

Study of public transportation of the city of Campinas, using the smart city concept, and specific equipment, for the accurate data collection, and improving this segment in the ergonomic concept

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Abstract— *The focus of the analysis is the public transport of the municipality, specifically the bus line No. 330, (Central Corridor / Central Terminal / Unicamp by Bus),, can be replicated to other city lines, other municipalities of the MRC (Metropolitan Region of Campinas) and even other national and international municipalities. To achieve the objective of this work, a descriptive and comparative analysis method was used, taking into account the perspective of the city's public sector. With this, it is intended to take the reflection to the public management of the city, to obtain public transport in an intelligent way, it is necessary to achieve its sustainable and more qualified, efficient and comfortable development for its customers and third parties.*

Keywords— *Smart Cities, Government, Sustainable Development, Quality of Life, Revolution, Public Transport, Predictions, Transport Quality.*

I. INTRODUCTION

According to the WWF Organization, I defined the concept of sustainable development, as: “Development capable of meeting the needs of the current generation, guaranteeing the ability to meet the needs of future generations”. [2]

It is development that does not exhaust resources for the future. [3]

This definition emerged from the World Commission on Environment and Development, created by the United Nations to discuss and propose ways of harmonizing two objectives: economic development and environmental conservation. [4]

In recent years, corporate social responsibility practices have become part of the strategy of an increasing number

of companies, aware of the necessary relationship between economic returns, social actions and nature conservation and, therefore, the clear link that unites prosperity itself with the state of environmental health and the collective well-being of society. [4]

It is increasingly important for companies to be aware that they are an integral part of the world and not consumers of the world. The recognition that natural resources are finite and that we depend on them for human survival, for the conservation of biological diversity and for economic growth itself is fundamental for sustainable development, which suggests the use of natural resources with quality and not in quantity. [5]

The consumer is increasingly aware of the ecological and social weight of his own choices. Thus, for the company to guarantee consumer satisfaction, it will

increasingly have to provide coherent answers to these issues, recognizing the growing market sensitivity to issues such as sustainability and striving to achieve positive results in favor of the environment. [4]

Companies that want to maintain competitiveness in the long run must therefore respond to the expectations of citizens-consumers, valuing responsible behavior. [4]

For WWF-Brazil, collaboration and partnerships with the private world represent an essential assumption for a sustainable future, thus helping to bring the concept of sustainability from theory to practice. [2]

According to the European Union, Smart Cities are systems of people interacting and using energy, materials, and services and financing to catalyze economic development and improve the quality of life. These interaction flows are considered intelligent because they make strategic use of infrastructure and services and of information and communication with urban planning and management to respond to the social and economic needs of society. According to the Cities in Motion Index, from the IESE Business School in Spain, 10 dimensions indicate the level of intelligence in a city: governance, public administration, urban planning, technology, the environment, international connections, social cohesion, human capital and the economy. [6]

Despite being a relatively recent concept, the Smart City concept has already consolidated itself as a fundamental issue in the global discussion on sustainable development and moves a global market for technological solutions, which is estimated to reach US \$ 408 billion by 2020. Currently, cities in emerging countries are investing billions of dollars in smart products and services to sustain the economic growth and material demands of the new middle class. At the same time, developed countries need to improve their existing urban infrastructure to remain competitive. In the search for solutions to this challenge, more than half of European cities over 100,000 inhabitants already have or are implementing initiatives to become de facto Smart Cities. [7]

“Instead of defining which cities should or should not be considered" smart ", it is constructive to think about the activities and factors that can make a city smarter.” [8]

According to Blog Sonda: “The bigger the city, the greater the concern with resource management - especially natural resources. This is where the implementation of technology in public administration comes in, which can significantly increase energy and water savings, in addition to enabling more effective distribution to the inhabitants”. [9]

According to a report by the World Population Prospects, revised in 2017 and released by the UN (United Nations), the world population in 2017 was 7.6 billion people. However, the perspective is 8.6 billion in 2030, 9.8 billion in 2050 and, in 2100, 11.2 billion inhabitants on planet Earth. Based on these numbers, we can identify that there is an unprecedented population growth, as well as countless challenges ahead, related to education, energy, environment, security, health, public services, among others.

Soon after the industrial revolution, which occurred in the 18th century, cities became major centers, with a high rate of urbanization and a complex social ecosystem, but in which their sustainable development cannot be guaranteed. From this scenario, we can mention technology, an extremely important element, which comes to assist in the creation of enterprises in harmony with nature and society, thus giving rise to the concept of smart cities.

The present work aims to make a study on how the city of Campinas, in the state of São Paulo, and the municipal bodies that represent it, have been behaving in relation to the development of a smart city.

II. HEADINGS

After collections of 03 (three) periods per day;

- Morning, afternoon and night.

During 7 (seven) days of the week;

Monday Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday;

The works were carried out and collected, during three periods of the year, as shown above;

- Collections made during school vacation periods, between January 30, 2020, until February 05, 2020;

- Collections on Carnival days, one of the main events in Brazil, which took place this year between February 20, 2020, until February 26, 2020;

- Collections carried out on the normal days of that year, carried out between March 2, 2020, until March 8, 2020;

Note: The collections of normal days meet the academic guidelines chosen by the Unicamp program, see figure 02, in which the majority of users who use this line, are university students at Unicamp;

Janeiro de 2020	
01	Contratização Universal.
04	DAC disponibiliza na WEB: relatório de matrícula do período de Férias de Verão - 2020.
06	Início das atividades período de Férias de Verão - 2020.
07 a 09	Alteração de Matrícula em disciplinas do período de Férias de Verão - 2020, na WEB.
13 a 27	Desistência de Matrícula em Disciplinas do período de Férias de Verão - 2020, na WEB.
Fevereiro de 2020	
10 a 12	Matrícula em disciplinas para o 1º período letivo de 2020 e 1ª e 2ª metades do 1º período letivo de 2020 - Alunos Ingressantes.
15	Término das atividades do período de Férias de Verão - 2020.
17 e 18	Exames Finais do período de Férias de Verão - 2020.
22 a 26	Não haverá atividades.
27	DAC disponibiliza na WEB: Relatório de Matrícula do 1º período letivo de 2020 e 1ª e 2ª metades do 1º período letivo de 2020 e Histórico Escolar atualizado.
Março de 2020	
03	Início das atividades do 1º período letivo de 2020 e da 1ª metade do 1º período letivo de 2020.
	Matrícula Suplementar para o 1º período letivo de 2020 e 1ª e 2ª metades do 1º período letivo de 2020 - Alunos Ingressantes.
08 a 11	Alteração de Matrícula em Disciplinas do 1º período letivo de 2020 e 1ª e 2ª metades do 1º período letivo de 2020, na WEB.
14 a 31	Desistência de Matrícula em Disciplinas da 1ª metade do 1º período letivo de 2020, na WEB.
16 a 06/05	Desistência de Matrícula em Disciplinas do 1º período letivo de 2020, na WEB.

Fig.1: DAC / UNICAMP 2020 calendar

Source: DAC / UNICAMP (2020)

More than 2 (two) thousand data were obtained and analyzed, referring to the temperature of 20 (twenty) points, noise, speeds, maximum number of people and minimum inside the bus, the data also shows the delay time, as shown in some images results obtained.

This data information was obtained from line No. 333, with an itinerary leaving the Central Terminal of Barão

Geraldo, and arriving at the Central Terminal of Campinas. In this section, all data were collected as shown in the figure below, specifically collected the route of the Professor Zeferino Vaz Highway;

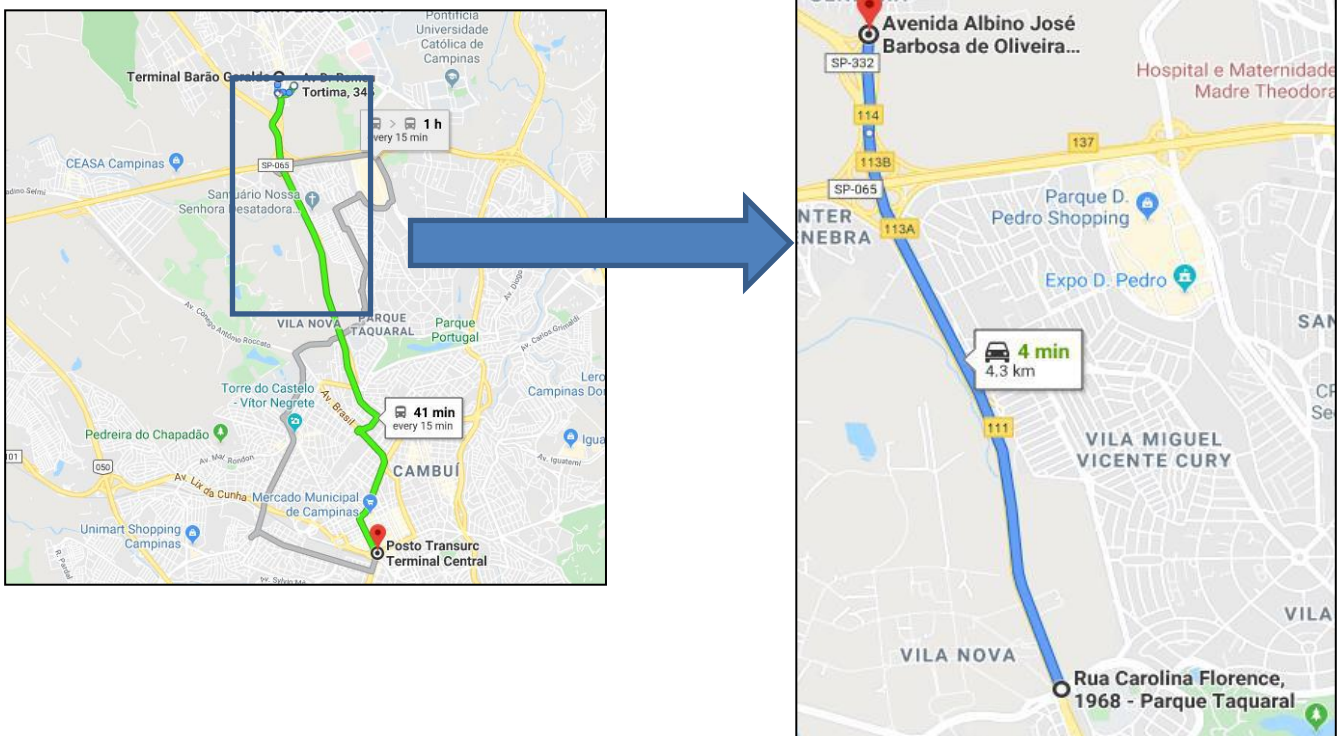


Fig.2: Bus Line 2020

Source: Google Maps (2020)

For research, it is fundamental and extremely important to choose a specific section along the entire line, since the objective of the work is to pass information and concrete data to companies, city halls and users, as shown in the diagram below;

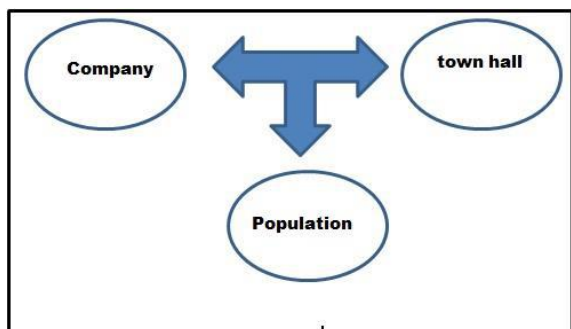


Fig.3: Pyramids of Strands 2020

Source: Gomes Gabriel (2020)

The validation on this data makes it necessary to choose a section along this line, in which when collecting the data, always having an identical scenario for all collections.

Differently if these data were collected along this line, which may cause a tendency in the collected factors, and analyzed, because the factors analyzed as well as (temperature, noise, number of people, speed, waiting time), are different over the your stretch.

Right after collecting all the data, following all the metrics and standards already evidenced in this work, I found values that allowed me to analyze them, compare them, and work on them using concepts of statics, in order to correlate them, and identify valid results. Always seeking to understand, see the data analyzed, being able to act on them in a clear, and objective, economical and meaningful way, for a better development of public transport, for society.

The analyzes and calculations were searched using the book of General and Applied Statistics, 6th edition, by the authors Gilberto de Andrare Martins and Osmar Domingues. Making understand and learn, several metrics of statistics, from my analyzes, and results obtained.

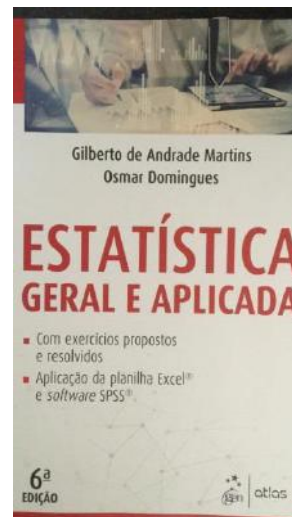


Fig.4: General and Applied Statistics Book -2020

Source: Gomes Gabriel (2020)

The collected data were used in the book General and Applied Statistics, by the authors, Gilberto de Andrade Martins and Osmar Domingues, 6th edition, by Atlas. The research aims to describe, explain to the reader all the concepts of statics that served in this work, to analyze the information and data collected,

III. INDENTATIONS AND EQUATIONS

The first paragraph under each heading or subheading should be flush left, and subsequent paragraphs should have a five-space indentation. A colon is inserted before an equation is presented, but there is no punctuation following the equation. All equations are numbered and referred to in the text solely by a number enclosed in a round bracket (i.e., (3) reads as "equation 3"). Ensure that any miscellaneous numbering system you use in your paper cannot be confused with a reference [4] or an equation (3) designation. The research extracted from the book General and Applied Statistics reports that the arithmetic mean is: [25]

It is the most used, and most intuitive of the measures;

It suits a large number of practical situations;

It is influenced by all the values present in it, so it is necessary to be cautious;

It is represented by:

X ► for a sample;

μ ► for a population;

Calculation of arithmetic mean

Simple series = data list = raw data

The arithmetic mean of a sample of n observations x1, x2 ... xn is represented by the symbol \bar{X} (reads x bar), and is calculated by: [25]

$$\bar{X} = \frac{x_1 + x_2 + \dots + x_n}{n} = \frac{\sum x_i}{n} \quad [1]$$

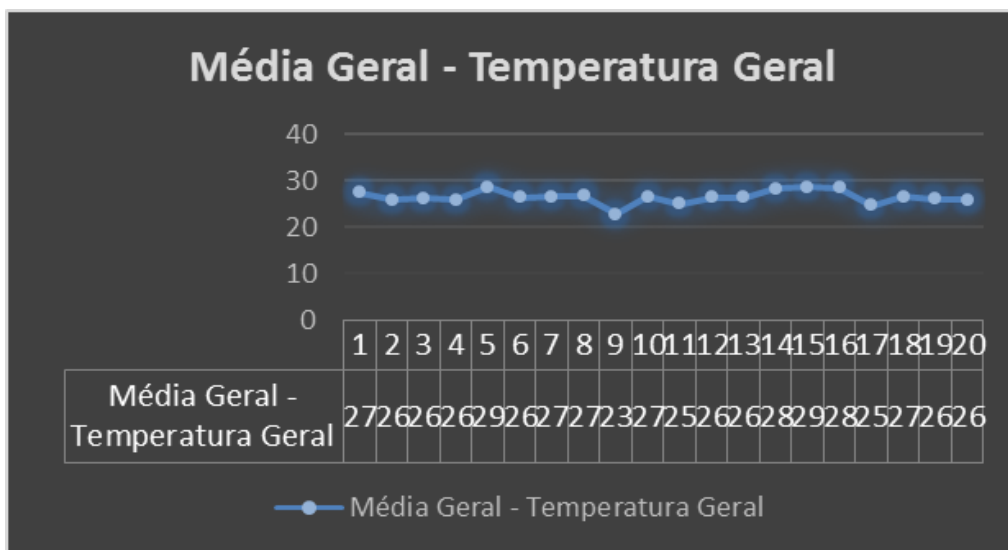
The arithmetic mean of a population of N observations X1, X2 ... Xn is represented by the symbol \bar{X} (reads X bar), and is calculated by: [77]

$$\bar{X} = \frac{X_1 + X_2 + \dots + X_n}{N} = \frac{\sum X_i}{N} \quad [2]$$

Observation: The difference between sample and population average is conceptual, since the calculation takes place in an absolutely identical way, that is, adding all the values of the sample (or population) and dividing them by the number of observations in the sample (or of the population).

IV. FIGURES AND TABLES

4.1 Temperature



Graph: 01 General Averages - General Temperature

Source: Gomes Gabriel (2020).

Graph n ° 01, is the average of the general temperature, that is to say, which is the comparison of all the trips, days and periods mentioned above, in relation to the temperature.

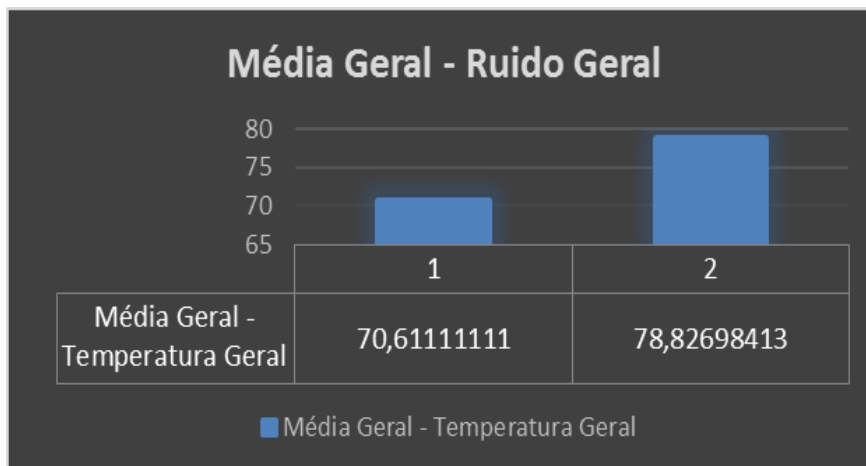
I identified that the general temperature inside the bus is adequate, according to the guidelines established by WHO, (World Health Organization).

According to ANVISA (National Health Surveillance Agency), the temperature in the environment must be between 23 ° C to 26 ° C in the summer, (collected period), the collected and verified studies pointed out that only points 01, 05, 07, 08 , 10, 14, 15, 16 and 18 are outside the established guidelines.

The general average surveyed is adequate; this is because of air conditioning, a great ally for this factor; public transport is between 41.22% to 57.66%, greater than allowed.

The general average is inadequate, this is due to several factors, such as: external traffic a lot of engine and Bosnian noises, there are also noises from the vehicle's engine, air conditioning is very loud, with all these noises together, people in inside the bus they are forced to speak louder so that the other can hear, added to all these negative factors the quality of the noise is much higher than what is allowed for people;

4.2. Noise



Graph: 02 General Averages - General Noise

Source: Gomes Gabriel (2020).

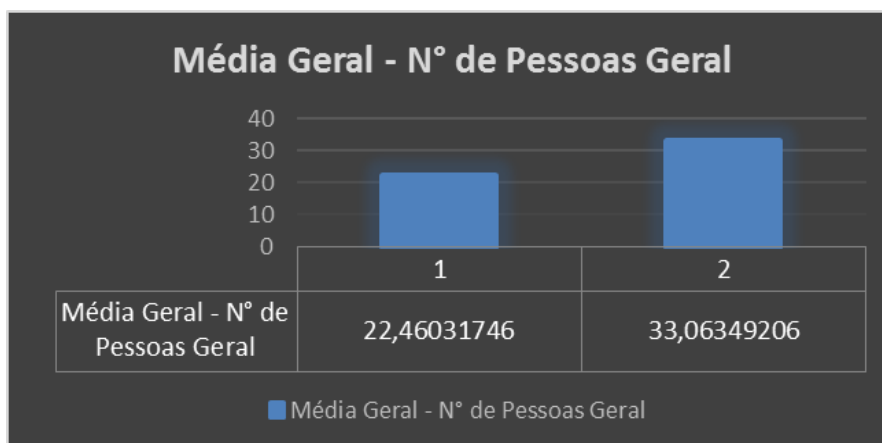
Graph n ° 02, is the average of the general noise, that is to say, that is the comparison of all the trips, days and periods mentioned above, in relation to the noise.

The collection identified and verified that the general noise inside the bus is inadequate, according to the guidelines established by the WHO, (World Health Organization).

According to WHO, (World Health Organization). The permitted noise is up to 50 dB (A) in the environment, therefore, the collection identified that the variation in public transport is between 41.22% to 57.66%, greater than allowed.

The general average is inadequate, this is due to several factors, such as: external traffic a lot of engine and Bosnian noises, there are also noises from the vehicle's engine, air conditioning is very loud, with all these noises together, people in inside the bus they are forced to speak louder so that the other can hear, added to all these negative factors the quality of the noise is much higher than what is allowed for people;

4.3. Number of People



Graph: 03 General Averages - No. of People General

Source: Gomes Gabriel (2020).

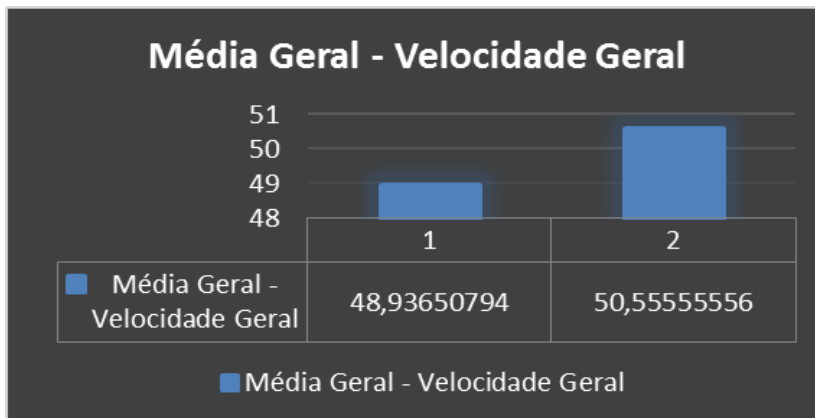
Graph No. 03, is the average number of people in general, that is to say, which is the comparison of all trips, days and periods mentioned above, in relation to the number of people.

The Survey Identified that the number of general people on the bus is adequate, according to the guidelines established by Brazilian road transport legislation.

According to the Brazilian road transport legislation, the maximum number of people allowed within 1 (one) bus is up to 50 people; the survey pointed and measured a capacity of people between 66.12% to 44.92% lower established by the legislation Brazilian.

The general average collected is adequate, this is due to the fact that there are enough buses keeping the flow of people on the line, the study identified, that people prefer to wait to go comfortably, often even seated.

4.4. Speed



Graph: 04 General Averages - General Speed

Source: Gomes Gabriel (2020).

Graph 10, is the average of the general speed, that is to say, which is the comparison of all trips, days and periods mentioned above, in relation to the permitted speed of the road, (highway Zeferino Vaz).

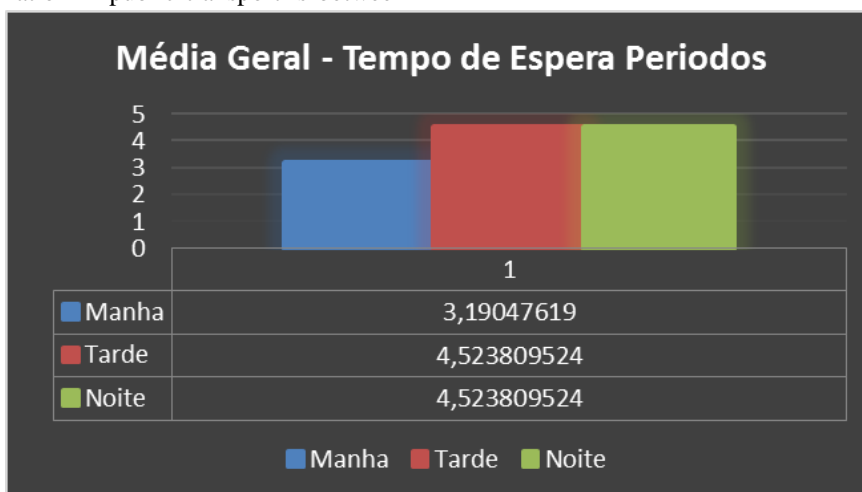
20% to 25% higher established by the Campinas legislation.

We found that the overall speed of the bus is inadequate, according to the guidelines established by EMDEC (Campinas Municipal Development Company).

The overall average is inadequate, this is due to the fact that it is a well-paved track, with numerous lanes, tight schedules, causing drivers to exceed the permitted speed of the road, and thus can even cause very serious accidents.

According to EMDEC (Campinas Municipal Development Company), the maximum speed allowed on the road, (highway Zeferino Vaz), is up to 40km / h, so we identified that the variation in public transport is between

3.4 Waiting Time



Graph: 05 Overall Averages - Waiting Periods

Source: Gomes Gabriel (2020).

Graph n^o 05, the average overall waiting time, is a comparison of all trips, days and periods mentioned above, in relation to the waiting time that people wait at the bus stop.

V. CONCLUSION

With the emergence of new innovative technologies, it has opened up a rhythm of growth and greater urban development, which has made cities increasingly complex; to face the most varied types of challenges every day, such as: urban mobility.

It is important and necessary that cities develop in a sustainable manner, in all forms and aspects, such as: environmental, social, cultural, political, economic and others, in order to promote the quality of life for their population, maintain and develop good urbanization policy and quality of life, promoting actions that make it possible, and always looking for new innovative techniques, are necessary measures for several future generations.

Good planning, transparency, respect for society, are necessary measures for public management to work and manage any municipality.

They are undoubtedly tools to improve all sectors and segments of a municipality, with teams of trained, committed, sincere and honest people, the results will appear immediately for everyone.

The research, gave a very immense north of various situations, measures, actions, and control, as it is fundamental, necessary, and of utmost importance the Public Transport of a City, because it makes possible to take several actions to promote the public health of people on the planet .

A more recent example were the measures and actions that authorities on the planet took in the Corona virus Pandemic, it is clear how important urban public transport is in people's lives.

Cities need to develop in a sustainable way, both at an environmental, as well as a social and economic level, in order to promote the quality of life of their citizens, their equity and the appreciation of future generations. It is, therefore, necessary to develop and seek new techniques and strategies, which allow better management of public transport in cities.

The concept of intelligent transport arises from the logic that technological progress must be submitted to the interests of sustainable, ergonomic and quality of life development for its citizens. But if public transport is the means that, on the one hand, create problems, on the other,

they are also means that daily assist the transfer of thousands of people to get around different places, in various regions of Brazil and all over the world, being thus, conducive to the creation of innovative solutions and ideas, not only because they are centers of science and technology, but also because of their importance in society.

The topic of public transport is a hotly debated topic, both internationally and nationally, achieving sustainable development must be seen as a metal and a global objective.

In this sense, government officials and businessmen in this segment are in a privileged position and promote actions that go against unsustainable trends, as they are negative impacts that prevent the results of major improvements for the population.

It is up to government officials and businessmen to promote more integrated programs with new innovative techniques enabling intelligent improvements in municipal public transport, it is necessary to monitor actions and goals, promoting tools and control programs, and training of the people involved.

Implementation of new programs, concepts, methods, and techniques, makes it necessary to verify, control, monitor, the results and deviation found, are of paramount importance to be studied, researched and analyzed, as they are important information for decision making. Cities that look for the electric bus as a potential ally to mitigate global warming and improve air quality encounter a number of barriers in adopting clean technology. High investment, lack of incentive and information, rigid bidding models, in addition to technological limitations, delay change.

The difficulties of transition in the transport sector, which accounts for a quarter of global greenhouse gas (GHG) emissions, distance countries from meeting targets to combat climate change. There are plenty of reasons to invest in clean public transport.

In the long run, the low operating cost outweighs the initial investment. Quiet and stable, electric buses save the populous urban centers from atmospheric and noise pollution, and provide more comfortable travel with less vibration. The environmental benefits are even greater if the electricity that drives the engines comes from a clean energy matrix like that of Brazil.

The research is based on line No. 333, in the city of Campinas / SP. Studies have shown that this line is on the right path, but there are other barriers that prevent it from being a totally sustainable line, it is a strategy that is not yet well specified and elaborated.

However, the research shows flaws in the system, presenting concrete and coherent information, for the three pillars of the municipality (government, business and society).

The research has the main objective of always identifying and showing the possible and diverse problems and points out reasons for investing in clean public transport.

It should also be noted that the issues addressed were of the utmost concern, responsibility and respect. Seeking and pointing out innovative solutions that can change, the current scenario we live in, and pointing out several solutions and medium term

Showing that, with political Will, it is possible to coordinate efforts to overcome institutional barriers. In 2017, the government launched an electro mobility plan with the goal of electrifying all public transport by 2050. The country sees the transition as a development engine that will bring many benefits, from combating high levels of pollution to stimulating the battery market in the the country itself is an important supplier of raw materials. To make the transformation feasible, he adapted bidding processes, created subsidies for the transition and included all interested parties in the conversation.

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