opportunity loss cost for each interval.

2- METHODS

3.1 - Quick simulation results average speeds

Here (Table 1, Table 2) is a reminder of the calculation results of traffic modeling in reference: Henipanala Mampionona, Rakoto David Séraphin, Rambinintsoa Tahina, simulation of antananarivo urban traffic, 2016 [7].

Table 1 - The average speed of traffic in the CUA

Times	[7h,9h]	[9h,11h]	[11h,13h]	[13h,15h]	[15h-17h]
Speed	4,6km/h	13,3km/h	6,2km/h	15,6km/h	11,4km/h

Table 2 - The average speed of traffic in the outskirts of Antananarivo

Times	[7h,9h]	[9h,11h]	[11h,13h]	[13h,15h]	[15h-17h]
Speed	12,5km/h	24,7km/h	16,3km/h	29,2km/h	21,1km/h

3.2 - The loss of time calculation

321- The speed of fluid traffic

In developed countries, in urban areas, there are areas where traffic speed is limited to 30km / h [4]. These are the "Area 30". They are used when the speed of 50 km / h is dangerous, particularly because of the narrowness of the streets [9], their accident-prone character or the particularly high presence of pedestrians. They are also placed at the entrance of some cities to reduce the speed of road users.

The maximum speed allowed in an urban area is 50 km/h. This limit was established based on human physiological limits (visual perception, incompressible reaction time of at least one second, impact resistance, etc.) and physical laws based on the relative distance / speed / time. 50 km/h is a limitation which aims to reduce the risk to pedestrians, in particular.

At 50 km/h on dry pavement, stopping distance, that is to say the distance traveled during the reaction time and the braking distance is 28 meters; it reaches 36 meters at a speed of 60 km / h, or 8 meters longer to stop. In other words, a motorist traveling at the speed limit of 50 km / h travels 28 meters before stopping. 50 km / h is the appropriate maximum speed to ensure the safety of users and to face the dangers of traffic in urban areas [2].

In the case of Antananarivo, where there is a large number of pedestrians and narrow streets, we suggest that the maximum permitted average speed in town is 35km / h. The calculation of the loss of time and opportunity cost is based on the difference between the speed of current traffic and the speed of "fluid traffic" which is 35km/h.

3.2.2 - The difference between the speed of the current traffic and the speed of "fluid traffic"

Here (Table 3 , Table 4) is the difference between these two speeds:

Table 3 - The difference between the two speeds in the case of the CUA

Times	[7h,9h]	[9h,11h]	[11h,13h]	[13h,15h]	[15h-17h]
Difference	30,4km/h	21,7km/h	28,8km/h	19,4km/h	23,6km/h

Table 4 - The difference between the two speeds on the outskirts of Antananarivo

Times	[7h,9h]	[9h,11h]	[11h,13h]	[13h,15h]	[15h-17h]
Difference	12,5km/h	10,3km/h	18,7km/h	5,8km/h	13,9km/h

3.2.3 - Calculation of total distance traveled during the time intervals

Here is the method to calculate the total traveled distance during the time intervals:

- The calculation is based on the number of displacement between each zone pair (or mesh) and the distance between each pair of zone.
- Modal distribution is taken to determine the number of trips by cars (cars, buses, carriers, etc.) between each pair of zone.
- The "total distance between each zone pair" (DTPij) is the multiplication of the "number of cars traveling between each pair zone" by the "distance between each zone pair."
- The «Total traveled distance during the time interval" is the sum of all the " distances traveled between each pair of zones": DTP = sum of DTPij [1].

a - The number of trips and distance between each pair of area (table 5)

Table 5 – The distance and the number of trips between each pair of area

Zone Pair	distance (km)	[7h, 9h]	[9h, 11h]	[11h, 13h]	[13h, 15h]	[15h, 17h]
Ankaraobato - Tanjombato	0.54	185	72	155	64	75
Tanjombato- Ankaraobato	0.54	1318	489	974	441	543
Anosizato- Itaosy	0.9	907	321	645	278	374
Anosizato- Bemasoandro	1.08	1587	663	1237	438	621
Bemasoandro- Anosizato	1.08	645	231	452	203	252
Soavina- Ampitatafika	1.63	96	21	107	28	41
5e arrond- 3e arrond	1.82	17460	6173	12643	4672	6721
Bemasoandro- Itaosy	1.98	4354	1441	2132	1312	1764
Ivato aérop- Ivato firais	2.32	541	164	603	176	213
Tanjombato- Andoharanof	2.36	1698	561	1577	453	683
Andoharanof- Tanjombato	2.36	412	196	501	132	178

(The table has 26 x 25 = 650 lignes, hence, we only present this excerpt)

b- The displacement performed by cars between each pair of area

According to the modal split of travel:

- 22,9% of trips are made by private vehicles
- 2,2% by taxis
- 1,9% by other vehicles (trucks, ...)
- 66% by pedestrians and taxi-be. We assume that the intra-zone distance is traveled on foot, and inter-area by taxi-be trips. In our calculations, a bus takes 18 passengers [9].

Hence, the travel by car is: 22, 9% 2, 2% + 1, 9% 66% / 18 = 30, 6% of the travels. It is noted that private vehicles account for the majority of car trips (22.9 / 30.6 = 74%). So in the calculations, it is assumed that each vehicle consumes an average of 9l Diesel per 100km.

Applying this distribution on the number of trips between each pair of area, we obtain the number of travel by car between each pair of zone. Hence, the following table 6:

Table 6 – The number of travel between each pair of zone

Zone Pair	distance (km) **by car**	[7h, 9h]	[9h,11h]	[11h, 13h]	[13h,15h]	[15h,17h]
Ankaraobato - Tanjombato	1.72	94.6	36.12	79.12	32.68	37.84
Tanjombato- Ankaraobato	1.72	684.56	252.84	505.68	228.76	280.36
Anosizato- Itaosy	4.85	273	96	194	83	112
Anosizato- Bemasoandro	3.12	479	200	373	132	187
Bemasoandro- Anosizato	3.12	194	69	136	61	76
Soavina- Ampitatafika	5.68	28	6	32	8	12
5e arrond- 3e arrond	2.95	5272	1864	3818	1410	2029
Bemasoandro- Itaosy	2.09	1314	435	643	396	532
Ivato aérop- Ivato firais	2.32	163	49	182	53	64
Tanjombato- Andoharanof	2.36	512	169	476	136	206
Andoharanof- Tanjombato	2.36	124	59	151	39	53

(The Table has 26 x 25 = 650 lines, hence, only this excerpt is presented)

c- The "total distance performed between each zone pair" (DTPij) and the total distance DTP

The "total distance between each zone pair" (DTPij) is the multiplication of the "number of cars traveling between each pair zone" by the "distance between each zone pair." For instance, the total distance traveled by all vehicles between Ankaraobato and Tanjombato between [7h, 9h] is: 0,54km / displacement x = 55displacements 29,7km. Another example, the total distance traveled by all vehicles between Tanjombato and Ankaraobato between [7h, 9h] is: 0,54km / displacement x 398déplacements = 214,9km.

The table 7 shows the "total distance between each zone pair" DTPij:

Table 7 – The total distance between each zone pair DTPij

Zone pair	distance (km) **by car**	[7h, 9h]	[9h, 11h]	[11h, 13h]	[13h, 15h]	[15h, 17h]
Ankaraobato - Tanjombato	1.72	94.6	36.12	79.12	32.68	37.84
Tanjombato- Ankaraobato	1.72	684.56	252.84	505.68	228.76	280.36
Anosizato- Itaosy	4.85	1324.05	465.6	940.9	402.55	543.2
Anosizato- Bemasoandro	3.12	1494.48	624	1163.76	411.84	583.44
Bemasoandro- Anosizato	3.12	605.28	215.28	424.32	190.32	237.12
Soavina- Ampitatafika	5.68	159.04	34.08	181.76	45.44	68.16
5^e arrond- 3^e arrond	2.95	15552.4	5498.8	11263.1	4159.5	5985.55
Bemasoandro- Itaosy	2.09	2746.26	909.15	1343.87	827.64	1111.88
Ivato aérop- Ivato firais	2.32	378.16	113.68	422.24	122.96	148.48
Tanjombato- Andoharanof	2.36	1208.32	398.84	1123.36	320.96	486.16

(The Table has 26 x 25 = 650 lines, hence, only this excerpt is presented)

The "Total distance traveled during the time interval" is the sum of all the «distances traveled between each pair of zones": DTP = sum of DTPij. For example, DTP [7h, 9h] = DTPij [7h, 9h] = 94.6 + 684.56 + 1324.05 + 1494.48 +....

Here (table 8) is the total distance traveled in each time interval:

Table 8 – The distance travelled in each time

$DTP_{[7h, 9h]}$	$DTP_{[9h, 11h]}$	$DTP_{[11h, 13h]}$	$DTP_{[13h, 15h]}$	$DTP_{[15h, 17h]}$
1 595 086	524 696	1 287 297	414 298	653 476

3- FINDINGS

4.1- Calculation of the loss of time and opportunity cost for each interval

The time lost in the traffic jam (table 9) is the difference between the "time with the current traffic speed" and the "time spent with fluid traffic speed which is 35km / h."
As for the lost time, we are interested in the interval [7h, 17h] because these are the times when people work (workers begin at 7am and 8am, then end around 17h). Besides, traffic is assumed to be fluid outside this range

Table 9 – The time lost in the traffic jam

	The difference between the "time spent with the current traffic speed" and the "time spent with fluid traffic speed which is 35km /h				
Time	[7h, 9h]	[9h, 11h]	[11h, 13h]	[13h, 15h]	[15h, 17h]
DTP (km)	1 595 086	524 696	1 287 297	414 298	653 476
Average traffic speed (km / h)	4,6km/h	13,3km/h	6,2km/h	15,6km/h	11,4km/h
Travel time (hours)	346 757	39 450	207 628	26 557	57 322

Fluid traffic speed = 35km / h	35km/h	35km/h	35km/h	35km/h	35km/h
Travel time (hours)	45 573	14 991	36 779	11 837	18 670
Lost time (hours)	301 184	24 459	170 849	14 720	38 652

Hence, during the working days, the lost time in the traffic jam is then:

301,184 hours +24 459 hours +170 849hours+ 14 720 hours+ 38 652 hours = 549 864 hours. According to calculation, the Antananarivo inhabitants lose 549,864 hours per day in the traffic jam. If we suppose that, on average, in Antananarivo, the salary is 1200 MGA / hour in terms of production, Antananarivo dwellers lose 659 836 800 Ariary a day with the speed of the current traffic.

4.2-Fuel Losses

According to the Federal Office for Territorial Development (ARE) in Switzerland, the increase of fuel consumption during the congestion on the highway is going from simple to double, with 176% of increase (so 76% of loss)
In the case of Antananarivo, traffic jams usually takes place during the peak hours of [7h-9h]; [11h-13h] and [15h-17h]. Let's calculate the cost of this fuel loss. The distance total (DTP) during these time intervals are: 1 595 086 km for [7h, 9h]; 1 287 297 km for [11h, 13h] and 653 476km for [15h, 17h].
We saw that each vehicle consumes an average 9litres of diesel per 100km. The loss is to 9litres x 76% = 6,84litres diesel per 100km. If diesel costs 2,730 MGA / l, the cost of the fuel loss is then (table 10):

Table 10 – The loss of fuel

	[7h, 9h]	[11h, 13h]	[15h, 17h]
DTP (km)	1 595 086	1 287 297	653 476
Lost fuel volume (litres)	143557	115856	58812
Cost of fuel loss (MGA)	391 912 630	316 288 873	160 559 053

According to the calculation, *Antananarivo inhabitants have 868,760,556 fuel loss Ariary per day***.**
It is reported that with the bottling, vehicles wear out easily, and the emission of CO_2 increases considerably.

4- DISCUSSIONS

- The limit of modeling: illegal parking, illegal vendors ... which constitute spontaneous disturbance on the pathways and cannot be considered in this modeling.
- Data collection: to be as accurate as possible, this study requires the displacement of manual counts and socio-economic surveys that have relatively high costs.
- Further research should be made in order to be able to approach, as much as possible to reality and become a very effective tool in decision-making;

5- CONCLUSION

This introduction to research approximates and reflects the reality on the traffic of Antananarivo despite the fact that modeling is and would never be the reality.

The worst case is during the 7 to 9 hour rush hour with a traffic speed of 4.6km / h, on average, for the agglomeration of Antananarivo. The economic loss during the wait is estimated 868 760 556 MGA / day while the cost of production is estimated 1200 MGA / h.

These enumerated values are extravagant. Daily losses in bottling are equivalent to the construction of more than one kilometer of road, if we assume that the cost of one kilometer lane making is 600,000 000Ar (studies and small expropriations included).

It is obvious that the new lane creation increases the property value. Thus, any road study should be accompanied and followed by its impact study on the land cost.

It raises the question: “How much do we estimate the land added value of Antananarivo with the current lane creation project?”

BIBLIOGRAPHICAL REFERENCES

- [1] Bunch, D.S., M. Bradley, T.F. Golob, R. Kitamura et G.P. Occhiuzzo, “Demand for clean fuel vehicles in California: a discrete-choice stated-preference pilot project,” Transportation Research A, 27A (3), 1993, pp 237-253
- [2] Cabanne I., Robin F. X. ; Ongoing work on IUD 8 (Urbanism and Displacement Interface Program, volume 8: “Observation of the local mobility and urban dynamics”)
- [3], volet 8 :« Observation de la mobilité locale et des dynamiques urbaines »)
- [4] Cecchini, L., “A logit analysis of the car market,” Applied Economics Letters 8, 2001, pp 199-201
- [5] Caubel D. « Transport politics and Town access for all? An applied evaluation method in Lyon agglomeration”, Doctoral thesis in economic sciences, transport economy- March 31, 2006
- [6] De Jong, G.C., J. Fox, A. Daly, M. Pieters et R. Smit, “Comparison of car ownership models,” Transport Reviews 24 (4),2004, pp 379-408
- |7] Henipanala Mampionona, Rakoto David Séraphin, Rambinintsoa Tahina, “simulation of antananarivo urban traffic”, 2016.
- [8] La Lettre de l’Insee Rhône-Alpes, « Inventaire communal 1998 », Avril 1999
- [9] Louis Berger, Plan de Deplacement d’Antananarivo, 2004.
- [9] Rahir N. « A measure of the accessibility weight to jobs in unemployment explanation », Travail de fin d’études –30 juin 2006-09-14
- [10] Wenglenski S. « Accessibility in the labor market according to the social categories and residential locations”(in Ile de-France), Dec 2003.

LITERATURE REVIEW

- Berger Louis, Urban Transportation Plan of Antananarivo, 2004. -Transportation Research B, 30(4), 1996, pp 263-276
- Cambridge Econometrics (CE) et BMRB, “Demand for cars and their attributes,” Final Report, Department for Transport,” 23 Janvier 2008

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