What is the most efficient type of transport for your city – Study case of rio de janeiro city

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ABSTRACT: The main goal of this paper is a development theoretical reflection of types of public transportation vehicles like, Light Rail Train (LRT), Bus Rapid Transit (BRT) and Heavy Train to reduce the ratio of the Greenhouse Gases (GHG) emissions with the capacity of those vehicles at the cities and the ecological footprint each one of them release. The concept of urban mobility could support the cities to choose the most efficient type of transport for the place, because having a big vehicle does not matter this one is the most effective as to mitigate the green footprint of the city. The new technologies will support those vehicles to reduce the GHG emissions to transform the type of the transportation of the city into an efficient one. The cities developments are different, but have types and some similarities like, education level, industry, economy, environment and temperature, those topics could be used to ranking them in categories, supporting the creation of this guide. As a methodology this paper will compare how much carbon dioxide (CO2) each vehicle release and measure the most sustainable transport for the transoeste carriageway area. To obtain a research as a result for the town hall or the governments states to management a sustainable and a small impact public transportation.

Keywords *Urban Mobility; Sustainable; Public Transportation; Greenhouse Gases, Transoeste and Transportation Management.*

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1. INTRODUCTION

Using the city of Rio de Janeiro as a model, the geography, temperature, economic situation, the Olympic Games and the World Cup was a very good focus to develop and manage a research to help and support to build a public transportation and which is the most effective for each neighbourhood and how it is the better way to do those developments.

The way they do the construction and how the steps are made it, shows some mistakes the city, mayor and state government are doing to improve the urban mobility of the Rio de Janeiro city. With some strategies and thinks about goals not to how they could have more money and campaign status.

Cities consume three quarters of the energy produced in the world, the modern ones, mostly by consumption of land, energy, water and food, material flow, and also emissions of greenhouse gases, solid wastes, air and water pollution press a considerable pressure on the planet`s natural environment (Zamba & Hadjbiros, 2007).

Now a days, different methods of qualifying the effects of human activities, one of them is ecological footprint or green footprint. The ecological footprint is an underlying philosophy of global demand on planets available land, thereby leaving a footprint on land (Agrawal et al., 2006). In other words, ecological footprint is used as a tool to calculate the environmental impact of human activities (Peters & Schouten, 2010).

After the research this work show each vehicle issue, and what is the best choice to build in a large area, with more than 500 million people.

1.1 Ecological footprint concept

Measure the footprint request different equivalence factors, because each place on earth have a singular aspect, make an easy equation have a many results. The averages of productivity in different land types are not the same, they need to be converted, using its corresponding equivalence factor in order to be expressed in global hectares (Schaefer et al., 2006).

$$Ftp = A * EF$$

where Ftp = footprint; A = area (hectares); and EF = equivalence factor.

1.2 Transportation foorprint

A city is a complex and organized set that is constantly changing and evolving. This complexity and dynamism makes it necessary to have strategic planning based on accurate and updated data and information (Shayesteh, et al., 2014) (Table 1).

To calculate the ecological footprint of a city, different components can be considered: cropland, grazing land, marine and inland water, energy and build-up area (Ewing et al., 2010).

Know how much fossil fuels are spend in the city or country, it is an important value too, because with this value it is possible to measure contribute of carbon dioxide CO2 on atmosphere, the predominant component of greenhouse gases emissions (Table 2).

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Nowadays have some technologies we could use spending only renewable energy, like, solar, hydrogen and electrical energy. Using some of this fuels on transports can decrease the footprint drastically.

Table 1. Totals vehicles in each category, licensed in Rio de Janeiro

Vehicles	units
Auto	2.201.146
Bus/Minibus	36.388
Motorcycle	357.316
Pick-up	102.437
Trucks	221.003
Public trans.	9.063
Others	59.419

Source: Detran/RJ – April 2016

Table 2. Fuels consumed, in Rio de Janeiro on 2015

Vehicles	m^3
Gasoline	141.816.481
Alcohol	664.305
Diesel	21.864
Natural Gas	998.803

Source: ANP – April 2016

2. METHODS

2.1 Research background

For Rio de Janeiro transportation during those events and the near future the government choose basically buses on Bus Rapid Transit BRT, light rail and with a small contribute for a subway extension for the current track.

Calculate the footprint for the method above and compare with the possibilities for transportation could be more efficient and less degraded for the planet and the city itself. Those numbers could support better usage of the public transportation for big cities like Rio.

Highways can also be rated with respect to their maximum capacity and energy consumption, thus making it easier to compare them with rail as a related transportation mode, relative to cost and energy usage. A great deal of research and observation has resulted in the understanding that a multi-lane highway has a maximum capacity on the order of 2,400 vehicles per hour per lane (Transportation Research Board, SR #209, 1994. Apud Dearien, 2004 p. 4).

2.2 Overview of methodology

As methodology for calculate the ecological footprint this study will use a consolidated in some papers around the world. This one is from Chi & Stone, 2005. The methodology developed to calculate the ecological footprint of transportation networks is presented as a chart in Figure 1. As indicated by the figure, to approach consists of three principal steps: 1

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estimating the physical footprint of the roadway network on the basis of the surface area of roadway paving; 2 estimating the energy footprint of the roadway network on the basis of the area of forest land required to sequester carbon emissions produced by network travel during one year; and 3 combining the land areas of the physical and energy footprints to derive an estimate of the total transportation footprint. To apply the methodology at the county or municipal level, information on average daily traffic counts, vehicle fleet composition, fuel efficiency rates by vehicle class, and roadway network design must be obtained from state departments of transportation. In addition, local rates of carbon sequestration may be adjusted with information from state departments of natural resources or other government agencies charged with forest management.

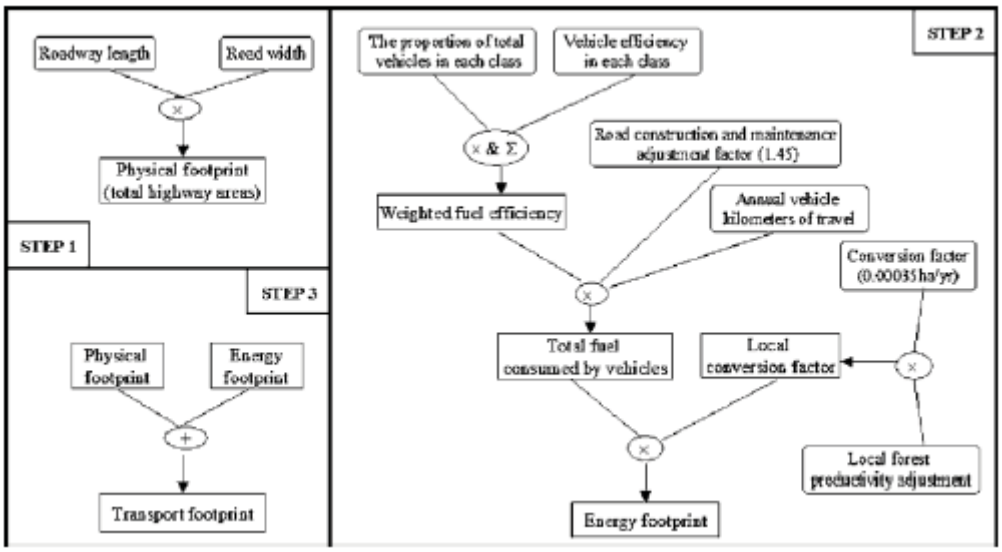

Figure 1. Methodology for estimating the ecological footprint of vehicle travel. Source: Chi & Stone, 2005

In the first step in the methodology, Step 1 in Figure 1, the physical footprint which is based on the physical dimensions of the roadway network is derived. Digital maps of the surface transportation network—which are available from a number of local, state, and federal agencies—can be analysed to measure the width and length of street segments in the regional roadway system. By summing the area of all roadway segments in a study region, an estimate of the physical footprint of the street network may be derived.

In the second step of the methodology, show as Step 2 in Figure 1, annual vehicle travel and vehicle fleet characteristics are employed to estimate the total quantity of fuel consumed in one year of travel along the network. In addition, the quantity of fuel consumed in constructing, allocated over the life of the network, and maintaining the roadway network is combined with that consumed in annual use to estimate the total quantity of fuel consumed per year of network operation. This estimate is multiplied by a carbon sequestration factor to estimate the area of forestland required to remediate the carbon dioxide emitted from each litter of fuel consumed in the operation of the transport network.

In the final step of the methodology, the physical and energy footprints are summed to derive the total transportation footprint, as indicated in Step 3 of Figure. 1. This estimate represents the total area of land required to physically support the transportation network and to sequester carbon dioxide emissions associated with the annual operation of the network. The derivation of the transportation footprint for present and past years provides

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a basis for projecting the ecological impacts of regional transport systems into future time periods.

3. CASE STUDY: CALCULATING THE GHG IN RIO DE JANEIRO, BRAZIL

3.1 Transportation GHG emissions

Doing the basic calculation from the methods above it is possible to estimate how much GHG the BRT buses will produce for GHG on transoeste, at Americas Avenue, and with the same aspects could reach the GHG of a LRT or a train on the same way, show on Table 3.

The environmental aspects normally never came in the first topics with mayors, because never call for votes on the next election, the public transportation yes, but only with the lowest cost and with the way they suppose reach more people.

Table 3. Transportation GHG emissions

Modal	CO2/PM
BRT	0.77
Cars*	0.54
LRT	0.67
Train	0.52

*average for passenger cars

3.2 Results

After see those numbers it is easy to choose what is the best vehicle to choose and construct on those neighbourhood, the transoeste in 52km and with 220 thousand passengers per day, could be more, because the lecture buses only reach 5% of cars passengers and LRT could reach nearly 10% and a heavy train 20 to 25%.

The reduction of cars on the road decrease those emissions substantially, and promote the reduction of the traffic on highways and streets, transform the weather and the time spend stuck during the day.

This work shows, how the GHG emissions and the footprint demand for each type of transport evidence how the politicians on Rio thinking only on themselves not on the citizens, because if they use a bigger modal, like LRT they could support more people than the BRT and if build a surface train on the same way the benefits for the city was huge.

The costs of those types of transport are really important too, but if the area have demand for this kind of vehicle, the payback is in less than 10 years, in urban time lapse this period it is really short, and the next generations will be thankful for those infrastructures.

The heavy train was the best choice for the government to build in that area, because reach too much people, could reduce the traffic, the GHG emissions and make the daily travels less painful for those citizens.

4. CONCLUSIONS

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Today the best usage on this way was cars, because the bus stops are really far from the buildings, the neighborhood was not thinking on pedestrians and walkability, only in cars with the huge condos and nothing else to attract the people. This kind of initiative demands more and more cars to support, because to buy anything for eating, drinking or utilities it is almost impossible to do walking.

The public transportation and the development of the city with the concepts of walkability and sustainability are important to build a better place for the citizens, the quality and the services with low emissions of GHG could improve this healthy quality become more pleasant and comfortable for everyone.

After all this research the heavy train was the best choice for the government to build in that area, because reach more people, could reduce the traffic, the GHG emissions and make the daily travels less painful for those citizens. According to that planning a new track for the subway the cars usage could reduce substantially making the city of Rio de Janeiro more softly, comfortable and sustainable posing as one of the best cities to live in the world.

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