Sustainable Transport System at the Federal University of Amazonas

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Abstract

The city mobility likewise the city dynamics might be influence the university space and how will be working the campus mobility. Some studies point out which herewith the cities' evolution, the universities have been developed the same mobility behavior as well as is influenced by the city model. Recently was investigate the constraints and how much it is possible to provide sustainable mobility at the campus. This issue will show the Federal University of Amazonas case. Nowadays,the university transport model is the same as the micro city kinds, at the regional system have been some constraints in the service level as in the sustainability performance. On the other hand, Amazon's university performance is smoothing the sustainable impact and minimize the ecological footprint by the green area at the campus; it is the very important front of the climate change actions to hit the temperature global goals. This article is shown which is possible to improve sustainable mobility at the campus when is provides other mobility kinds and redesign the transport systems.

Keywords: Sustainable mobility, University mobility, Sustainable transport sustem

1. Introduction

In recent years, mobility systems in universities have been studied around the world, this is due to the contingents that start to transit in the university space. Many authors studying transport and mobility systems in the university environment considered the models implemented as one of a city. Therefore, they identify them as micro cities because these models come close to urban geographic space. In many cases, the university environment has a population impact that is as big as a neighborhood. In this sense, there are universities contingent is bigger than the population of the city. For these reasons, among others, the university space has been demanding a certain amount of attention regarding the level of mobility services and transport services of the university community.

A common study to be observed, is the case that evaluates the behavior of the university public, regarding the type of service provided and its variations, in general it was observed that universities generate a large number of trips, which depending on the modes of transport and mobility generate negative externalities such as levels of greenhouse gas emissions. The Federal University of Amazonas-UFAM has a mobility profile very similar to that of large universities such as Yale, Kant University, where the demand for a level of mobility services that is predominantly met through private vehicles and buses. In the case of collectives, they are executed by concession contracts made with the City Hall. Thus, the mobility models of the university when generating the demands for travel, maintaining a usual format, generates a level of

pollution that can be improved by applying a more flexible model and using cleaner technologies.

Thus, through the essay "Sustainable Mobility of the University Space", an analysis is made of the present model of mobility and shows other models applied in other university centers. The study points out alternatives that may contribute to generating positive externalities on the Manaus campus. These alternatives are directly related to the acceptance of the academic community to use other modes of transport in the mobility process. And here, it is shown that the city's predominant mobility model influences campus mobility. However, the study sought to understand why a more flexible model is not used in the campus environment. The relevance of the study may show that there is an interest in the use of other modes. This fact can make the campus environment a reference for other urban environments in the city. The study approach here will be presented in six sections, is outlined as follows: In the first part, this is a presentation of the theme and how it will be presented, the study's problematic and relevance. Part two will be an exposition of a presentation of sustainable models and a comparison between the models applied in other university centers, in part the study will show a literature review, where other studies on the topic will be shown, methodologies that have been adopted. The profile of the Federal University of Amazonas-UFAM and pointing out hypotheses of possible mobility models that are appropriate to the regional and specific characteristics of the university will be the third phase. The next section deals with the presentation of the adopted methodology and lastly, the discussion and conclusion

of the theme followed by references.

2. Planning in the Brazilian cities.

In Brazil, the transport system concession system is regulated by law 8987/95, where article 6 provides for efficiency, safety, and timeliness of the system. And when current issues are addressed here as well as efficiency, modernity is generally considered, which implies the issues of innovation and sustainability. As noted, urban environments have been looking for cleaner and more efficient mobility alternatives, which is a factor of modernity and efficiency. This process requires strategic planning and application of a range of knowledge in a multidisciplinary format, without considering the process of urban space growth, which is a challenge. Regarding the management of urban space in Brazil, law 10.257/2001 known as the city statute is the instrument that regulates Brazilian urban structures. Among the guidelines proposed by the law (Article 2), the issue of guaranteeing sustainability was observed among several factors that may include the development of smart and sustainable cities. Many cities started to adopt restrictive measures by zones of the city, applied a diversity of transport modes as well as the connectivity between the modes. Large urban centers have developed master plans for a horizon of more than ten years, aiming to reduce the use of individual vehicles, improving the modes of mass transportation, and implementing alternative models. At this point, many cities have adopted systems of shared mobility that can be applied to vehicles, bicycles, and scooters, these influence and are influenced

by factors such as (COHEN, A., SHAHEEN, S.A.; Jul. 2016):

• Transport and circulation: This factor influences the choice of modes and distance to be traveled;

• Zoning and land use: This factor requires planning at the level of zoning, management, and demand for

parking spaces, etc.;

• Urban design: This point is related to the issues of connectivity between modes and encouragement to reduce the use of individual vehicles;

• Residences: Because of them, there is a reduction of car parks demanding new development;

• Economic development: It can generate new jobs and income opportunities.

As the mobility model of the UFAM/Manaus university is directly related to the urban mobility model of the city and its characteristics, it reflects all the things that happen in the system, if the model has an inefficient format and generates negative externalities it will also affect the university mobility. On the other hand, this study raises the idea of taking advantage of the university space as a mobility model for the city, in the case of adopting more sustainable mobility modes where the structure of the transport system can affect the form of land use (KEHINDE, 2019).

1.1 Review and state of the art.

In studies carried out at the University of Toronto-Canada, it was noticed that education and information campaigns did not effectively contribute to changes in people's behavior in the sense of adopting cycling practices. However, users' behaviors were shaped by the barriers they faced. At this point, the perceived restrictions were as follows:

(1) Physics;6

(2) Social;

(3) Financial and;

(4) Psychological.

According to studies, bicycle sharing in Brazilian cities is motivated by health and environmental issues, according to Cerutti et al (2019) apud Mont et al (2020, pg7), the study also considers the perception of non-users, primarily women, who report the fact that they realize that the infrastructure of cities is not sufficiently secure. One way to shape a change in behavior to implement new practices would be through standardization. Command and control rules can influence the behavior of families and people involved (RIVAS, 2014). Concerning incentives, in the study by SAVAN et al. (2017), the case of Canada, it was observed that the combination of incentives and information had more results than financial incentives. Here, care must be taken as to the type of information and how to guide the academic community regarding the correct use of public goods. This is a situation that is effectively raised by environmental responsibility. This is related to the observation of the target audience and management of the process, according to Slack et al (2018), in the same way, that emissions or residues are reduced, avoiding costs for the organization, and this must be taken into account consideration in the development of the project.

An example can be seen in the case of the government of Denmark which developed in 2012 a strategy to implement innovative actions through public-private partnerships that encourage environmental initiatives, for this it designed an action agenda for 2020, this strategy was based on five pillars:

• Prepare for climate change;

• Environmentally friendly transport system;

• Reorganization of energy systems

• Produce energy efficiently

• Green shopping (environmentally friendly)

As for the mobility system, Denmark made a major investment in the implementation of cycle paths, not only that, developed regulations, and worked on issues of education and safety, leading Copenhagen to be a reference in the use of bicycles and pedestrian structures. Today, around 50% of citizens use bicycles as a means of transport. The municipal governments made investments in specific spaces for the circulation of this modal, spaces for bicycle parking spaces were created (OECD, 2012).

The implementation of an eco-efficient process reduces costs with energy consumption and generates a lower level of emissions. Thus, following the target audience of the action, we must observe which restrictions can be removed and establish a commitment strategy, as well as increase the integration between modes. According to Azzali and Sabour (2018), when planning a campus considering parking space, air quality, and limited financial resources, the most applied common strategy is the use of bicycles and walks. One factor in the study by Azzali and Sabour is "How much university mobility can impact on local society?", that is, what externality is being generated in their mobility process. Thus, according to the model adopted, a social impact usually results in congestion or accessibility problems. Indirectly, by reducing congestion, or the less it occurs, the greater the energy use. On the other hand, according to Allen & Farber (2018), they understood how the student travels, from home to campus, from work to campus, which can negatively affect their academic activities. This understanding attests that social activities can enrich learning by enhancing opportunities to enter the job market a low level of accessibility can limit the opportunity for people's availability, reaching a type of social exclusion. The accessibility is one of the transportation study lines that are related to how the city can implement interactions including benefits, work, and services. The same involves factors such as:

1. Use of soil;
2. Partnerships;
3. Form of travel;
4. Time of day
5. Socio-economic standard

The Castro et al Study (2019) showed the importance of the implementation of Flores Avenue and shows how relevant the impact in the region caused by deforestation is also. At this point, if considered zoning, it can be observed that the investment in infrastructure for the implementation of cycle paths and terminals appropriate for this modal would have a low environmental impact.

3. Mobility Planning in the Brazilian cities.

The Federal University of Amazonas is considered the first in a green fragment at the urban area in the country with 6.7 million square meters. In general, the University has something around 65% of the green

area. This factor is a differential if we consider the generation of ecological footprint and the levels of emissions generated that can have a softening impact since this area is of mature forest, which is not growing. About the others studied, this is a differential.As for the adopted model of mobility on campus, currently, a system powered by two bus lines and an integration line (circular) that makes a connection between campuses (north and south sector) is used, the interconnection between campuses is the order of up to 3 (three) kilometers. According to the Dean of Teaching and Graduation/PROEG (2019), UFAM offers something around 114 on-site courses in various modalities comprising more than 20 (twenty thousand) students. Thus, unlike other mobility studies for university campuses, this study was aimed at formulating proposals that will implement alternative modes of mobility on campus, thus concluding the phase of applied research. From the elaboration of the questionnaire, it was obtained a proportion of the participants on the use of modals for commuting between campuses and to the campus. The data obtained can be seen in the graph of (figure 01). Here, we analyzed only the lines that originate from the campus.
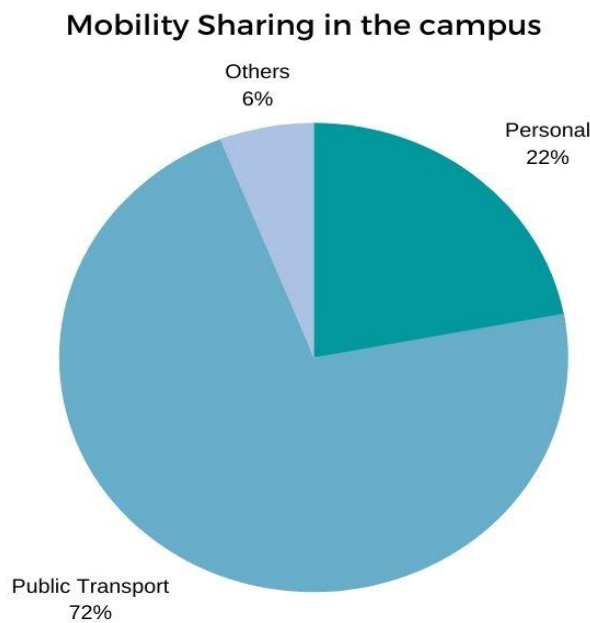

Figure 1: Modal trabsports in the campus
Source: the author

As expected, more than 77% of the academic group is a public transport user, so the current mobility configuration on the university campus is very close to the studies done by David Kaplan (2015). They studied the level of sustainability of mobility at Kent State University, as well as a model very close to what is called micro cities. In the case of the UFAM university campus in Manaus, the use of cleaner modes such as bicycles, in the data collection showed that less than one percent of those who participated in the survey use bicycles (0.4%).

In general, studies have shown that the university community has an interest in using bicycles in the campus environment, lacking motivators, and specific infrastructure for this. As for the service provided by regional

collectives, improvements may be implemented, given the present model adopted in the city, it needs to be updated as provided for in the law on public service concessions.

At this point, taking into account the most common bus models that serve the services on campus for the three lines (DUARTE, GATTI & SILVA, 2020). The level of annual carbon dioxide emission in the order of 1,058,302.2 (CO2.Kg/Year) was estimated using the top-down method, where energy use was considered. It can be seen that line 2 has greater participation in the levels of emissions generated, something around 63.8%, even though it is not the one that circulates the most, in the case of integration (Fig.02). Although not even a survey has been made, it can be observed that certain groups of students walk on campus, something around a kilometer, equivalent to the entrance of the southern sector. The profile of the academics was observed, because of the use of another mode of transport, who believe that if there were infrastructure, it would be possible greater adherence to the use of vehicles such as bicycles. Because they do not know how scooters work, the modality had low adhesion on the Manaus campus.

It should be added that the city has no infrastructure for these types of vehicles. At this point, the university space could be a pilot for other points in the city.
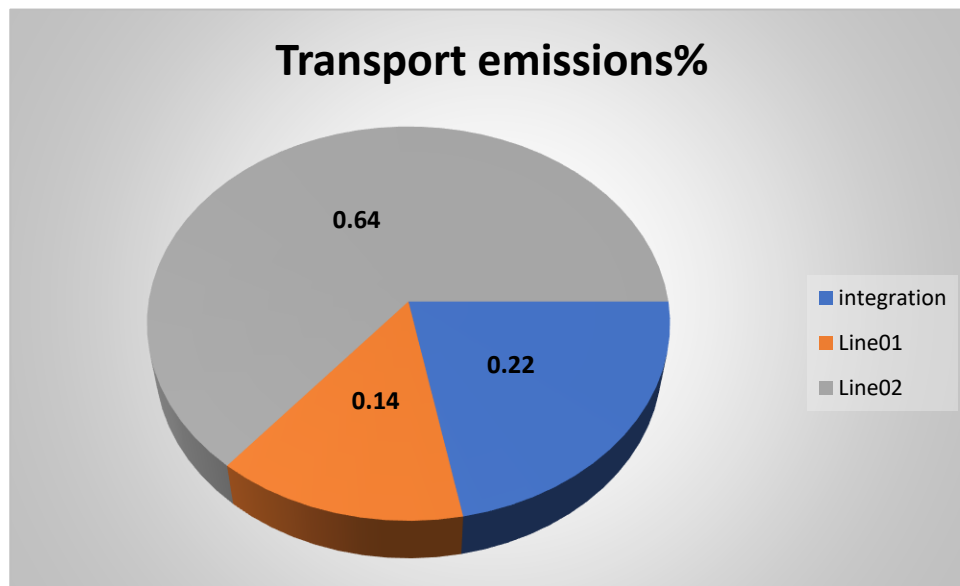

Figure 2: Transports Emisions participation of the campus
Source: The author

4. Applied methodology

The development of the project includes a bibliographic survey in all its phases, questionnaires were prepared to collect data in the form of field research. As for the questionnaire application strategies, two were used, one for sending electronic forms and the other for interviewing different types of the target audience. The result of the field research is what supports the activity reports and this article. In the medium term and the long term, it is expected that the opinions and results observed in the study will be the basis for implementing a sustainable mobility model in the campus environment. Together with the first phase of the research, a study was developed to find out how much emissions are generated in the mobility system that is performed by the public transport model. This study applied the top-down method to estimate the

annual carbon emissions of the model adopted in three steps: Calculating energy consumption, calculating the amount of carbon, and the CO2 emissions generated.

The project has a multidisciplinary format assuming an exploratory, descriptive, and applied form. Thus, as one of the objectives of the project is to improve ideas, make discoveries and model analyzes, part of the project to be carried out will be in the form of exploratory research, using other methodologies such as the descriptive one to study the profiles of the various groups involved. Regarding data collection, a total of 511 (five hundred and eleven) people from the university were interviewed. The collection of data had two phases: In the first phase, the questionnaires had as objective to raise the data of the System and profile of the users. At this stage, the questionnaires were sent in an electronic format. In the second phase, the forms were aimed at evaluating alternative modes of transport that would satisfy the academic community. Here, the field research was carried out in the physical spaces of the University. Using an electronic form, the main target audience was the students, of whom 96% of the interviewees were reached. As already reported, the University is divided into two sectors, being north and south. 56% of those who participated in the survey, transit between these sectors. When entering the campus of UFAM-

Manaus, to reach the northern sector, one travels approximately three kilometers and to the southern sector, one-third of that. The survey showed that 76.7% of respondents would agree to travel up to one kilometer on the campus by bicycle or scooter. However, the use of scooters was very low. It was noticed when interviewing the students, that this fact may be related to the little knowledge about how to use this type of transport modal in the region. On the other hand, 38.9% of respondents confirmed that if there was infrastructure, they would use bikes for your mobility on campus.

The study considered the use of shared vehicles and the use of applications by campus students (Fig03). It was observed that approximately 19% of students use vehicle services for applications three or four times a week. Using application vehicles has a contribution regarding the issue of land use, in some cases, these vehicles are shared between one or more colleagues. With the second phase of the study, it was observed that the flow on the campus is greater towards the north zone of the campus. This is because in the north of the campus, services that are not found in the south, are offered, such as bank agents and it is where most academic centers are concentrated.
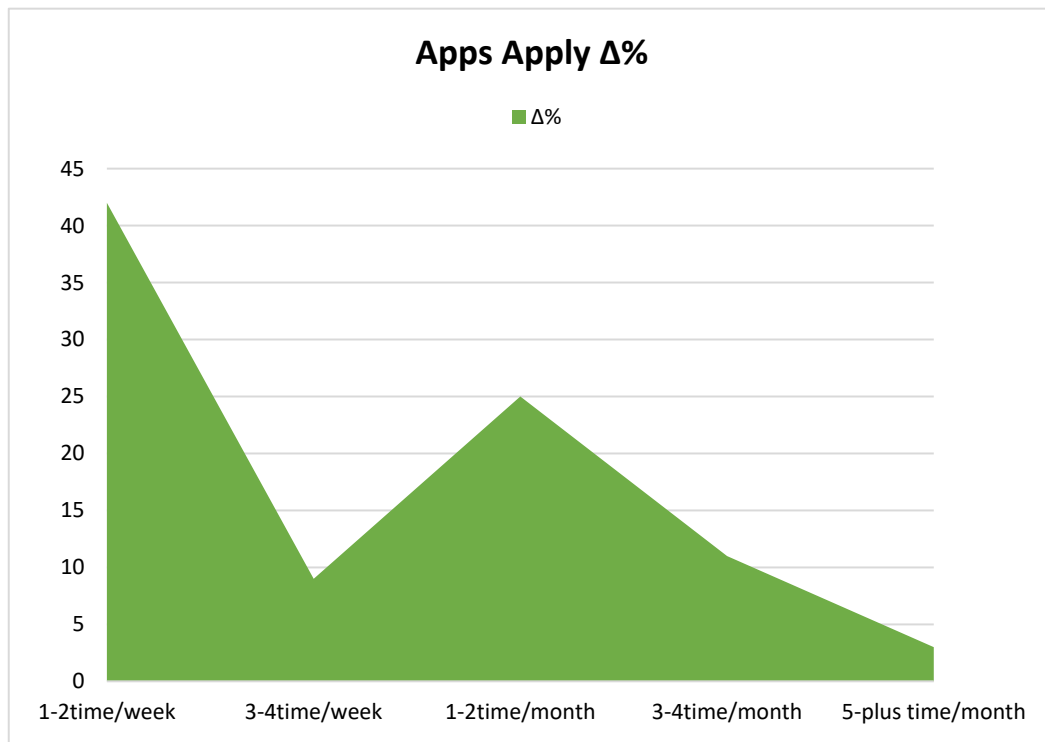
Apps Apply Δ%

Figure 3: Shared Vehicles
Source: the author

5. Applied Discussion and Expected Results

Presenting a proposal for sustainable mobility on the university campus in a way is an activity that demands a governance practice since the Federal University of Amazonas/UFAM is a federal public organization. Thus, it is expected to mobilize the sector's stakeholders in ways that another mobility modality can be implemented to serve the internal space of the campus. And here it will be necessary to dialogue with industries, engineering, and architecture institutions as well as groups from the university itself to implement the proposed changes. Here you can insert an innovative model while having the current and in the long term change the mobility system in operation looking for a more eco-efficient format and better service level. Thus, the proposal must have medium-term and long-term actions to have effective results.

Research has shown that there is a possibility to improve the energy performance of the transportation system on campus, making the system more eco-efficient. To this end, some   proposals can contribute to reducing negative externalities in the medium and long term. In the current situation, the use of bicycles is very low, research has shown that it reaches less than 4%. However, it is believed that by implementing an infrastructure that guarantees safety in bicycle mobility, together with command and control processes this mode can be further stimulated. Some studies attest that offering other transport modal alternatives can make the system more flexible and sustainable.

It was possible to observe that implementing another transport model, making mobility more flexible and sustainable, was not a very simple task in the other cases observed and certainly in the Amazon region will be no different, not least because this involves changes in behavior and even changes in culture. To begin, we must outline a plan for the long, medium and short term, where in the short and medium-term, there is

the question of removing barriers, as already mentioned.

To work on sustainability and energy use, we have to first working physical barriers, these being:

1. Apply cycle path infrastructure over one kilometer
2. Implement bicycle terminals
3. One kilometer reduction in bus routes where travel originates on campus

These actions can be implemented in the short and medium-term as they are simpler, making it possible to improve and extend innovative solutions on campus in the long-term. Applying the bike path infrastructure over a kilometer, as observed in research, people have a certain predisposition to use bicycles in a distance of up to a kilometer, this was also observed in the study carried out on campus, it is expected that there is a good adherence, as shown in the study developed, 76.7% of students would adhere to the modal. Thus, using motivating measures, initially, as well as command and control, this action will be promising.

Implement terminals for bicycles, here the question of positioning must be considered, as well as the practicality and technology to be adopted, to make the model accessible to students and teachers within the campus.

One kilometer reduction in bus routes, if the region's transport matrix is considered to be the same, this measure will reduce emissions generated in the trip, as well as generate externalities positive in the environmental and social sphere, therefore sustainable.

5.1 Expected results

It is expected that there will be an inversion in the flow of influence of mobility, where instead of the transport model and the form of urban mobility it will influence the system of university mobility, often generating negative externalities. The university and those who pass generate positive externality and influence urban mobility plans. Even if the physical barriers are removed, cultural issues may have to be worked on, since in the region it has never carried out this type of mobility.

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