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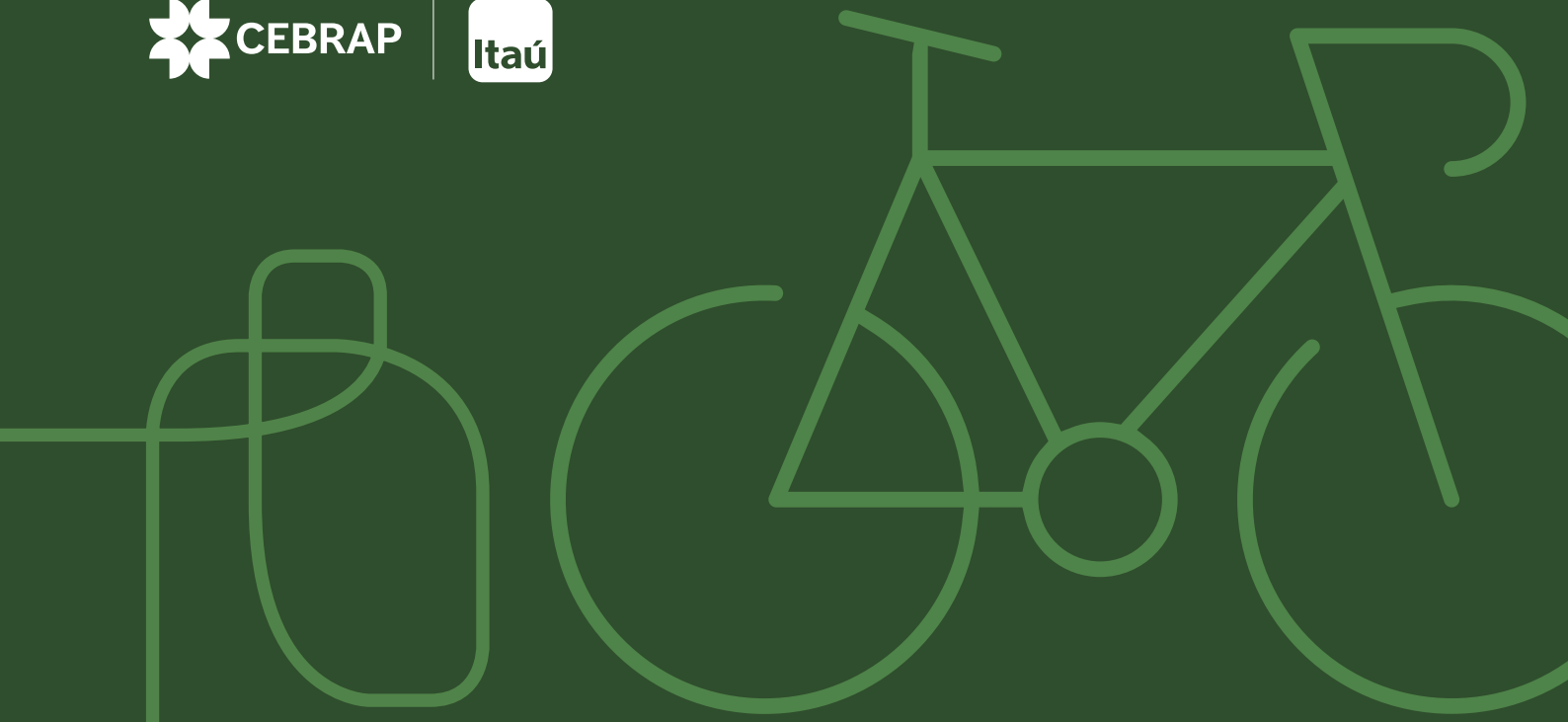

SOCIAL IMPACT OF BICYCLE USE IN SÃO PAULO

CEBRAP

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SPONSOR'S MESSAGE

Itaú Unibanco is committed to the development of shared value generation in the communities in which it works. Being an essentially urban bank and recognizing the importance of valorizing active transport in the sustainable development of cities, we have defined urban mobility as an investment pillar within our sustainability platform and we foster the integration of bicycle culture into city transport together with public authorities and society, with the view to influencing public policy that promotes bicycle use in the day-to-day lives of individuals.

Itaú Unibanco.

OVERVIEW

This document presents the results of research on the Impact of Bicycle Use in the City of São Paulo 2017. The study was conducted by the Centro Brasileiro de Análise e Planejamento – Brazilian Center of Analysis and Planning (CEBRAP), with the sponsorship of Itaú Unibanco bank.

Studies regarding the impact of bicycle use around the world investigate how this mode of transport affects different areas such as urban mobility, economics, local commerce, environment, household income, and health. Research about this topic is rare in Brazil. For this reason, the research presented here, seeks to report on the diverse possible impacts of bicycle use in the city of São Paulo.

The study seeks to estimate impacts in two dimensions. One is the individual, or the impacts on the living conditions of the individual; on their health, their well-being within the city, and their personal spending . The other is the social dimension, or the impacts on macro social dynamics such as the environment, the health care system and the economy (society's productivity).

Stemming from a series of household interviews conducted in 2017 with samples from two groups in the municipality of São Paulo (general population x bicycle users), it was possible to compare life conditions and gauge social and individual impacts of bicycle use, regarding population estimates, public spending, and economic models.

Within the theme of health, we compared the physical activity profiles of cyclists and the general population. If the activity profile of cyclists could be replicated in the general population, this could result in a savings of R$ 34 million (US$10,3 million) per year for the Sistema Único de Saúde* – Unified Health System (SUS) with hospitalizations for circulatory system diseases and diabetes in the municipality of São Paulo.

Regarding the environment, the analysis of cyclists and the general population within the city showed that the feelings of well-being during trips; such as pleasure, relaxation, and satisfaction, are experienced by cyclists in a proportion twice that experienced by the general population of São Paulo.

With respect to the current emissions of CO_2 in the journeys of inhabitants in the city of São Paulo, as a result of changing from other modes to the bicycle, cyclists are responsible for a 3% reduction in CO_2 emitted by transport in the city. In terms of projected impact, we estimated that CO_2 emissions could be reduced by up to 18% if the cyclable potential was achieved, which account for only a part of the journeys in the city.

With respect to the economy, based on detailed information from individuals' monthly spending, we calculated the burden of transport on monthly income. We then estimated how much individuals could save using bicycles in cyclable journeys on working days. We verified that there was an important reduction in expenses if a bicycle was used for commuting. The impact would be greater among lower socioeconomic classes with an average savings of 14% of monthly income (R$ 214 (US$ 65)).

We also projected a potential increase in municipal GDP by considering travel times. If the cyclable potential of trips taken by car and bus in São Paulo was used, there would be a R$ 870 million (US$ 264 million) increase in municipal GDP per year.

The projections produced by the research are far from exhausting the impact possibilities of bicycle use in the city of São Paulo. The impact is much greater. New research can help measure these. Other information and calculation models are needed for the multiple projection possibilities that exist. In

*The dollar exchange rate considered along this work is R$ 3.29.

the economy, for example, bicycle impacts could be measured on economic activity (manufacturing, trade, and services). With respect to the environment, it is possible to explore questions regarding space saved on public roads with greater bicycle use or even the reduction of other pollutants in addition to CO_2. In the area of health, hospitalization costs for diseases in addition to those mentioned, as well as medication costs, are other methods of calculating the impact of bicycle use.

There is, therefore, an ample research agenda available for measuring the impact of bicycle use on cities and on the lives of individuals.

CONTENTS

1. INTRODUCTION

This document presents the results of research on the Impact of Bicycle Use in the City of São Paulo 2017. The study was conducted by the Centro Brasileiro de Análise e Planejamento – Brazilian Center of Analysis and Planning (CEBRAP), with the sponsorship of Itaú Unibanco bank.

The project's objective was to identify the impact of the bicycle on three areas: environment, health, and the economy. To do this, we looked at two dimensions of analysis: the individual, the impact that bicycle use can cause on the life of those that cycle; and secondly, the social, which refers to the impact that the collective use of the bicycle as a mode of transport can have on society as a whole.

In relation to the environment in the individual dimension, we identified the impacts related to the experience of life within the city and of travel well-being; and in the social dimension, the reduction of CO_2 emissions resulting from the switch from the use of motor vehicles to bicycles.

In health, we compared the proportions of sedentary and active individuals among the populations of cyclists and the general population and measured the savings generated for SUS through decreases in hospitalization costs for circulatory system diseases and diabetes in the municipality of São Paulo in the scenario that there was an increase in the number of active individuals among the population.

In the area of the economy, we demonstrated the potential of an increase in disposable income for residents of São Paulo if they began using the bicycle more in their daily commutes and measured the impact on municipal GDP due to the increase in average productivity as a result of travel time gains.

The projections presented in the research do not exhaust the possibilities of analyzing the impact of bicycle use on the city of São Paulo. However, the scarcity of methodologically consistent calculation models for its measurement imposed some limits in carrying out this study.

Other possible indicators for measurement from the point of view of wealth production could be, for example: the weight of the bicycle in economic activity (manufacturing, trade, and services); the economy of space on roads with high bicycle use; the reduction of pollutants other than CO_2; or the reduction of costs with medications and other diseases, beyond that of diabetes and cardiovascular diseases that were selected for this study

It is also worthwhile to highlight that the impact of bicycle use is much greater than what is presented here. The results of this study point to relevant transformations that could be generated through the increase in the use of the bicycle in the municipality of São Paulo.

In addition to this introduction, this study is divided into six parts. In the second section we discuss the design and methodology of the study. In the third, we look at the profile of the population studied, and the journeys observed. The fourth part shows the impact projections of bicycle use in three areas: the environment, health, and the economy. Following this, we analyze the perception of the population about bicycle use and the perspective and motivation for its adoption among the general population as well as motivations for bicycle use among cyclists. We finish with our concluding remarks.

2. RESEARCH DESIGN AND METHODOLOGY

Data collection was carried out via a household sample survey. 1,100 household interviews were conducted between September 20 and October 10, 2017. Part of these targeted the general population of São Paulo (regular sample) and the other, the group of bicycle users (cyclist sample), which served as a control group for our analyses. The survey considered cyclists as those who used a bicycle for journeys on the last working day prior to the interview.

The representative sample of the population of the city of São Paulo (regular sample) was designed around 1,000 individual interviews. A sample selection of 100 city census sectors was conducted and in each, ten questionnaires were applied. For the group of 100 cyclists (cyclist sample), interviews were conducted in the neighboring census sectors of the previous selection. This strategy allowed us to capture the number of occurences of cyclists in the city by way of a regular sample and also understand the characteristics of this group when considering cyclists in all regions of the city (cyclist sample).

To guarantee population representativity and comparability among the groups, probability samples were defined with quotas from the census sector (gender, age, education).

The general population samples from São Paulo and the group of cyclists were weighted using data from the Pesquisa Nacional por Amostra de Domicílios – National Household Survey (PNAD) from 2013 and the Pesquisa Origem e Destino – Origin and Destination Survey (OD) from 2007.

Data collection was carried using a structured questionnaire organized in eight blocks:

1. **General information:** questions about the demographic profile of the sample population.

2. **Problems with the city:** perceptions of those interviewed about the principal problems in the city of São Paulo and those that affected them personally.

3. **Economy:** family and personal budgets of those interviewed.

4. **Mobility:**

   a. the routes and modalities used by those interviewed in all trips[2] undertaken on the last working day prior to the application of the questionnaire;

   b. feelings regarding travel;

   c. transport costs;

   d. weekly frequency of use of the modalities of transport.

5. **Health:** questions from the reduced International Physical Activity Questionnaire (IPAQ) developed to identify physical activity levels among the population.

6. **Well-being:** the amount of time those interviewed were exposed to urban spaces.

7. **Violence:** the feeling of security in the city of the individuals interviewed.

8. **Cyclist:** directed questions, specifically towards those who used the bicycle as a means of transport on the last working day prior to the application of the

[1] The margin of error is three percentage points, with 95% confidence. [2] The terms "travel", "trip", and "journey" are used to describe any movement between point A and point B.. The term "commute" refers specifically to commuter "home to work" movements.

questionnaire. Those interviewed were questioned about:

e. how long they had used a bicycle as a means of transport;

f. reasons that made them use the bicycle;

g. the frequency with which they cycled;

h. perceptions about the cycling infrastructure in the city.

From the survey of the two groups (general population x cyclists), it was possible to compare different conditions and quality of life indicators which allowed the assessment of individual impacts on the use of the bicycle and simultaneously project the impact on macro social dynamics, combining population, public spending and economic modelling estimates.

2.1. Impact of bicycle use on the environment

The possible impacts of bicycle use on the environment were calculated with respect to: i) life experience and perception of well-being in the city considering the individual aspect of the analysis; and ii) the reduction of CO_2 emissions linked to the means of transport in the city for the social dimension the analysis.

The indicators defined for the comparison between cyclists and general population about their experiences with the city and their feelings of well-being were: time spent outdoors declared by the representatives of each of the groups, and feelings of well-being declared during the commutes by the individuals interviewed.

This allowed us to study the hypothesis that there are differences (Barros, 2014; St. Louis et. al., 2014) between the populations studied regarding enjoyment of open urban spaces, feelings of security, perceptions about problems in the city, and perceptions about the comfort of daily commutes.

With respect to the social dimension – the environmental impact as a result of the reduction of CO_2 emissions due to bicycle use –, we sought to identify possible reductions with the substitution of car and bus use by bicycles in certain types of travel around the city.

Figure 1 – Environmental dimensions and indicators

Dimensions	Indicators	Impact analysis
Individual	Traveling well-being	Perceptions of comfort and discomfort in daily trips around the city
	Well-being by time outdoors	Interaction with open urban space Daily security perception Daily security perception
Social	Total CO2 emissions per mode	Reduction of CO_2 emissions from switching to bicycles for traveling

2.2. Impact of bicycle use on health

The possible impacts of bicycle use on health were calculated by adopting the counterpoint between sedentary and active lifestyles as the dimension of analysis. Health research studies show better indicators for individuals with greater levels of physical activity (Arem et al. 2015; Ekelund et al. 2015). It was expected that possible impacts of physical activity could be identified in those that journeyed by bicycle.

To measure the impact of bicycle use on health at the individual dimension, the indicator used was the distribution of the population among inactive, irregularly active, and regularly active individuals. The analysis of the impact of physical activity from bike use was made through a comparison between the general population sample and the control group composed of cyclists.

To measure health impacts in the social dimension, we used expenditure indicators from the Sistema Único de Saúde – Unified Health System, (SUS) in the municipality of São Paulo with Autorizações de Internação Hospitalar – Hospital Admission Orders (AIH) regarding "circulatory system diseases" (chapter IX, codes 100 to 199 in Datasus) and "endocrine, nutritional, and metabolic diseases and the list of morbidities regarding all types of diabetes" (chapter IV of Datasus). With this, we compared the general population sample and the control group and estimated the odds of these diseases occurring in the different groups. We then calculated the potential savings for the public health system if the general population had the same physical activity profile as the cyclists.

Figure 2 – Health dimensions and indicators

Dimensions	Indicators	Impact Analysis
Individual	Population distribution: inactive, irregularly active, regularly active	Comparison between general population and cyclists
Social	Physical inactivity as risk factor associated with diseases	Comparison between general population and cyclists

2.3. Impact of bicycle use on the economy

At the individual dimension, we verified how bicycle use could impact an individual's disposable income. Considering that travel by bicycle can be made at zero cost with the exception of the low cost of sporadic maintenance, we verified that there is a potential for personal income savings for users of public transport as well as users of private motorized transport. This means an increase in the disposable income of the individual for consumption of other non-transport goods.

When looking at the social dimension, we presume that worker productivity is influenced, among other factors, by the time the individual spends traveling from home to work (Haddad and Vieira, 2015). Individuals that travel more quickly to work tend to contribute to the increase in the level of productivity of the economy. This increase in productivity can be reflected in an increase in GDP. In our sample, we identified individuals that would have spent less time commuting if they had completed their journey by bicycle and verified how much this time saved in commuting would represent in terms of an increase in the GDP of the municipality of São Paulo.

We also verified what the impact would be on commute time – and on productivity as a consequence – of the group of individuals in the city should they switch to using bicycles for their commutes. More people cycling means less use of motorized vehicles, freeing space on the roads for those taking journeys that cannot be made by cycling. Thus, a decrease in automobiles circulating could also lead to a decrease in traffic in the city, benefitting other users generally and consequently having a positive impact on the economy.

In the next section, we present profiles of the groups analyzed and their respective commutes.

Figure 3 – Economic dimensions and indicators

Dimensions	Indicators	Impact Analysis
Individual	Individual expenditure with transport	Aumento da renda disponível
Social	Productivity associated with commute times of individuals Productivity associated with commute time in general	Projection of potential GDP increase

3. PROFILE: POPULATION AND TRAVEL

The information used was based on several criteria. Similar to the Origin – Destination surveys conducted by the Metrô in the metropolitan region of São Paulo, we captured all journeys made by the individuals on the last working day before the survey. Travel taken on weekends and/or holidays was not represented in our sample.

We considered travel taken between point A and point B for a specific reason. Thus, if the individual left home and went directly to work, this was considered one trip. If the individual had, for example, left a child at school and then proceeded to work, two trips were counted.

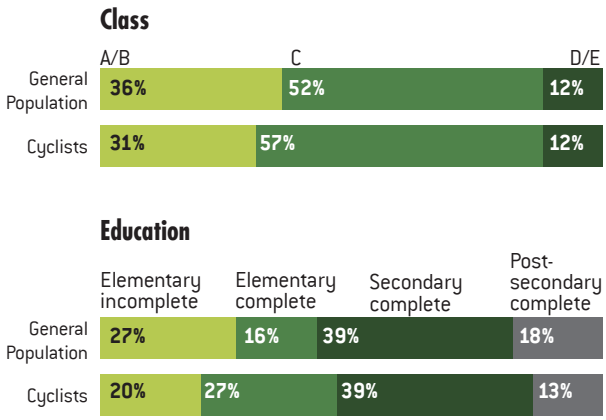
To define who were cyclists within the control group (cyclist sample), we considered those individuals who needed to make at least one journey by bicycle on the last working day prior to the survey. Additionally, we captured the occurrence of cyclists in the municipality of São Paulo in the regular sample; those individuals who were not part of the control group but spontaneously declared to have used a bicycle in a journey taken on the last working day prior to the survey.

In this section, we have described the profiles of the population of São Paulo and our sample of cyclists, as well as detailed the travel profile of the individuals represented in this study.

3.1. Profile of the population and cyclists

The population of São Paulo and the group of cyclists; considered as those who journeyed by bicycle on the last working day prior to the interview, demonstrated similarities in relation to composition by class (Brazilian criteria)[3] and education[4].

Graphic 1 – Profile of the population of São Paulo and cyclists



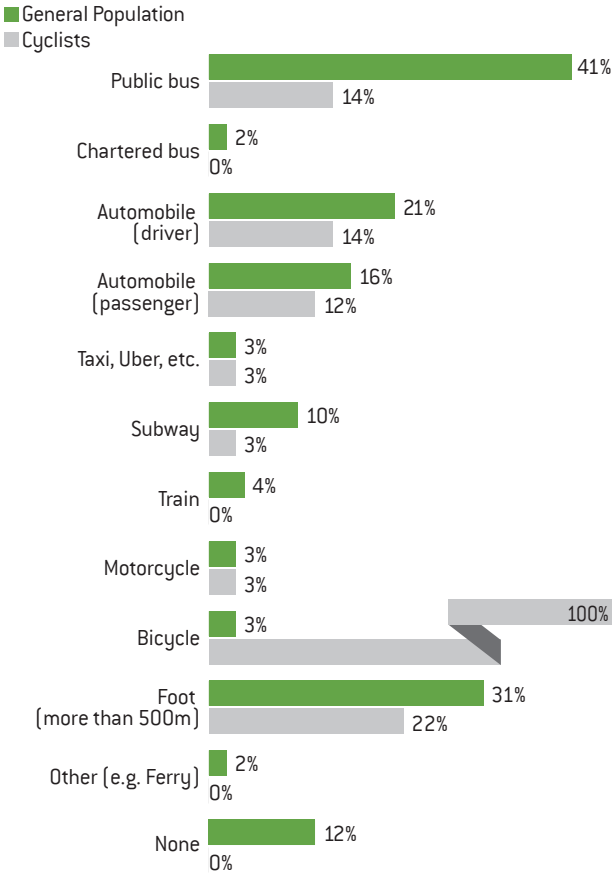
To better understand the mobility profile of the public surveyed, we collected information regarding the means of transportation used the week prior to the survey. Although this data does not permit the exact measurement of the proportional use of each means of transport in the total number of journeys in the city, it does show the frequency of use of each modality by the population.

[3] Brazilian criteria is a classification system which atributes socioeconomic categories to families based on a series of information composed of: ownership and quantity of specific durable goods, education levels of head of households, access to basic public services (ABEP, 2017).

[4] The variables of gender and age were used to weight the sample, taken from the Origin and Destination survey of 2007 by the Metrô.

Public buses represent the most used means of transport by the population (41%). The results also show that 3% of the population of São Paulo used the bicycle for some type of journey in the week prior to the survey. The group of cyclists have a more homogenous mobility profile, and, after the bicycle, their most common means of locomotion is by foot, followed by bus and automobile.

Graphic 2 – Transport use in the week prior to the survey



3.2. Profile of travel

The population of São Paulo takes on average, 2.3 journeys per day. In other words, they travel around two times from point A to point B (for example, from home to work/school and vice-versa). These journeys are an average distance of 3.3km and last around 41 minutes. These numbers vary widely in relation to the type of transport used and location of residence. People living farther from the expanded center, despite also making short journeys, tend to make longer daily journeys (work and school).

Information collected regarding all journeys and modalities used by those interviewed on the last working day prior to the application of the questionnaire, permits a detailed analysis with respect to commutes, including the distance traveled, time spent, and the combination of modalities.

In referring to modalities used for travel, the bus occurred most often in the population and appears as the greatest number of journeys and the longest average duration of travel. On the other hand, despite the low occurrence, motorcycles account for the modality that travels the greatest average distance. Commuting by active modalities (foot and bicycle) appear in 30% of trips, with the bicycle showing an occurrence of 1.2% in the population and appearing in 2% of journeys. (Table 1).

Table 1 – Characteristics of modalities used in the city

	Modes	Occurrence of modality in the population	% of journeys in which modality appears	Average duration of journey in minutes	Average distance traveled in meters
Population of São Paulo	**Foot (more than 500 meters)**	20.0%	28.0%	35	2,528
	Automobile	22.0%	19.0%	35	6,655
	Bicycle	**1.2%**	**2.0%**	30	2,645
	Subway/train	7.0%	13.0%	46	11,281
	Motorcycle	2.0%	3.0%	40	11,453
	Bus	28.0%	38.0%	62	10,250
	Cyclists	-	-	30	3,089

For a more precise analysis of the use of means of transport by the population of São Paulo, we grouped users by commuting profile according to the intensity of use of each mode in the previous week; classifying the population into three groups: "more active mode use", "more public transport use", and "more individual motorized transport use".

In verifying the number of journeys in each group, it was possible to see that those who travel more using individual motorized transport show the greatest average number of journeys, with a distance traveled also above average. Additionally, the incomes of this group were greater which confirms findings in other studies: the inequality of opportunities for movement in the city is linked to income variation of individuals (Vasconcellos, 2013).

Table 2 – Profile of commute by average journeys completed and income

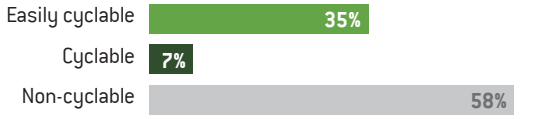
Groups	Average journeys	Monthly family income per capita
More active mode use	2.29	845
More public transport use	2.18	1.064
More individual motorized use	2.42	1.669

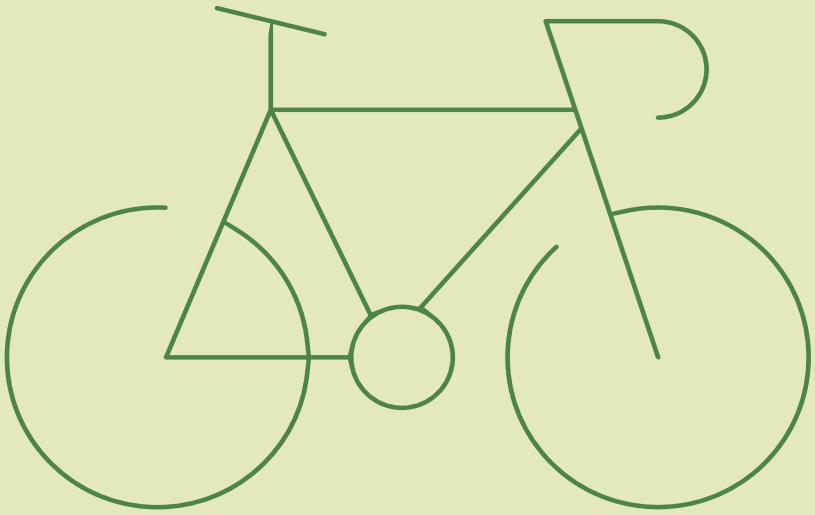
To qualify the understanding about the potential increase for bicycles within the structure of the city of São Paulo, we only considered trips made by inhabitants that could actually be taken by bicycle, rather than assuming that all commutes, regardless of distance and by any individual, could be substituted. Drawing on the study about cyclable journeys by Transport for London (2016), and Amigo (2018), suggesting a typology for journeys that could be taken by bicycle and which we adapted, we divided the journeys into three groups: cyclable, easily cyclable, and non-cyclable:

- Cyclable journeys are those up to eight 8km between origin and destination, taken between the hours of 6am and 8pm by individuals up to the age of 50;
- Easily cyclable journeys have the same characteristics as the above groups, up to a distance of 5km;
- Non-cyclable journeys are those that do not fit into any of the preceding two groups.

From this perspective, 42% of journeys could be made by bicycle, with more than a third of the total journeys being easily cyclable.

Graphic 3 – Cyclable potential of journeys taken in the municipality of São Paulo





4. IMPACT PROJECTIONS OF BICYCLE USE: ENVIRONMENT, HEALTH, AND THE ECONOMY

This section details the process of data collection and preparation of the projections that evaluate the potential impact of bicycles on the city of São Paulo. In some cases, we made an estimation of the current impact of bicycle use on the municipality. In each section we explain how data was collected and how this data was organized to generate the results presented here.

It is important to stress that the methodological analysis adopted in this step of the study was the result of a lengthy study process by the researchers and a search for consistent national and international references compatible for adaptation to the case of the bicycle in São Paulo. For some months, the team focused its efforts on a bibliographic survey and read studies, articles, and theses from various areas that proposed impact measurement methodologies for the various themes. Periodically, the team met to discuss the defined themes – health, the economy, and environment – and, within each theme, their individual and social dimensions. Following this, guidelines were outlined to support the development of the questionnaire used.

As a result, the impact projections took into consideration a series of data obtained throughout the questionnaire. Trips taken on the last working day prior to the survey supported the projections of potential CO_2 reductions. Also central were the economic calculations in which the time saved by switching modalities and the consequent increase in productivity, could be calculated. Data related to health was obtained through a specific section of the questionnaire where a reduced version of the IPAQ (International Physical Activity Questionnaire), an international standard, was used. The comparative information regarding living in the city and experiences with urban spaces was obtained through closed questions strategically developed for this analysis. The following presents the methodological strategies created and the potential impact on each of the themes.

4.1. Environment

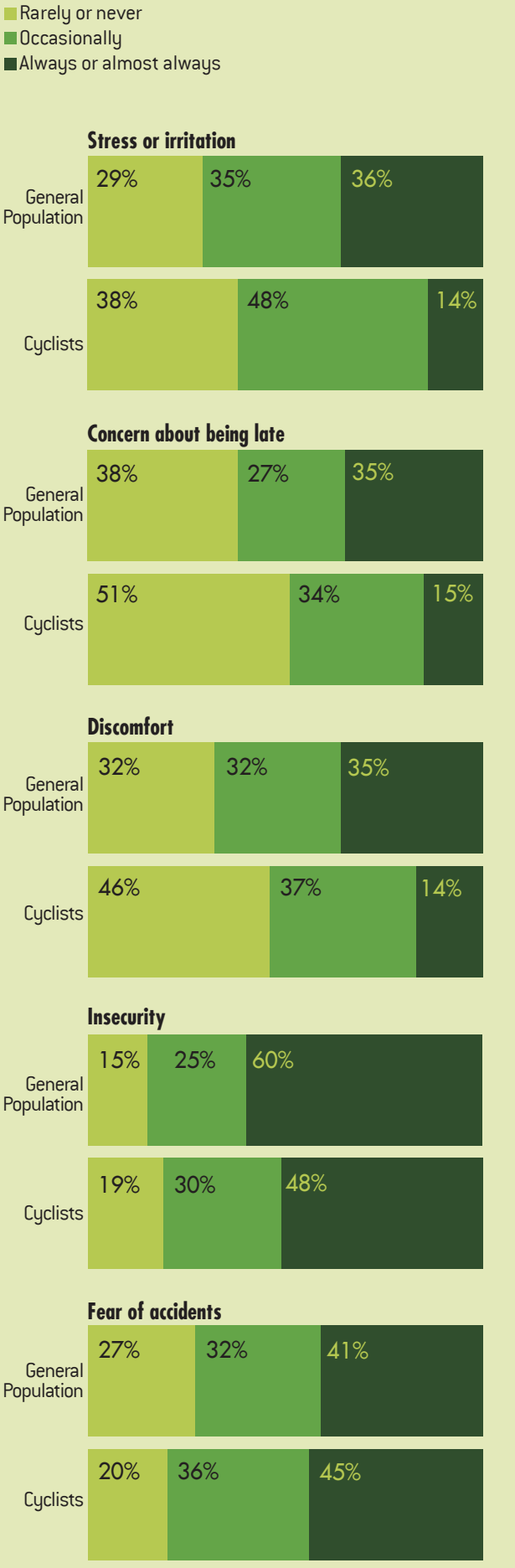
This section of the study sought to explain the nuances between the perceptions of cyclists and the general population in relation to the city. General themes related to life in the city were investigated; as well as more specific feelings experienced during the daily journeys of both groups.

4.1.1 Well-being: experiences of comfort and discomfort in city journeys.

To address the individual dimension of bicycle use impact, we looked to capture perceptions experienced by the population of São Paulo and by cyclists in their daily interaction with the city and the feelings of well-being during their journeys. We began with two central hypotheses. The first was that the relation between the individual and their urban environment is essential for the quality of life they experience (Adams, 2013; Pacione, 2003). Secondly, we assumed the tendency for cyclists to be more present in the outdoor public spaces of the city and therefore to have qualitatively different relationships with urban space.

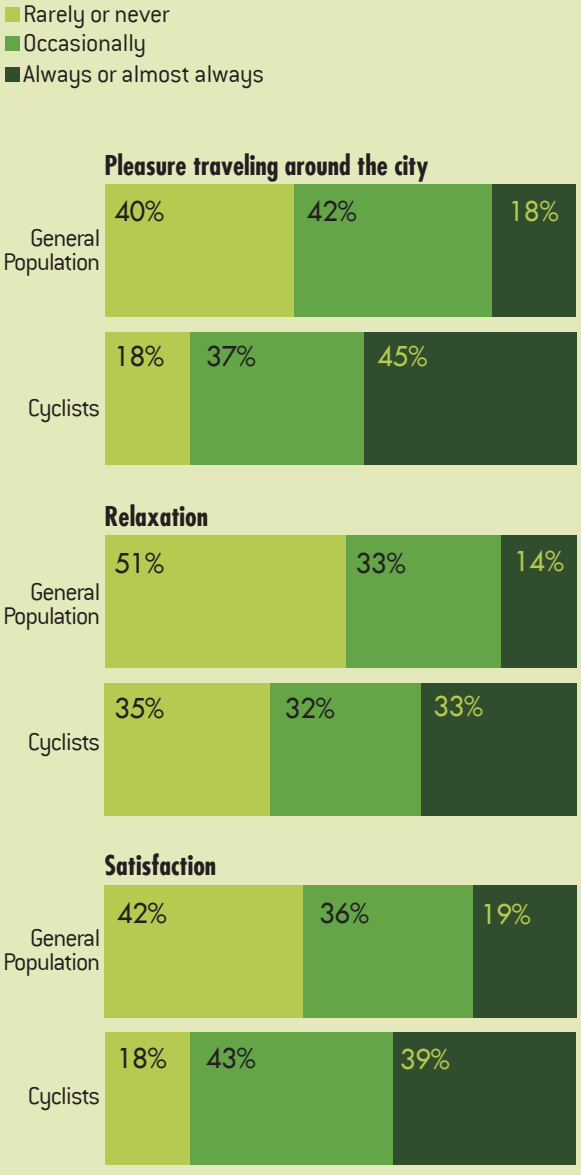
We therefore sought to obtain notions of the feeling of well-being, comfort/discomfort, and stress linked to commuting. The results showed that the cyclist group tended to have less stress and irritation, less concern about being late, and less discomfort when compared to the population of the city (Graphic 4). While cyclists felt less insecurity than residents of São Paulo generally, the rate observed among them was still high and affected almost half the group. Cyclists, however, felt more fear of suffering traffic accidents in the city, which was expected given that together with pedestrians, they are the users with the least protection in the event of a collision.

Graphic 4 – Negative commuting feelings



To test the hypothesis that cyclists enjoy a better relationship with the city, we asked about possible positive feelings during their trips. The data showed that the proportion of cyclists that experienced pleasure traveling around the city and satisfaction with their journeys was more than double the proportion of São Paulo residents in general (Graphic 5). A substantial difference also appeared in relation to feelings of relaxation.

Graphic 5 – Positive travel feelings



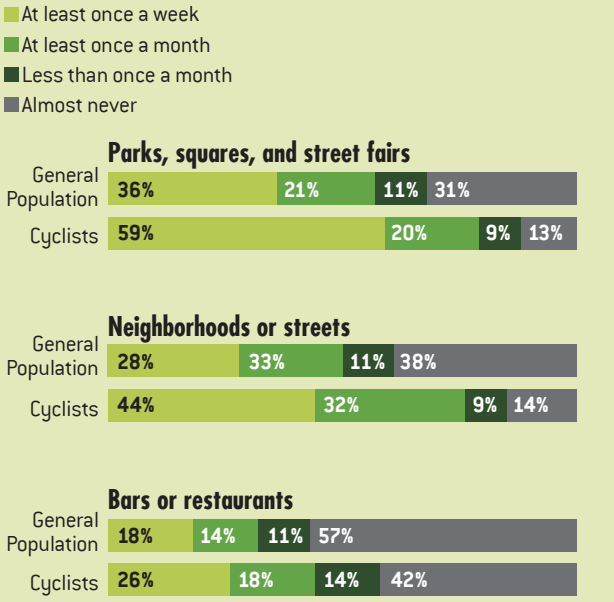
At the same time, we looked for information regarding the frequency with which the population spent time outdoors, the enjoyment of urban spaces, the feeling of security, and the perception of problems with the city.

4.1.2. Well-being: interaction with urban spaces, perception of day-to-day security, and perceptions of problems in the city.

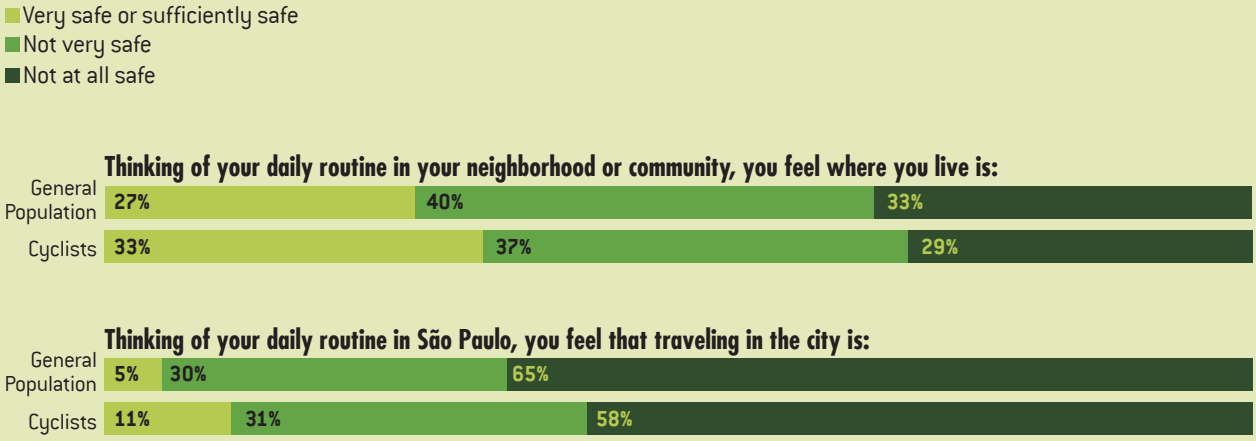
Following the same line of reasoning, we could suppose that if cyclists had a more favorable experience in their daily travel, it was possible that they also had a richer experience with the city. To this end, we looked to verify the frequency of outdoor activities by users.

In the cyclist group about 80% went to parks, squares, and street fairs at least once a month, while in the general population group, this proportion did not reach 60%. Additionally, more than 75% of cyclists usually did physical activity in the streets and neighborhoods. Among the general population, this proportion did not reach 50%. The frequency that both groups went to bars, restaurants, or similar establishments that have street patios was the same for both groups, although the proportion was slightly greater among cyclists.

Graphic 6 – Frequency of outdoor activities (bike, walk, physical activity)



Graphic 7 – Feeling of security in the city



The second topic we addressed was the level security felt by those interviewed. We demonstrated that the perceptions of safety in relation to the location where they live is very similar among cyclists and residents of São Paulo in general (Graphic 7).

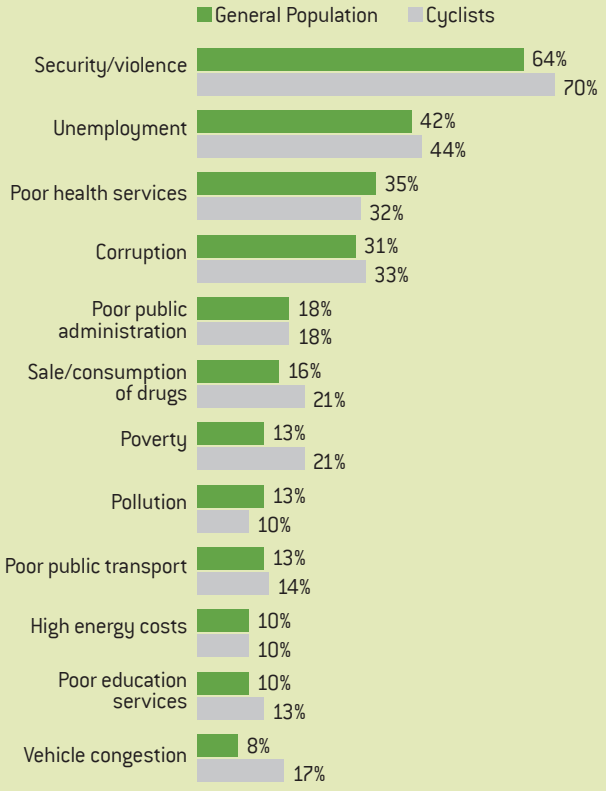
With respect to perceptions of safety when traveling throughout the city, the result was different. Despite cyclists showing a low proportion (11%), it was double that of the general population (Graphic 7).

The data appears to confirm the hypothesis that the greater the exposure to the public environment through outdoor activities results, however timidly, in a feeling of greater security.

With regard to the city's problems, despite showing important differences relating to their daily experiences, the general population of São Paulo as well as cyclists saw that the two principal problems of the city are violence and unemployment. While there were some differences in the positions of the categories, both groups appeared to see city problems in a similar manner.

An exception was the category "traffic congestion", in which the proportion of cyclists that saw this as a problem for the city was double that of the São Paulo population.

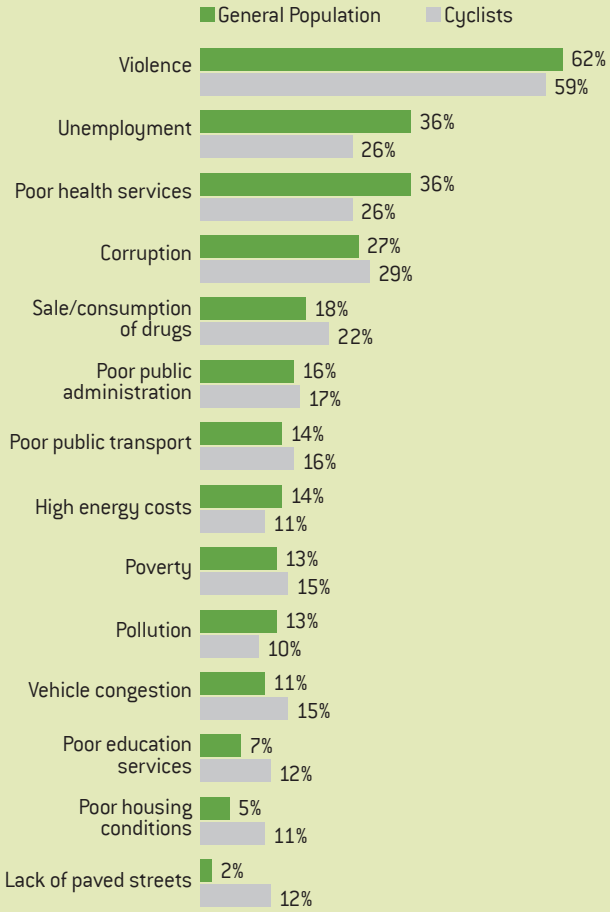
Graphic 8 – Perceptions about principal problems in the city



Those interviewed were also questioned about which of the city's problems affected them most personally. Again, the frequencies with which the categories appeared are relatively similar. What stood out however, was that the proportion of cyclists that pointed to the category "lack of paved streets" was ten percentage points higher than that of the São Paulo population. This was most likely due to the fact that the cyclist is much more subject to

accidents stemming from potholes or poorly paved streets. Therefore, while campaigns such as "tapa-buraco – pot hole filling" or the repaving of streets have the objective of appealing to the users of motorized transport, the cyclist appeared to feel more affected by this question than the rest of the population.

Graphic 9 – Perceptions about the personal effect of principal city problems



The more general data, regarding the way in which the two groups perceived the city, show that the cyclists had a vision of city problems very similar to that of the population of São Paulo. What stood out however, was the greater sensibility on the part of cyclists to questions related to travel around the city, be it greater recognition of congestion as a city problem or noting paving problems as something important.

As we can see, the bicycle appears to truly exercise a positive impact when observing the individual dimension. Cyclists apparently experience a better of quality of life with the city. With more positive and less negative feelings during their journeys, greater use of urban spaces, and while they are affected by the same problems of São Paulo residents in general, they displayed a slightly greater feeling of security with their life in the city.

We will now look at the social impact of the bicycle on the city; the possible reduction of polluting emissions in the case that a determined cyclable potential was reached. We also calculated the probable saving in CO_2 emission of cyclists already pedaling in the city.

4.1.3. CO_2 emissions by mode of transport.

The collective benefit arising from bicycle use as a means of transportation was measured from the point of view of the potential CO_2 emission reductions. Two impact measurements were calculated: one considered a scenario wherein more people used bicycles in their daily trips; and the other from the current use of the bicycle in journeys in the city.

a) Potential reduction in CO_2 emissions

To carry out this projection, we used data related to the journeys of those interviewed which was similar to that obtained by the study used by the São Paulo subway system in its Origin-Destination survey. The option to use this questionnaire was due to the fact that it was a complete and valid instrument that has been used by the Metrô since 1967; more than 50 years of tests and revisions. In our study, we used the questionnaire from the 2007 Pesquisa de Origem-Destino – Origin-Destination Survey (Metrô, 2008).

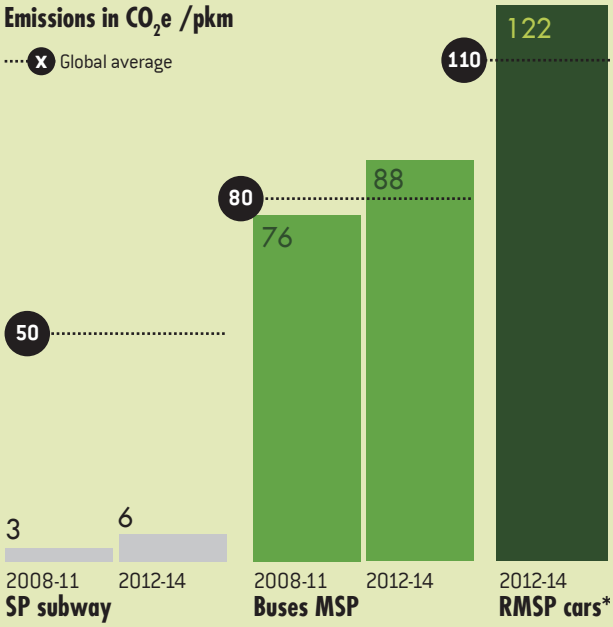
It is worthwhile mentioning that pollutant emissions in São Paulo are the result of various activities in the city. Commercial establishments, industries, and restaurants emit pollutants. The case addressed here takes into consideration emissions from transport. Emissions from trucks and cargo transport were not part of our calculations

as our study concentrated solely on the movement of individuals.

From the study, we verified what distance was traveled by those interviewed, what modalities of transport were used, as well as the time of use of each modality. Following the process of geo-referencing the journeys, we verified the distance between points A and B of each journey. The environmental impact of bicycle use was determined by comparing the emission of CO_2 (greenhouse gas - GHG) released by automobiles and buses on routes that could be substituted by bicycles with zero pollutant emissions. Thus, the route defined for the analysis resulted from the calculation of CO_2 emissions related to journeys made by automobiles and buses by the sample. The calculation of CO_2 emissions was made considering average global emissions of CO_2 for automobiles and emissions from municipal buses in São Paulo from 2012 to 2014.

The average greenhouse gas emission values used here are public knowledge from literature on the theme (Neun and Haubold, 2016; Vasconcellos, 2008) and were calculated using the Brazil GHG Protocol methodology (Graphic 10).

Graphic 10 – GHG emissions (calculation using the Brazil GHG Protocol methodology)



*Gasoline Source: Energy costs, renewable sources, and CO_2 emissions

From the identification of the journeys made by automobile and bus in our sample, we estimated which could be substituted by bicycle. For a realistic projection of the environmental impact of switching to bicycles, only those groups of journeys by bus and automobile classified as cyclable or easily cyclable according to the stratification developed by Amigo (2018); presented previously and adapted for our study, were considered:

- Cyclable journeys: those up to 8km, taken between 6am and 8pm, by individuals up to 50 years of age;
- Easily cyclable journeys: those up to 5km, taken between 6am and 8pm, by individuals up to 50 years of age.

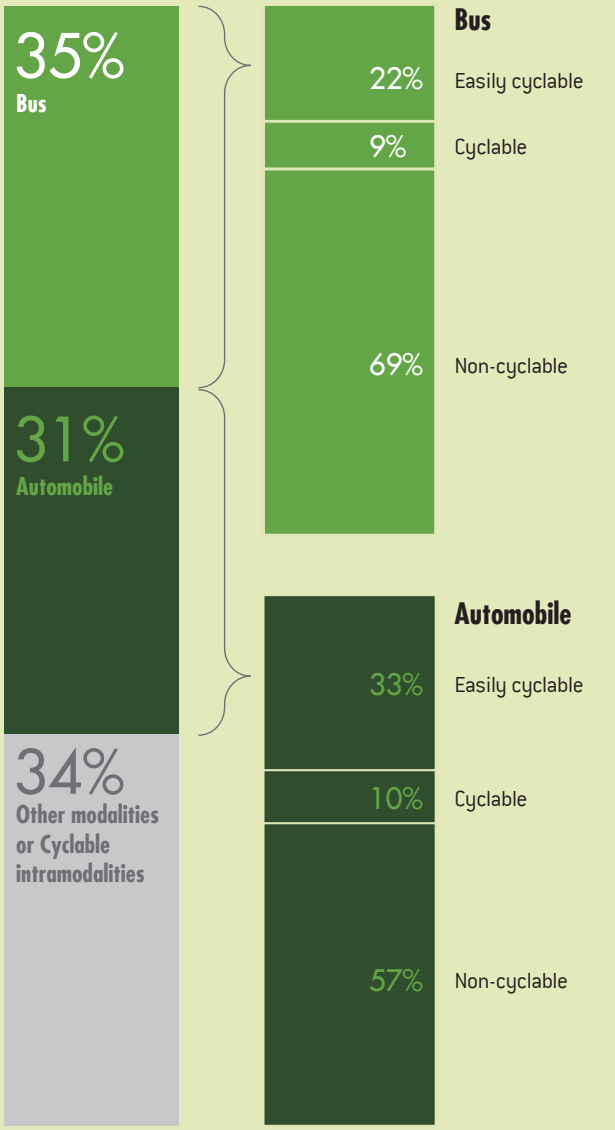
For this calculation, only journeys taken from beginning to end using the same modality were used: 35% of journeys made by bus and 31% of journeys made by automobile (Graphic 11). The 34% of journeys made by other modes or multi-modal were not considered for methodological reasons. The subway, for example, has a level of emissions per person and a volume of use, less than other motorized transport. Switching from subway to bicycle would not result in significant environmental impacts. Additionally, its infrastructure is fixed, and the migration of some users would not cause a change in the manner the modality is operated, differently from automobiles and buses which tend to adapt to demand with more flexibility.

We demonstrated that of the total journeys made by bus, 9% are cyclable and 22% are easily cyclable. Among car journeys, 10% are cyclable and 33% are easily cyclable.

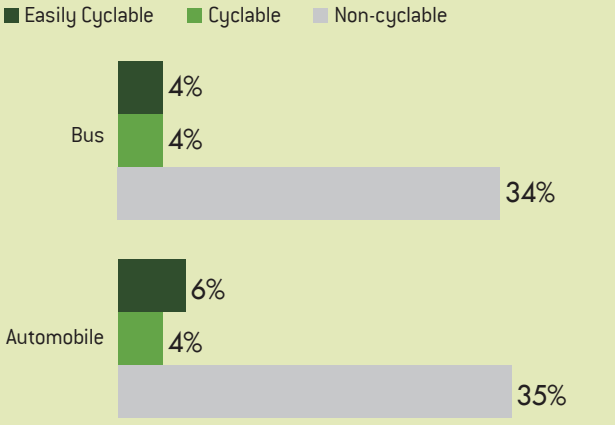
Reaching cyclable potential and the fact that there are zero CO_2 emissions for bicycles, it was possible to calculate the impact of the emission reduction resulting from the substitution of the car with the bicycle. It is worthwhile noting that cyclable journeys correspond to shorter journeys, thus the potential reduction in CO_2 is not reflected vis-à-vis the proportion of eligible journeys to be made by bicycle.

31% of bus journeys could be cycled, causing a decrease of 8% in CO_2 emitted by this means of transport. Considering journeys made by automobile, up to 43% could be made by bicycle, generating a potential decrease in emissions of 10% (Graphic 12). If the cyclable potential was reached, we could have an 18% reduction in the CO_2 emissions that stem from transport in the city of São Paulo.

Graphic 11 – Proportion of journeys per transport modality of the population of the municipality of São Paulo and the possibility of them being cyclable or easily cyclable



Graphic 12 – Percentage of CO_2 emitted per type of journey and modality (bus and automobile) in the city of São Paulo



b) Current reduction in CO_2 emissions

Another exercise to assess the social impact of the bicycle on the environment through the reduction of CO_2, was the projection of how much current cyclists are already contributing with their journeys. In this case, the methodological exercise was in a certain way the inverse of the previous: here we estimated how much cyclists would have emitted in the case they had made their journeys using motorized modalities.

The following procedure was undertaken:

1. We calculated the distance pedaled by cyclists from the "cyclist sample".

2. We assessed how the population of the city made their journeys

3. We verified the total distance cycled by individuals composing the cyclist sample. We then assumed that this total distance, if not made by bicycle, would be made using the same pattern of journey of the population of the city. As the cyclists were interviewed in the neighboring census sectors of the sectors that made up the sample of the total population of the city, there was a high possibility of their replicating the transport dynamic of the São Paulo sample that did not cycle.

4. We calculated the reduced emissions using the Brazil GHG Protocol multiplicator.

5. We extrapolated the result for the population of São Paulo, keeping in mind that the occurrence of cyclists captured in our survey was 1.2%.

From the analysis of the journeys, we demonstrated that cyclists in São Paulo are responsible for a 3% reduction in total CO_2 emitted by the transport of passengers in the city.

The exercises presented here show that the bicycle can be an important tool in public policy for the environment; not only with respect to the reduction of GHG emissions, as shown in the estimates, but also as an instrument for the better use of urban space by citizens. Space exists for an impact study to measure this last theme.

4.2. Health

To analyze the impact of bicycle use on health, we structured the study using the counterpoints of sedentariness and physical activity.

From the individual impact perspective, we compared the physical activity profiles of the population of São Paulo in general, with that of the cyclists, with the hypothesis that the second group would be more active.

In the social dimension, we began with the idea of physical activity as a risk factor associated with diseases and projected the potential for resource savings in the health system in the case that the population of São Paulo adopted a physical activity profile similar to cyclists in the city.

For these tasks, the use of the IPAQ (International Physical Activity Questionnaire) to collect information was fundamental. The IPAQ is used to obtain information regarding physical activities, serves in the analysis and study of various themes in the field of health, and is valid internationally.

The IPAQ allows for classification of the population studied in function of volume (time) and intensity (force exerted) in physical activities performed. For the analysis presented here, we used a classification that segmented the group studied in the following manner (Bielemann et al., 2010; Garret et al., 2004):

1. **Regularly active:** performed vigorous physical activity in the last week on at least three different days with a duration of at least 20 minutes per day;

2. **Irregularly active:** performed physical activity in the last week, but less than the minimum necessary to be considered regularly active;

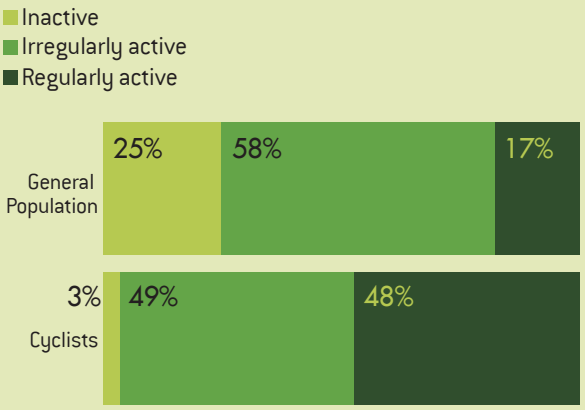
3. **Inactive:** did not perform moderate vigorous physical activity in the last week.

It is important to make clear that moderate activities are those that require some physical force and make the individual breathe a little harder than normal while vigorous activities are those that require strong physical effort and make the individual breathe much harder than normal (CELAFISCS, 200-?).

4.2.1. Profile of physical activity of cyclists and the population of São Paulo

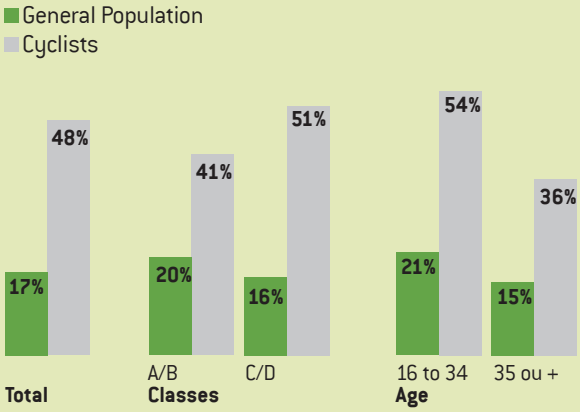
Bicycle use as a means of transport appeared to directly reflect the level of physical activity of the population studied: on average, 53% of the physical activity time of cyclists was carried out in bicycle journeys. While inactivity accounted for 25% of the population of the city of São Paulo, among cyclists, this did not surpass 3% (Graphic 13). It is important to note that we considered a cyclist to be any person that had traveled by bicycle the previous day, or in other words, it was not a filter for the study that the cyclist use their bicycle daily. This is reflected in the fact that 49% of cyclists were irregularly active; they did not practice the minimum activity necessary to be part of the group of regularly active but were active enough not to be considered inactive.

Graphic 13 – Profile of physical activity



Another important aspect of the impact of the bicycle is the fact that it contributes to some level of physical activity in social levels where, in general, inactivity is greater. For example, 20% of class AB and 16% of class CD were composed of individuals that were regularly active (Graphic 14). Among the group of cyclists, 41% of class AB and 51% of class CD were considered regularly active. In other words, the bicycle appeared to contribute to physical activity among the poorest. The bicycle also appeared to contribute to increasing the level of activity among older individuals. While in population of São Paulo only 15% of individuals over 35 years of age were regularly active, among cyclists this proportion was 36%.

Graphic 14 – Regularly active by class groups and age



The bicycle appeared to strongly influence the level of physical activity of the individual and, as we will see in the next section, the bicycle can generate a positive social impact in contributing to reducing SUS expenditures on certain diseases due to an increase in physical activity of the population in general.

4.2.2. SUS savings with circulatory system diseases and diabetes

The analysis here considers some of the studies in the area of health (Bueno et al., 2016; Carlson et al., 2015; Codogno et al., 2015; Bielemann et al., 2010; Garrett et al., 2004) that show that an individual who is regularly active has fewer chances of contracting certain diseases. For this study, we considered cardiac diseases and diabetes.

An estimate of possible economic impacts on the health system was made through the application of the Relative Risk Factor presented in the studies of Bielemann et al. (2010) and Garrett et al. (2004). As can be observed in Table 3, different levels of physical activity have different associated risk factors for a series of chronic diseases.

Table 3 – Risk factor associated with physical activity profile

Groups	Inactive	Irregularly active	Regularly active
Cardiac diseases	2.0	1.4	1.0
Hypertension	1.5	1.2	1.0
Heart attack	2.0	1.4	1.0
Depression and anxiety	1.3	1.1	1.0
Diabetes	1.5	1.2	1.0
Breast cancer	1.5	1.2	1.0
Osteoporosis	2.0	1.4	1.0
Colon cancer	2.0	1.4	1.0

Source: Garrett et al. (2004)

As in the previous analysis, the first step in identifying possible savings impacts in the health system as a result of the increased use of bicycles for traveling was the collection of information about levels of the physical activity in the population via the IPAQ.

Using this information, we identified the proportion of inactive and irregularly inactive individuals in the population and then applied the risk factors for cardiovascular diseases and diabetes (Table 4). To calculate physical inactivity, additional variables such as pregnancy and the impossibility of practicing

Table 4 – Projection of SUS savings on circulatory system diseases and diabetes

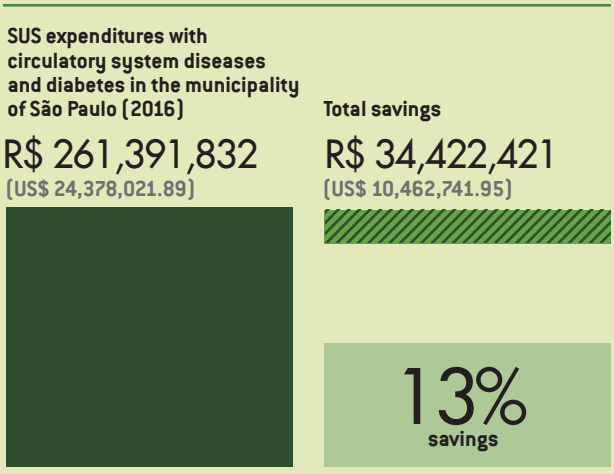
Circulatory system diseases		
SUS Expenditures – Municipality of São Paulo (2016)		**R$ 255,195,930.61 (US$ 68,448,611.12)**
Savings with reduction in inactive individuals	Calculation (% saved)	(SP% inactive - Cyclists% inactive) *0.5
	% saved	11%
	Savings	R$ 28,071,552.37 (US$ 8,532,386.74)
Savings with reduction in irregularly active individuals	Calculation (% saved)	(SP% Irr active - Cyclists% irr active) *0.28
	% saved	2%
	Savings	R$ 5,818,467.22 (US$ 1,768,531.7)
Total savings		**R$ 33,890,019.59 (US$ 10,300,017.81)**

Diabetes		
SUS Expenditures – Municipality of São Paulo (2016)		**R$ 6,195,901.69 (US$ 1,883,252.79)**
Savings with reduction in inactive individuals	Calculation (% saved)	(SP% inactive - Cyclists% inactive) *0.33
	% saved	7%
	Savings	R$ 449,882.46 (US$ 136,742.39)
Savings with reduction in irregularly active individuals	Calculation (% saved)	(SP% irr active - Cyclists% irr active) *0.16
	% saved	1%
	Savings	R$ 82,578.98 (US$ 25,099,99)
Total savings		**R$ 532,401.44 (US$ 161,824.15)**

activities were considered. Finally, a projection of expenditures by SUS for the treatment of the diseases was made considering the reduction in the inactive and irregularly active populations due to the increase in bicycle use.

We verified that there would be a potential savings for SUS with circulatory and cardiovascular diseases if the population of São Paulo conformed to the physical activity profile of the cyclists. A reduction in the chance of having diabetes or circulatory diseases as a result of a greater level of physical activity would see a reduction in SUS expenditures on these diseases and could generate an impact of more than R$ 34 million (US$10,3 million) in savings in the city of São Paulo.

We can see that bicycle use for daily trips provides individuals with a better quality of life. And can also bring the social benefit of savings to the health system which positively benefits society.



The analysis shown here took into consideration only hospitalizations due to cardiac and circulatory system diseases. Spending on medications as well as other diseases could be reduced with an increase in the level of physical activity, generating even greater impacts. Again, we highlight that there is space for other studies to assess the impact of bicycle use on health.

4.3. Economy

As in the themes previously addressed, we looked at the two dimensions of the analysis of economic impact: individual and social. The individual impact of bicycle use was measured by the increase in disposable income of residents of São Paulo in the case that they used the bicycle for daily trips. Here, we used data obtained about family budgets included in the questionnaire. We saw there was a potential for an increase in individual disposable income if the bicycle was adopted as the means of transport for those who made journeys that could be cycled.

To analyze the social impact of bicycle use on the economy, we used the paper of Haddad and Vieira (2015) as a reference. The authors developed a model using data from the Origin-Destination study from 2007, where they demonstrated that workers with shorter commute times tended to contribute to an increase in productivity. The model showed how much this increase in productivity could contribute to the generation of wealth (increase in GDP) over a determined period of time. The social impact on the economy was calculated using only those journeys where the switch from the usual modality to the bicycle would see a shorter travel time.

Another analysis, still considering productivity, looked to identify how much the total travel time would decrease if all potentially cyclable journeys were made by bicycle. This would result in a reduction in travel time of those who were stuck in traffic in motorized transport. Therefore, the transfer of users from public/private motorized transport to bicycles would result in a collective benefit for those who remained in motorized transit.

4.3.1. Bicycle use as a means of transport and increase in disposable income.

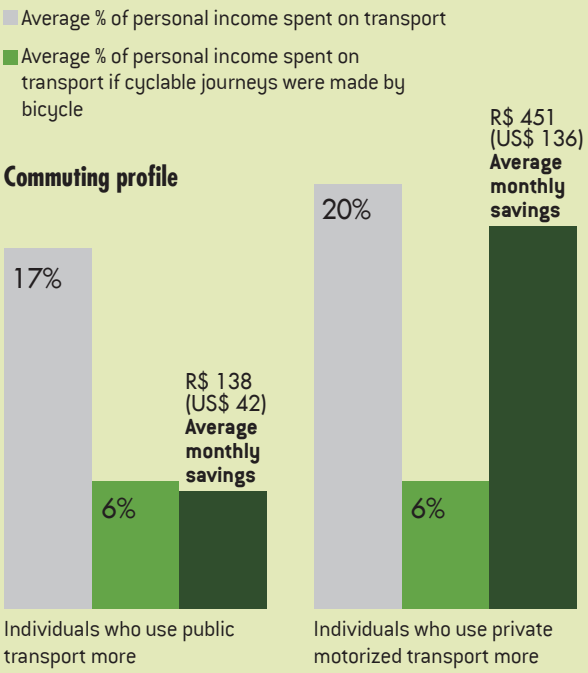
The data collected in this study spanned a series of questions about the composition of the family budget of those interviewed. It was possible therefore, to show not only how much each individual spent with transport, but also, to detail how much each individual spent on bus passes, parking, fuel, fines, taxes, and vehicle maintenance of private vehicles.

In calculating the impact of bicycle use on disposable income, we adopted the following steps to calculate monthly transport expenditures (the calculation used the average values of each group):

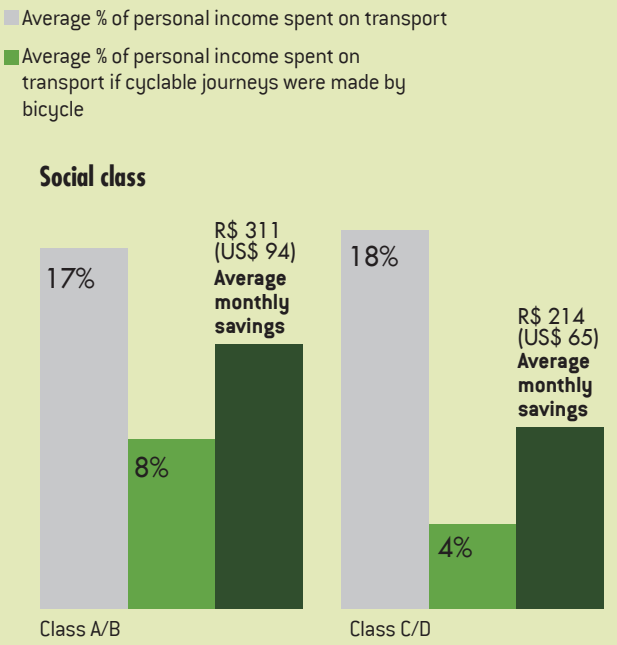
- For those using public transport, the reference was the cost of a single ride at the time of the study (R$ 3.80 US$1.16) multiplied by 20 working days;
- For those using automobiles in their daily trips, we looked at total expenditure in a month, divided by 30 to estimate how much the individual spent per day, and multiplied by 20 working days.

The groups analyzed showed a significant potential saving in the event that they would switch their usual means of transport for the bicycle. This was even more evident when we took into consideration the travel profile of the user; if they used more active, public transport, or motorized individual modalities.

Graphic 15 – Potential reduction in personal income spent on transport based on profile of commute



Graphic 16 – Potential reduction in personal income spent on transport based on social class



In the group that used public transport more, on average 17% of their personal income was spent on transport. If cyclable potential was reached, this cost could be reduced by up to 11 percentage points. In practical terms, this could signify monthly savings of up to R$ 138 (US$42) (Graphic 15).

For those using private motorized transport, the reduction could be even greater; 14 percentage points. This could result in monthly savings of up to R$ 138 (US$42) for those that use the automobile in their daily trips (Graphic 15).

The impact measured was even more important when we took into consideration the social class of individuals (Brazilian criteria). For class C/D, the savings were very significant as monthly expenditure on transport fell from 18% of total income to up to 4%, possibly representing an average savings of up to R$ 214 (US$65) (Graphic 16).

Bicycle use has a possible potential to generate more disposable income for individuals, as well as being a possible instrument for economic impact from the social point of view via an increase in municipal GDP, as we will now demonstrate.

4.3.2. Bicycle use as a means of transport and of GDP increase.

Bicycle use as a means of transport can influence GDP in different forms, such as the consolidation of the supply chain on the offer side, or in other words, in manufacturing, trade, and services related to the modality.

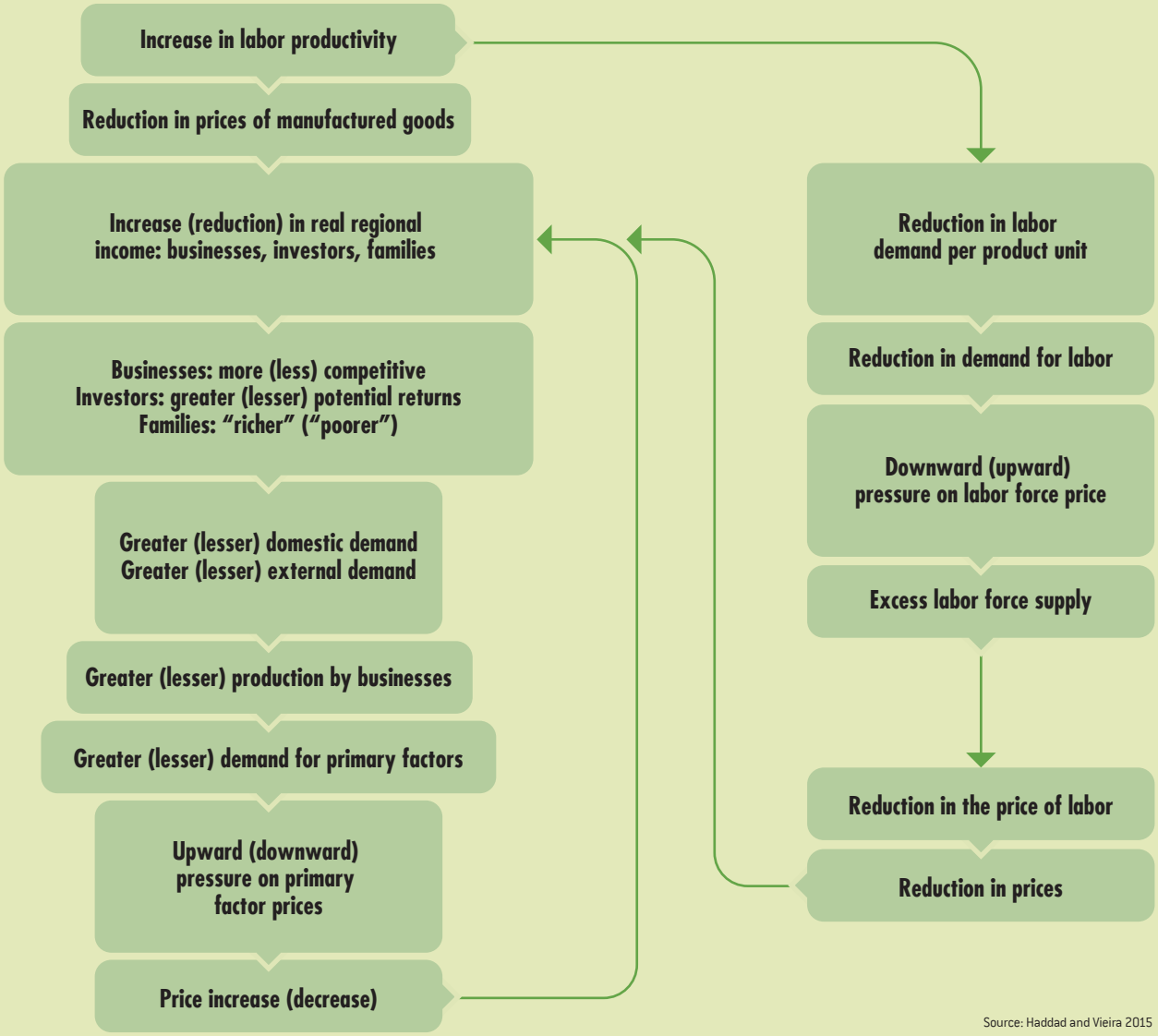
The method adopted here to measure the impact of the bicycle on GDP is productivity. Economic studies such as those of Haddad and Vieira (2015), Van Ommeren and Gutiérrez-Puigarnau (2011), Melo and Graham (2009), and Zenou (2002), show that there is a correlation between shorter travel times in daily commutes and increased productivity. The increase in productivity can be read in two different ways according to the model developed.

On the one hand, it brings about a reduction in the price of manufactured goods which positively affects real regional income: in this approach (cost-competitiveness), businesses become more competitive given that the costs

of production are reduced (inputs are cheaper); investors foresee higher potential returns – as the cost of capital production also decreases; and families increase their real income which allows them greater consumption possibilities. Greater real income generates greater domestic demands, while the increase in the competitiveness of national and regional products, stimulates external demand. This creates space for an increase in the production of businesses – directed at the domestic and international markets – which in turn demands more inputs and primary factors. This increase in demand pressures prices in the factors markets, while at the same time generating expectations that the prices of domestic goods will increase (Haddad and Vieira, 2015).

On the other hand, the increase in labor productivity is also associated with a reduction in the labor requirement per unit of production in sectors employing workers affected by changes in commuting times. As production becomes less labor intensive, all else being equal, the demand for labor falls, causing a labor surplus in the economic system. This creates negative pressure on wages, as well as capital income, given the possibility of imperfect substitution among primary factors, that are passed on in the form of lower prices.

Figure 4 – Causal relations of the model used



Source: Haddad and Vieira 2015

Table 5 – Economic value of commuting time of workers in the RMSP (Metropolitan Region of São Paulo)[5] in 2010

	Consumption			GDP		
	Very short term	Short term	Long term	Very short term	Short term	Long term
São Paulo	0.54	9.14	15.27	0.57	9.16	25.93
RMSP	0.32	6.06	10.77	0.23	4.86	12.73
Rest of State	0.03	0.52	3.96	0.03	0.53	5.99
Rest of Brazil	0	0.09	-0.61	0.04	0.49	6.36
Brazil	0.9	15.81	29.4	0.88	15.04	51.01

Source: Haddad and Vieira (2015)

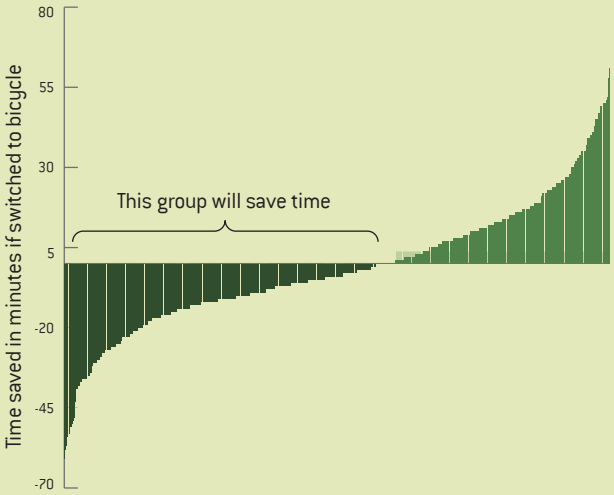
The model identifies the value of the time of the workers' commutes and how much this could impact on consumption and GDP (Haddad and Vieira 2015).

Assuming an increase in productivity and consequent increase in GDP due to reductions in journey times, the steps for identifying the potential impact of GDP by a reduction in journey time by means of bicycle, were the following:

1. Calculate the average journey time of all modalities in the sample;
2. Analyze all journey times and identify those up to 8km taken by motorized means that would be faster if made by bicycle;
3. Evaluate how many of these journeys correspond to the total number of journeys and what is the possibility that they would have an impact on GDP as a result of the reduction in commuting time due to a possible switch to bicycle.

In this way, we identified which journeys in our sample would be faster if made by bicycle (Graphic 17).

Graphic 17 – Time saved in minutes if all journeys were switched to bicycle

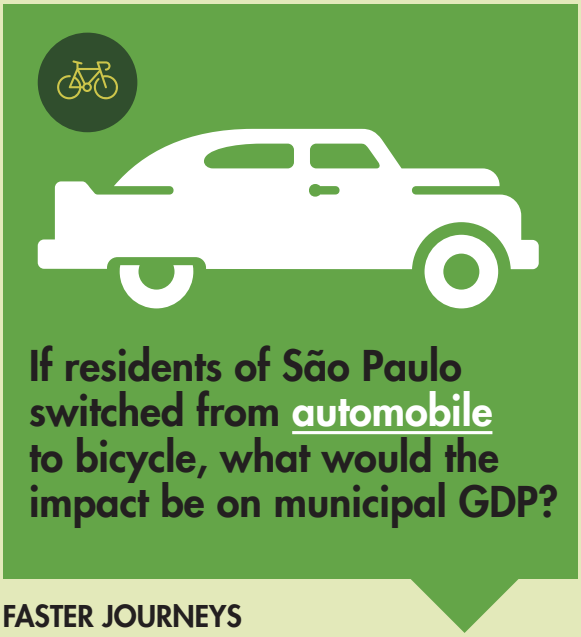


[5] A issue regarding the model is that it considers the economic value of the commuting times of workers in the RMSP (Metropolitan Region of São Paulo). Our sample is centered in the city of São Paulo. While there was a mismatch in applying these multipliers only to the municipality, we used this calcualtion as an estimate as there was no model that considered only the inhabitants of the city of São Paulo.

After identifying the group of journeys that would be faster if made by bicycle, we conducted two exercises.

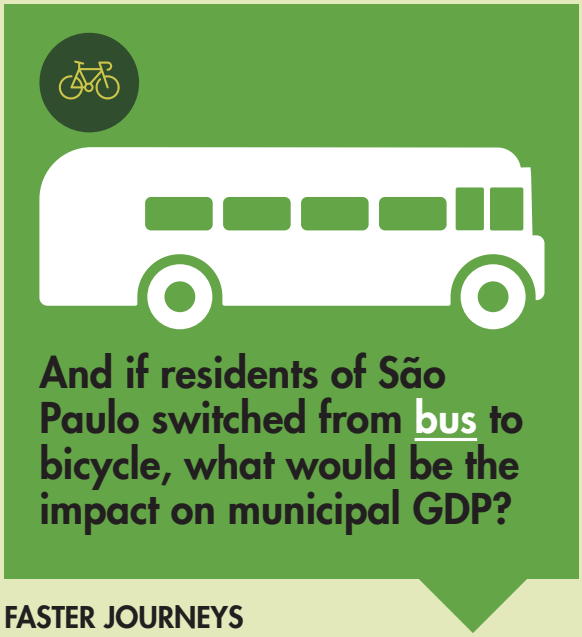
The first looked at the possible switch to bicycle by those who use automobiles in their commutes to work. We discovered that 11% of the journeys made by automobile had up to 8km and were motivated by work. Of these, 26% would have a shorter time if made by bicycle. This represents 3% of total automobile trips. Therefore, of the group that would save time using bicycles, each would save on average, nine minutes. This would represent a productivity increase of R$ 0.12 (US$0.04) per day per person. Taking into consideration that projections of economic gain in GDP vary according to the period of the scenario analyzed; between one and three years, we could expect an increase of almost R$ 19 million (US$ 5,8 millon) in municipal GDP, around 0.003% of the total production of the city.

Figure 5 – Calculation for economic projection of the switch from automobile to bicycle



*considering a scenario of one to three years Note: Considering a) each year has 240 working days, b) the potential population is 168,833 inhabitants of the city of São Paulo aged 16 years or older, c) short term scenario (1 to 3 years), for the very short-term scenario (6 months to 1 year), the projected impact is R$ 11,719,408 (US$ 3,562,130) – 0.002% of GDP (Haddad & Vieira, 2015)

Figure 6 – Calculation for economic projection of the switch from bus to bicycle



*considering a scenario of one to three years Note: Considering a) each year has 240 working days, b) the potential population is 290,854 inhabitants of the city of São Paulo aged 16 years or older, c) short term scenario (1 to 3 years), for the very short-term scenario (6 months to 1 year), the projected impact is R$ 38,942,246 (US$ 11,836,549) – 0.006% of GDP (Haddad & Vieira, 2015)

Following the same methodology, we projected the increase in GDP if bus journeys were switched to bicycle. Of the total journeys, 11% were made by bus, were up to 8km, and were work commutes. Of these journeys, 45% would have a shorter duration if they were cycled. This represents 5% of total bus trips. The average time saving per person who switched from bus to bicycle would be around 19 minutes. This would generate a GDP increase, as a result of increased productivity, of approximately R$ 0.25 (US$0.08) per person. In a period of one to three years, the increase in GDP could reach around R$ 623 million (US$189 million), the equivalent of approximately 0.096% of municipal GDP.

The second exercise measured the collective gains of the switches presented above. As we see, the switch from automobile to bicycle in commutes saw a time gain for part of the individuals in the city of São Paulo and this had an impact on the economy with an increase in municipal GDP. But the reduction in the number of automobiles in circulation could also result in a reduction in city traffic, benefitting other users generally and as a consequence, generate a positive impact on the economy. In other words, with fewer automobiles circulating, there would be less time lost in traffic generally for the group of commuting automobiles, and not only the individuals as we have shown.

To investigate this hypothesis, we began with a measurement from CET – Companhia de Engenharia de Tráfego (Traffic Engineering Department) (2017) that allowed us to assess the average percentage of general traffic delay, which we call here "time lost in transit". We calculated the reduction of this "time lost in transit" in the case that there was a change in scenario A, the current one, to B in which all journeys to work of up to 8km made entirely (from origin to destination) by automobile, were switched to bicycle.

Each user who traded an automobile for a bicycle would be responsible for a 3-minute reduction in time lost by motorists. With this

Figure 7 – Calculation for economic projection of the reduction in transit if all automobile journeys up to 8 km were switched to bicycle

*considering a scenario of one to three years Note: Considering a) each year has 240 working days, b) the potential population is 656,768 inhabitants of the city of São Paulo aged 16 years or older, c) short term scenario (1 to 3 years), for the very short-term scenario (6 months to 1 year), the projected impact is R$ 14,124,781 (US$ 4,293,246) – 0.002% of GDP (Haddad & Vieira, 2015)

average time saving per day per user, we can use the same model from Haddad and Vieira (2015) that considered the reduction in the commuting time of individuals as a factor in average productivity increase to calculate the impact on municipal GDP in São Paulo. In summary, in a scenario of one to three years, this gain could be almost R$ 226 million (US$ 69 million) or 0.035% of municipal output.

The bicycle as a means of transport could, however, bring about a series of impacts from the point of view of the economy. It could favor the increase of disposable income of individuals, increasing the possibility of a greater diversification in family consumption. At the same time, it could be an instrument for increasing GDP in two ways: by allowing individuals to commute to work more rapidly, as well as contributing to a reduction in general congestion as road space is freed up with the switch of motorists to bicycle use.

Other economic impacts of the bicycle can be calculated but are not within the scope of this work. The supply chain of the bicycle is one. We do not know what the impact of bicycle production on GDP is, nor what chains they drive. Studies do not exist that measure how greater disposable income, as a result of a cost reduction with basic services, (such as transport) could impact GDP if this resource was invested in consumption. While these and other impacts were not addressed in this study due to the inability for measurement given the resources available, or the lack of robust statistical models, they do constitute a future research agenda.

5. PERCEPTIONS ABOUT BICYCLE USE

As we have seen previously, the possible impacts of more intensive bicycle use as a means of transport can be extremely relevant for the improvement of various aspects of life in the city.

However, there do exist other questions that tend to hamper the increase in bicycle use in São Paulo. This section, divided in two parts, is dedicated to understanding some of the aspects of the use, or not, of the modality.

First, we looked at the willingness and motivation for adopting the bicycle as a means of transport among the general population. The second part, applied to cyclists, sought to understand what led individuals to adopt the bicycle as a means of transport and what made them continue to use the modality.

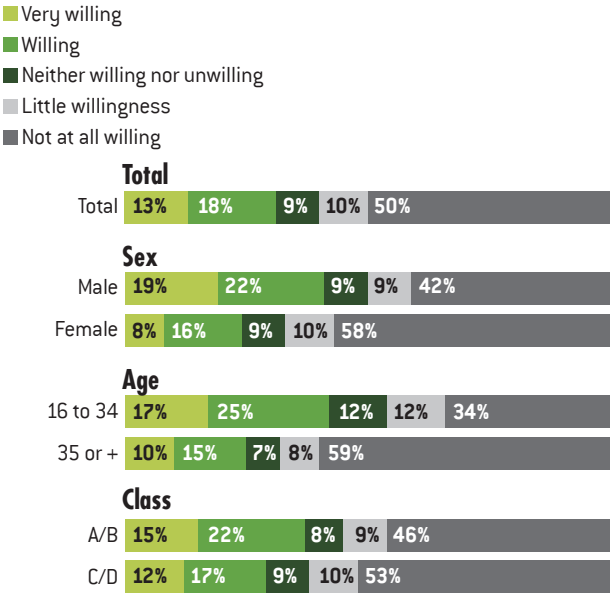
If in the first part of this report, we identified the vast potential impact that the bicycle presents, in this stage, we look at the principal challenges that need to be overcome to increase the number of users and thus reach this potential.

5.1. Willingness and motivation for adopting the bicycle among non-cyclists

While the potential impact of bicycle use in relation to the environment and health is significant, half of the population of the city did not demonstrate any willingness to adopt it as a means of daily transport (Graphic 18). 31% of the population would be willing to use the bicycle in their daily journeys. Among younger men and higher social classes, the willingness appeared greater. However, among C/D classes, precisely those who benefit most in terms of personal income, willingness appears lower (Graphic 18).

What also stands out is the unwillingness for greater bicycle use among those over 35 years of age, the group with the lowest physical activity levels and that could benefit from a reduction in the risk of cardiovascular diseases and diabetes if they adopted active commuting practices.

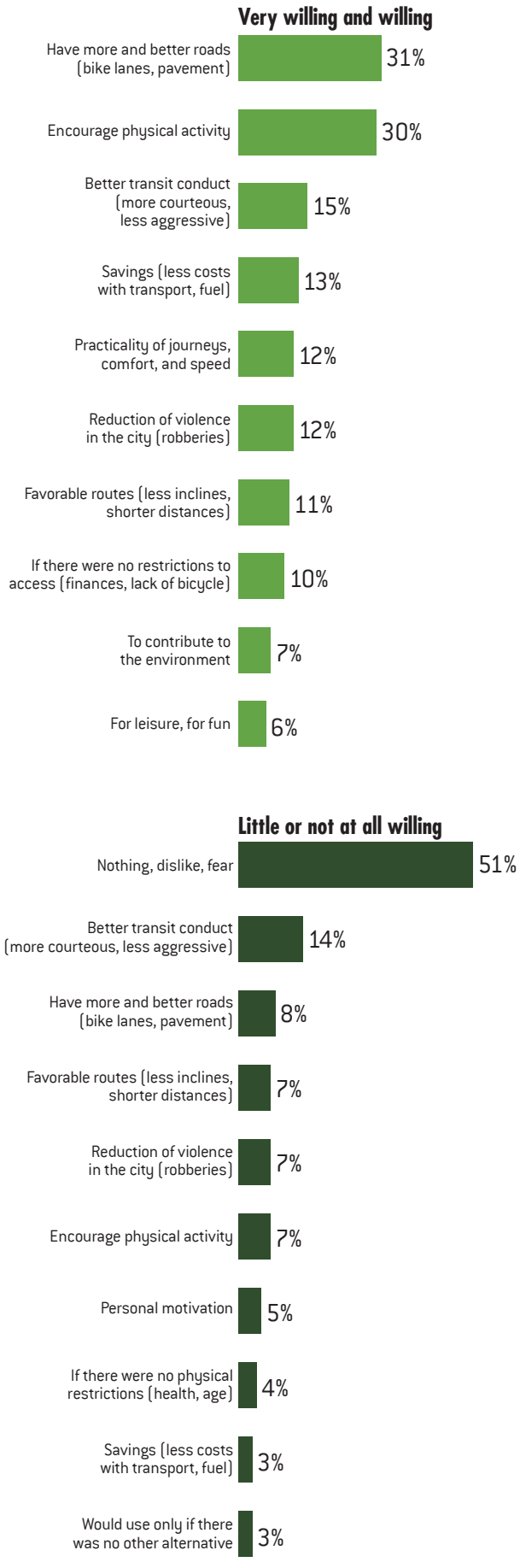
Graphic 18 – Willingness to use the bicycle as a means of transport



We furthered the analysis and sought to capture what led an individual to use the bicycle as a means of transport. What stood out, was that between those willing and those showing little willingness or none at all, the nature of the traffic was a frequently cited factor. In other words, independently of the degree of willingness that a person had to start using the bicycle, the expectation of a reasonable interaction with the traffic was an issue that carried important weight (Graphic 19).

It is worthwhile to highlight as well, that among those willing to use the bicycle, infrastructure and physical activity are elements that stand out (about 30% of this group). Among those with little or no willingness, while infrastructure appeared as an important factor, it was mentioned by only 8% of those interviewed. These responses further reinforce the importance of good bicycle infrastructure

Graphic 19 – Reasons for bicycle use as a means of transport



(bike lanes), as well as more welcoming roads for those who get around by active means, given that traffic aggressivity appeared as a crucial factor for both groups.

With respect to what would convince individuals to use the bicycle, half of the population responded "Nothing, I dislike it, I'm afraid", demonstrating that they are not open to this change (Graphic 19). This shows that there is a very important challenge to be faced by policy makers and other actors involved in bicycle mobility: a good part of the population, (half) do not wish to use the bicycle as a means of transport.

5.2. Motives for bicycle use among cyclists and satisfaction related to bike lanes

More than 70% of city cyclists have used the bicycle as a means of transport for more than three years. Regardless of cycling experience, the principal motivation for beginning to cycle, was travel time – in other words, those who considered that their trip time was too long the way they were originally doing it. It is important to note, that among recent cyclists, health appeared in second place, and among more experienced cyclists, the pleasure of cycling appeared in second place (Graphic 20).

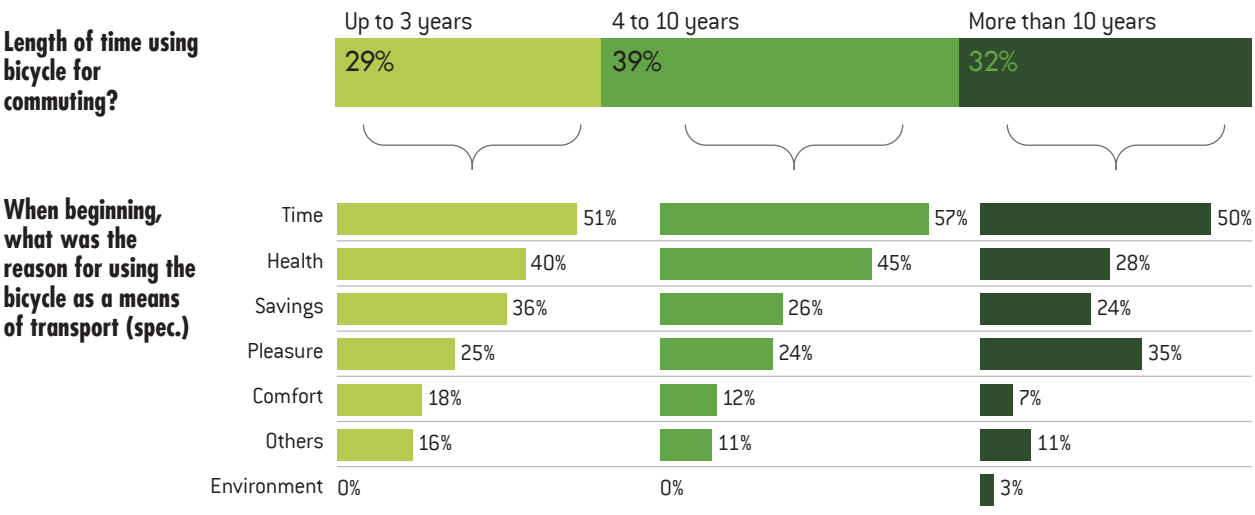
When questioned about the reason for continuing to cycle, those interviewed principally mentioned the financial saving associated with bicycle use. The income impact from bicycle use is something that influenced the decision of individuals to continue cycling. As presented in the Economy section of this paper, it is an important aspect in promoting bicycle use as transport.

In the analysis of the total of motives, health and journey time appeared in first place. It is useful to highlight that both motives are associated with conditions of individual well-being. To have a healthier life and/or faster journey between points of origin and destination thereby increasing free time for other activities, are factors that are directly associated with quality of life.

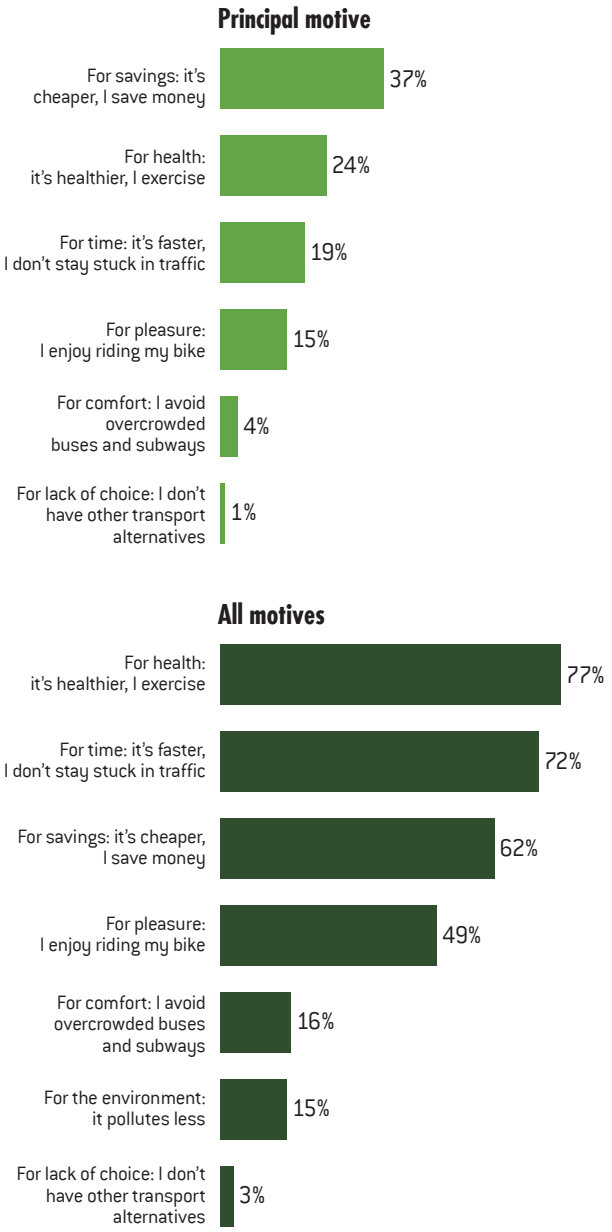
We also sought to analyze the intensity of bicycle use by cyclists and how important bike lanes were in their day-to-day lives. Half of the cyclist group responded that they use bicycles every day of the week, including Saturday and Sunday, with 70% using them at least five days a week. Additionally, 22% of cyclists did not usually use the bike lanesin the city (Graphic 22). This is reflected in the fact that they are considered essential for just 36% of the cyclist sample, while 60% consider them to be important. Thus, while bike lanes were not used by all cyclists, there appeared to be a consensus among the group that they are important for the city (Graphic 23).

When questioned about what they thought in respect to city bike lanes, cyclists appeared relatively divided. The points that generated most dissatisfaction was the lack of respect of other users for spaces reserved for bicycles and the upkeep of infrastructure. The best evaluated point was the quality of the bike lanes with respect to width, barriers, or detours (Graphic 24).

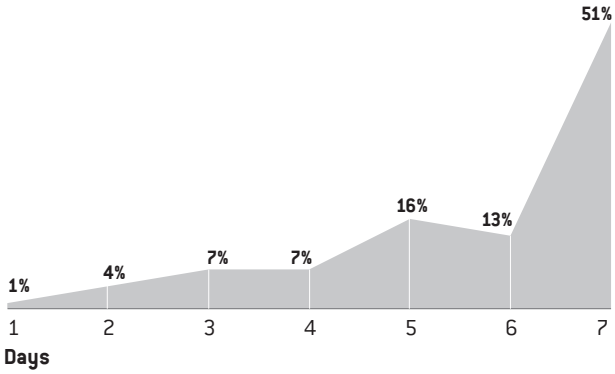
Graphic 20 – Length of bicycle use by reason



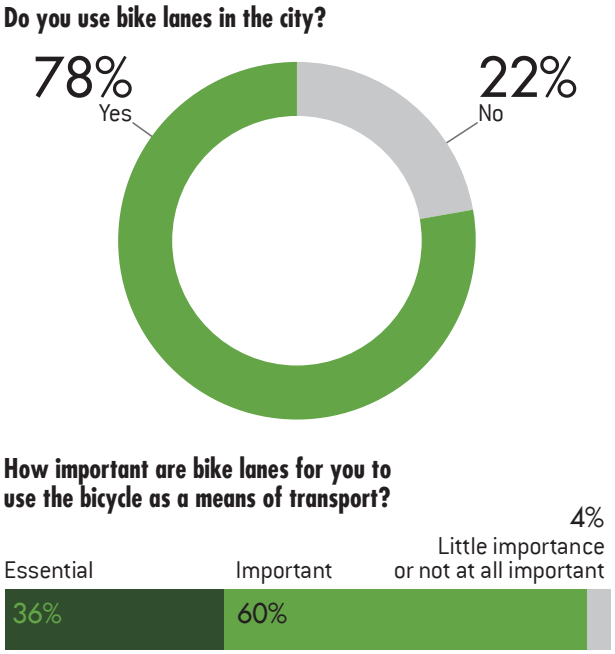
Graphic 21 – Reason for bicycle use in daily trips



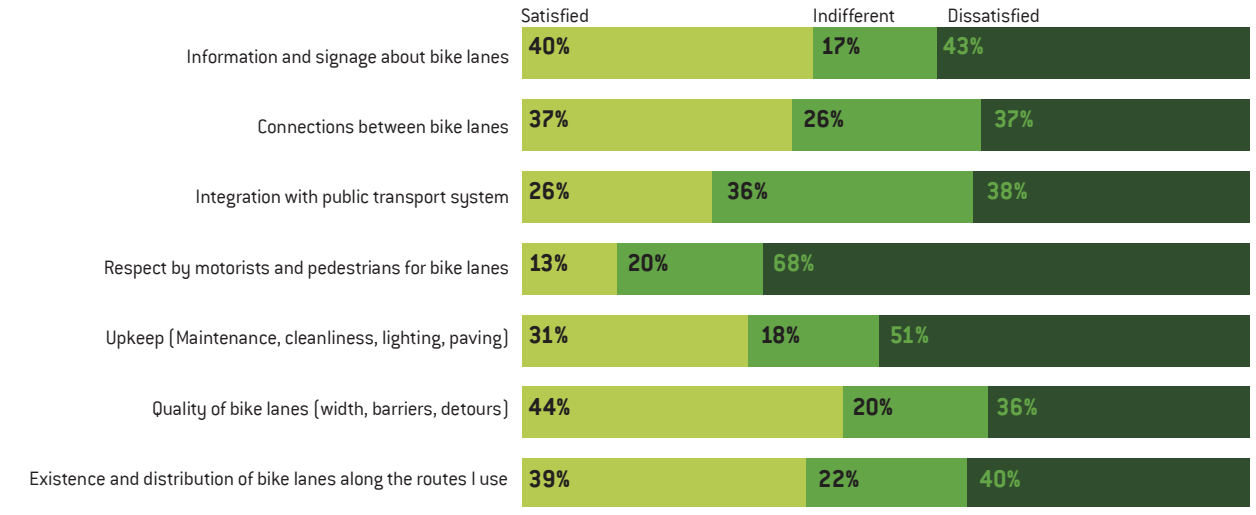
Graphic 22 – Number of days per week of bicycle use (leisure or transport)



Graphic 23 – Bike lanes use and importance



Graphic 24 – Bike lane assessment



This data showed us that the allocation of a portion of the road or sidewalk for bicycle use will not resolve a larger question for the city: the struggle for space. In locations where the sidewalk is narrow and there is a bike lane alongside the curb, it is very common for pedestrians to use the bike lane as an extension of the sidewalk. In roads with heavier traffic, where bike lanes are alongside the central area, it is very common to see motorcyclists, police cars, and ambulances using the space designated for cyclists.

The data shows a dual challenge for public and private institutions interested in promoting bicycle use in the city. There is a long road ahead to raise awareness and persuade society about how the bicycle can bring benefits to not only the individual but also to the social dimension of the city. There also exists a conflict for space in daily transit that needs to be managed.

6. CONCLUDING REMARKS

The main objective of this research project was to estimate the impact of bicycle use in the municipality of São Paulo. We analyzed the study regarding impressions about bicycle use as a means of transport for part of the population, as well as the city's acceptance of bike lane infrastructure.

The impacts of bicycle use as a means of transport presented here were limited by the scope of the project, by information available, and by methodological reasons such as existing models for estimates. While there are various other impacts to be measured, we concentrated our efforts on those for which we found consistent methodological support in the literature, for which it would be possible to use secondary sources, and could be reproduced by other researchers.

We observed that the bicycle has the potential to produce extremely positive impacts for individual inhabitants, as well as for the city in general. In the individual dimension, it could produce a better quality of life for individuals in the city, a more effective appropriation of urban space by part of the population, as well as a feeling of greater security. Additionally, the bicycle could serve as an important source of physical activity for part of the population which has an inactivity rate of 25%. More physical activity means a healthier population and strengthens the feeling of quality of life. Finally, the bicycle could contribute to the generation of savings in the personal sphere, increasing the disposable income of individuals to be spent on other goods and services that are not transport.

In the social dimension, the most effective use of the bicycle has the potential to reduce the volume of greenhouse gas emissions. The adoption of the bicycle by part of the population would raise levels of physical activity to a point that reduces the chances of some diseases occurring. A significant amount of resources could be saved in the area of health and directed towards other areas within SUS itself. Furthermore, the bicycle could contribute to an improvement in the commutes of individuals, making their journeys quicker and generating improvements in productivity at work. This productivity would positively impact the GDP of regions that move forward with promoting bicycling as a means of transport.

This study is the first of its kind to look at measuring the potential that the bicycle has as a transformational element in the reality of three central areas of life in the city: Environment, Health, and the Economy. No study existed, until now, that measured the possible impacts that the bicycle could cause on the city of São Paulo. If urban planners, policy makers, politicians, students, or the population had difficulty understanding why it is so important to encourage bicycle use in São Paulo or in any other large city, this stuy provides some answers.

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