MSc Programme in Urban Management and Development

Rotterdam, the Netherlands

September 2019

Thesis title: Determinants of the cycling behaviour to commute to work in Bogotá, Colombia

Name: María Angélica Pérez Avendaño

Supervisor: Somesh Sharma

Specialisation: Manage and Finance Urban Infrastructure

Country: Colombia

Report number: No.4 Final Thesis

UMD 15

IHS Making cities work Erasmus

Institute for Housing and Urban Development Studies of Erasmus University Rotterdam

Summary

This research aims to explain the determinants of cycling behaviour to workplaces in Bogotá. Using a survey strategy data and an on-line questionnaire method sent on four workplaces in the city which had implemented Workplace Travel Plan (WTP), more than 700 commuters' responses were collected. Through three binary logit model the determinants of cycling behaviour to work were explained. The choice of bicycle, the frequency of use and the acquisition of a new cycling behaviour were explained trough those models based on the individuals' needs, contextual opportunities, and abilities. The study found out that work-related factors which shape the individuals' contextual opportunities have a crucial role in cycling behaviour and suggest that the regulation, promotion or encouragement of the implementation of WTP could lead to the achievement of a more sustainable mobility on the city.

Keywords

Workplace, cycling, travel behaviour, commuting

Acknowledgements

This thesis is inspired by a country which has shown me the possibilities of a life empowered by bicycling. The Dutch, a nation intertwined with sustainable transportation, I will thankfully bring home your knowledge and inspiration.

Firstly, I would like to thank the Mobility Secretary of Bogota for their trust, inspiring projects and all the support on the fieldwork. I consider it an honour to have worked with such inspiring professionals. I would also like to thank all the companies who believed in me, cooperated with me during this process, became part of this research and their continuous hard work to aim for a more sustainable future.

I'm thank full to the Erasmus University Rotterdam, and in particular the academic teams of Manage and Finance Urban Infrastructure (MFUI) specialization and Public-Private Partnership module, for the most exciting lectures full of knowledge which provided me with the right training and tools to develop this research, and strengthen my professionals skills to build a better future on urban centres.

I would like to express my special thanks of gratitude to my supervisor Somesh Sharma, it was a great privilege to work under your guidance. You guided me through the process, provided me with valuable feedback which strengthened my critical thinking, but most importantly you allowed me to create and to think out of the box.

Furthermore, I would like to say thank you to Robert Kleijn for being on my side on this path, filling it with support, laughter and love. And finally, I would never have accomplished this master program without the love of my parents, Luz y Jose. Thank you for your inspiration and support, no matter the distance your values remain with me.

Abbreviations

BKT	Bicycle kilometres travel
GDP	Gross Domestic Product
IHS	Institute for Housing and Urban Development
PBC	Perceived behaviour control
MNL	Multinomial Logit Model
NOA	Needs, opportunities and abilities model
TDM	Transportation Demand Management
TPB	Theory of planned behaviour
WTP	Workplace Travel Plan

Table of Contents

List of Figures

List of Tables

1 Chapter 1: Introduction

1.1 Background

Bogotá is the economic centre of Colombia, as it contributes with more than 26% of the National Gross Domestic Product (GDP), concentrates more than 7,8 million opportunities of employment and allocates more than 728.000 companies, which represent 29% of Colombian enterprises (SDP 2018, CCB 2018, DANE 2017). Bogotá is the most competitive city of the country, with a bigger, more dynamic and more diverse economy. However, its competitiveness is in risk due to current mobility conditions in the city.

As it is well-known intensively car use in urban areas results in excessive congestion, pollution and road safety challenges for developing cities, and Bogotá it is not an exception. In Bogotá 537 deaths in 2017 were attributable to road traffic incidents, 49 percent of all the greenhouse gasses were emitted by motorized vehicles, and the average travel time on peak hour exceeded one hour (SDM 2017, SDA 2018). These negative externalities of car use threaten the economic competitiveness of cities, limit employment growth and affect enterprises productivity and citizens well-being (Hilbrecht, M., Smale, B. and Mock, S. E. 2014, Mullen, C. and Marsden, G., 2015).

Transport system connectivity, accessibility, capacity and effectiveness support competitiveness of a city and sustain its economic growth in the long term (Mullen, C. and Marsden, G., 2015), and both, transportation infrastructure provision and transport demand management solutions, are needed to achieve it. Undoubtedly, public infrastructure provision is a governmental responsibility, and should aim to guarantee a high level of service delivery of the overall transport system, however, the role of the enterprises on transforming daily commuting patterns is also crucial on achieving a fluent mobility which supports cities and companies' competitiveness, as the majority of trips in the large urbes are business related.

Corporations decisions directly influence their employees' choice of transport mode, so they can serve as a mean or an obstacle to reaching more sustainable mobility in developing countries. Enterprises can promote the use of automobiles or motorbikes with its negative externalities, increasing its attractiveness when offering free parking, being in an area with low coverage of public transport or cycling/walking infrastructure, giving bonuses for purchasing vehicles and gas, among other incentives that promote non-sustainable mobility patterns. Moreover, companies can increase the travel time of its employees setting fixed working hours which force them to travel in rush peak hour. On the other hand, through a workplace travel plan, corporations can induce a sustainable travel behaviour, which can bring benefits for the business itself, its employees and the city (Cairns, S. et al., 2010). These workplace travel plans include a set of transportation demand management (TDM) strategies oriented to reduce motorized vehicle trips, promote active means of transport (walking and cycling) or electric mobility, reduce commuting in rush peak hours, or even to eliminate specific work trips by providing employees with incentives, information, technologies, and alternative transportation options (Seattle Department of Transportation, 2008).

In the year 2009 in Bogota, the private sector initiated a volunteer action for promoting the use of sustainable means of transport such as cycling, walking or carpooling for commuting to work. These, in order to alleviate the impact of city mobility in their employee's well-being and mitigate the negative externalities to the city (congestion, pollution, accidentality, etc.) generated by its operation. This initiative was called PEMS, it was a corporate network guided

by academics, where the sharing of knowledge and best practices on sustainable mobility strategies was the central axis. In 2016, this network evolved to PIMS, including private and public companies, and was led by the government. Through this program, government entities lead by example implementing workplace travel plans and initiatives in all public bodies, and strategies like monthly car-free days were applied by law to public entities and promoted in a volunteer manner among the private ones. PIMS was built on three axes; 1. capacity building among the companies to improve the results of the program 2. Recognition and follow up of companies' effort for the implementation of successful workplace travel plans strategies 3. Best practices documentation platform to facilitate developing and implementation of the companies' mobility strategy. The key moments of these efforts are presented as following (See Figure 1).

Figure 1. Highlights of workplace travel plans' promotion effort in Bogotá

2010 — **Pilot project of workplace travel plans for private companies-PIMS**

- Launch of PEMS program: Private initiative between academia, Los Andes University, and NGO, Fundación Chevrolet, to promote the development and implementation of worplace travel plans in Bogotá
- Development of a pilot project with 3 companies to measure mobility impacts of commuting to work

2011-2015 — **Establishment of private sector network of workplace travel plans for private companies-PEMS**

- The launch of a private enterprise network PEMS in order to:
- **Capacity building:** Generate capacity among companies to a successful implementation of workplace travel plans
- **Knowledge transfer & recognition:** Document, share, learn and recognize from the best practices of the network companies
- **Promote implementation:** Connection of providers of mobility solutions and companies interested in implement sustainable mobility solutions.
- **Results 2015:** 36 private companies were actively participating in the network meetings and implementing mobility solutions

2016-2018 — **Public-private network PIMS was launched**

- Gamification strategy "Cuando te mueves, Bogotá se mueve" was launched to motivate organizations to implement workplace travel plans and invite them to share their expirience and results, and to compete for public recognition
- Implementation of monthly car-free-day policy on public entities
- **Results 2018:** 67 private companies & 60 public companies, with more than 140.000 employes/students in total were formally part of the network and were participating in the gamification strategy.

2019 — **Regulation of workplace travel plans implementation for public sector, and awarness and promotion of voluntary implementation among private sector**

- Regulation of workplace travel plans implementation for public sector organizations, trough the decree 037 of 2019
- Continuation of the initiative "Cuando te mueves, Bogotá se mueve" with public and private companies

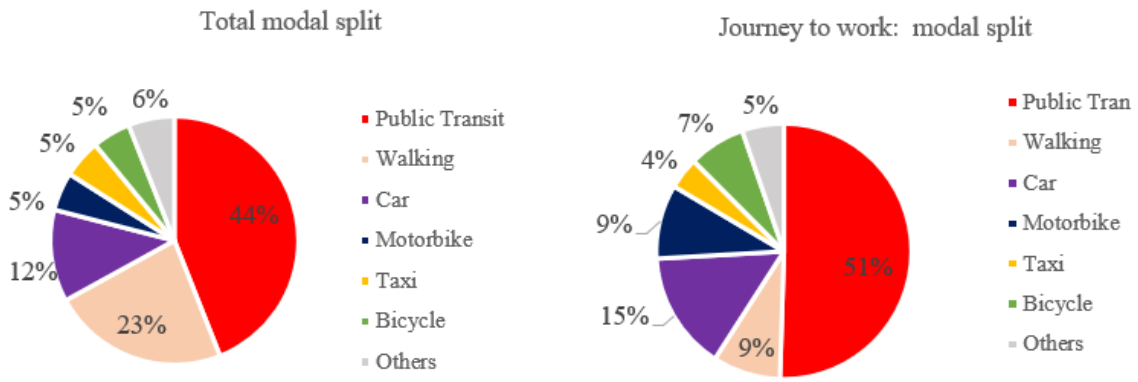
By June 2019, 66 public enterprises, 68 private and 18 universities were subscribed voluntarily on the gamification initiative *Cuando te mueves, Bogotá se Mueve* promoted by the government looking to follow up, encourage and recognize the efforts of the enterprises in the promotion of sustainable mobility to commute to work (SDM, 2019). These organizations earn points and recognition by the number of strategies designed and implemented, and by the magnitude of the results achieved. Among all these organizations, cycling strategies are the most popular, and their level of success measured as the increment of cyclist commuting to work varies dramatically among them. These divergent results can be attributable to several factors, as the individual characteristics of the employees, the company organizational culture and the type of strategies implemented, among other elements subject to this research.

1.2 Problem statement

In Bogotá, more than 13.3 million trips are made every day, of which 2.7 million correspond to trips to work, representing 20% of the total (SDM, 2017). Considering that every trip to work demand a coming back, it is possible to say that companies generate and attracts at least 40% of the total journeys in the city to its central business district CBD. On the other hand, 24% of the trips with work purposes are made on car and motorbike, 7% more than the overall city modal split (See Figure 2), intensifying the negative externalities of these means of transport. A motorized daily commute contributes to congestion, pollution, and accidentality on the city, and even more reinforce sedentarism, and reduce the available time and financial resources of employees, affecting its general well-being.

Transforming current mobility patterns of commuting to work is mandatory in order to achieve more sustainable mobility, which enhances city competitiveness, enterprise productivity, and citizens well-being.

Figure 2. General modal split of Bogotá vs. modal split of the trips to work



Source: Own elaboration based on SDM, 2017

In order to reach sustainable mobility which supports the competitiveness of Bogotá, detached from carbon fuel vehicles, the role of corporations on inducing a more sustainable mobility pattern among employees is vital. Given the context of Bogotá in terms of commuting impact and orientation of its business corporate policies, workplace travel plans offer an innovate and cost-effective solution to address the current mobility challenges of the city. However, the effect of the recently implemented workplace travel plans in Bogotá is still unknown, so its potential and relevance are blurred.

In the last decade, the voluntary effort from the private and public sector, have resulted in several workplace travel plans being developed and implemented, which seems to increase bicycle use to commute to work. Promoting the bicycle on a daily use basis for the journey to work can improve employees' general health and well-being (Oja, P.method et al., 2007; Rissel, C., et al., 2014). Even more, it can reduce the social gap, as it makes commuting more affordable, enhancing social cohesion. Additionally, it can generate significant revenues to companies due to a reduction of employees' absenteeism, and an increment on its productivity (Rissel, C., et al., 2014). And lastly, it could contribute directly to reduce the environment and traffic problems caused by motorized vehicles.

However, to understand if these workplace travel plans are a feasible solution to Bogota´s mobility by increasing the number of bicycle trips, it is necessary to evaluate the impact of

these programs in cycling use on journeys to work, and more importantly to understand the critical factors for its success or failure.

1.3 Research Objective

This research aims to identify the factors that explain the level of cycling to commute to work in Bogotá city. In parallel, this research also looks forward to understanding the reasons behind an increment in the propensity to cycling on workplaces with travel plans implemented. Trough the achievement of these objectives it could be possible to identify the main factors for the success/failure of a cycling promotion program on a company, and also identify the target group which is more propensity to change behaviour and chose the bicycle. This knowledge could help companies to design more effective travel plans on cycling use and could help the city government build better policies related to workplace travel plans, achieving the long-term goal towards more sustainable mobility trips to work.

1.4 Provisional research question(s)

1.4.1 Main research question

Which are the factors that explain the current *cycling behaviour* on commuting to work in Bogotá?

1.4.2 Research sub-questions

In order to respond to the main research question the following two subquestions need to be answered:

1. To what extent work-related factors, individual characteristics and city mobility conditions explain the *choice of cycling to work* of employees in the workplace?
2. To what extent work-related factors, individual characteristics and city mobility conditions explain the *level of cycling* of employees in the workplace?
3. Which are the drivers of a *behavioural change* towards *cycling* to work?

The first question will allow us to identify the factors behind the desition of cycling to work. The second question allows understanding which factors are more critical in the reaching of a higher level of cycling among workers of Bogota city. The third one, targeted exclusively to the new cyclists, exposes the drivers of behavioural change after implementation of workplace travel plans, allowing to understand which factors are more relevant on a company in promoting cycling as a new commuting behaviour among employees.

1.5 Significance of the study

Considering that ‘journeys to work’ in Bogotá represent the second most significant purpose of travelling after ‘coming back home’, the change of its status quo could be an entry point for improving traffic conditions in Bogotá. Among all the commuting choices that can be promoted within a workplace travel plan, the increment on bicycle use is one of the most relevant ones for its related benefits. If workplace travel plans prove to be effective on the increase in the use of the bicycle on commuting to work in Bogota, they could become one of the most relevant tools to transform the city’ mobility in the long term, on a more cost and time-effective way than infrastructure solutions.

In practical terms, the results of this study could lead to pertinent advice to policymakers interested in promoting cycling. Even more could show governments how a collaborative approach with the private sector could end up on a win-win situation, for the city, the companies and the commuters. Additionally, this research could result in practical guidance to companies which wish to increase the number of cyclists or the intensity of the use of this mean of transport. Furthermore, expanding the knowledge of the cyclist needs, preferences and

characteristics, both government and companies could design user-tailored policies to promote cycling on a broader scale and on a more effective way.

On the other side, all the research made on this subject have been concentrated principally on Australia, European Countries and the United States, which are regions with broader implementation of this type of policies and programs. However, no literature exists for Latin-American countries, where the context is entirely different, so the current findings in research may not apply for the countries in this continent. Even more critical there are no practices of workplace travel plans documented for this region. Within this study, it could also be possible to spread the findings and results of existing workplace travel plans practices on Latin-American context among researchers and practitioners in the transport sector.

Finally, scientific research has been concentrated more in the assessment of hard transport policy measures to promote cycling, rather than the soft transport policy measures like the workplace travel plans. Therefore, this research aims to add value to scientific research with more knowledge about the drivers of cyclist behaviour for commuting to work, on the environment of companies which promotes sustainable mobility.

In conclusion, the results of this study would contribute to broader the literature of soft transport policy measures, expand the knowledge for workplace travel plans in Latin-American context, orient policymakers regarding the regulation of cycling promotion and workplace travel plan, and even more contribute to better corporate policies in the promotion of cycling.

1.6 Scope and limitations

This study will analyse the outcomes of four (4) public companies which implemented the workplace travel plans in Bogotá in the last three years. However, this research will not be representative to all the companies, public and private, which have made efforts to promote a more sustainable behaviour to commute to work, due to a lack of resources and time to evaluate each of one separately.

As a workplace travel plan is a tool made for the specific conditions of a company, the results should not be generalized to a city level. Nevertheless, the outputs of the study could be taken as lessons learned to improve existing travel plans and the methodology used could be implemented to study the specific results of a company regarding bicycle use in each case.

2 Literature review

In order to achieve the aim of this research, firstly the theoretical framework of travel behaviour of geography, economics and psychology field is complied, review and analysed, allowing us to identify the key elements that explain commuter's choice. Following, the academic literature of workplace travel plans case studies is reviewed, to determine the relevant factors that explain the level of success of this transportation demand management (TDM) strategy on the promotion of cycling. Lastly, the conceptual framework for this research is proposed.

2.1 Travel behaviour theory and determinants

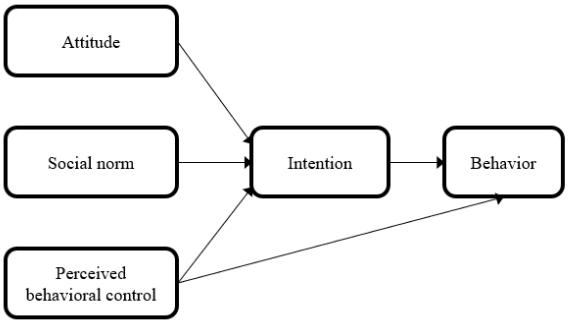
Travel has been widely conceived as a *derived demand*, as people travel motivated to satisfy a particular need or desire on a distant location, like work, study or shopping, and they hardly ever travel just for the placer to do so (Ortuzar, J. D. and Willumsen, L. G., 2011; Pas, E. I. and Koppelman, F. S. 1987). These needs and desires are satisfied within individual constraints in resources, time and abilities to travel, which in turn restrict the personal travel opportunities and also the feasibility to realize the desired activities (Pas, E. I. and Koppelman, F. S. 1987; Ortuzar, J. D. and Willumsen, L. G., 2011; Dijst, M., Rietveld, P. and Steg, L. 2013). In other words, people travel from one place to another according to the sequence of activities they need or desire to fulfil along the day, and they choose a mean of transport considering its available time, resources, personal preferences and the accessible means of transportation.

Psychology, economics and geography fields, developed different but not divergent perspectives and theories on travel behaviour (Dijst, M., Rietveld, P. and Steg, L. 2013).

The psychology field explains travel behaviour principally through three motivational theories; namely, the *theory of planned behaviour*, the *norm activation model* (NAM) and the *symbolic and affective motives*.

The *theory of planned behaviour* (TPB) explained the travel mode choice of an individual based on its *attitude*, *social norm* and *perceived behaviour control* (PBC) (Dijst, M., Rietveld, P. and Steg, L. 2013). The factor *attitude* represents the individual internal evaluation of the means of transport, *social norm* reflects the influence of the approval/disapproval of the behaviour by other members of society, and lastly PBC refers to the perception of the individual regarding to its own capability to use a specific transportation mode (Dijst, M., Rietveld, P. and Steg, L. 2013). As presented in Figure 3, under the TPB, the *attitude*, *social norm* and PBC influence behaviour via *intentions*, but the PBC can also influence behaviour directly (Dijst, M., Rietveld, P. and Steg, L. 2013), when for example the availability of a mean of transport is affected by weather conditions, mechanical failure, closure of a specific route or service, among other situations that could influence directly the traveller behaviour.

Figure 3. Theory of planned behaviour (TPB)

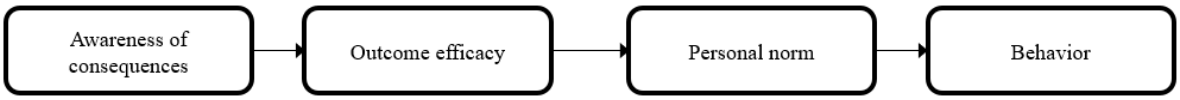


Source: Dijst , Rietveld , & Steg, 2013

Whether *attitude, social norm and perceived behaviour control* shape together with the travel behaviour choice of an individual, the extent of how each of the elements influences the behaviour is not fixed and can vary among transport alternatives (Dijst, M., Rietveld, P. and Steg, L. 2013).

On the other hand, the *norm activation model* (NAM) highlight morality as a primary driver of travel behaviour change, explaining that when an individual is aware of the consequences of its behaviour (as global warming or congestion related to car use), he will recognize itself as co-responsible for the problem and potentially part of the solution, shaping his personal norm and subsequently his travel behaviour, as he will feel morally obligated to do so (Dijst, M., Rietveld, P. and Steg, L. 2013).

Figure 4. Norm activation model (NAM)



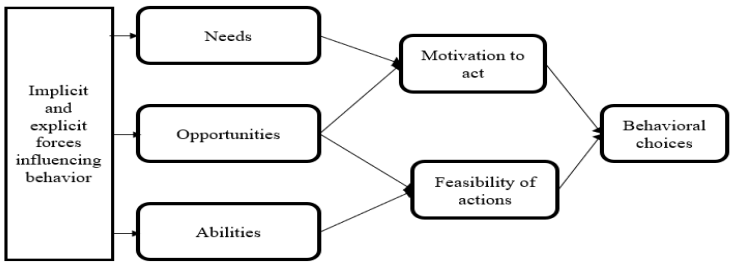
Source: Dijst , Rietveld , & Steg, 2013

Alternatively, the *symbolic and affective motives* theory, explains that the symbolic factors (e.g. status) and the affective ones (e.g. feelings or emotions), can be more important than instrumental motives (such as time and cost), when it comes to the transportation mode choice (Dijst, M., Rietveld, P. and Steg, L. 2013). This theory recognizes that behaviour is shaped by symbolic, effective and instrumental motives, but highlight that the first two are the most important.

The three lines of psychology research explained above, focus on individual motivation factors to explain travel behaviour, in other words, focus directly on the values, preferences, perception, and norms of everyone. Even if contextual factors, like transport infrastructure, accessibility or quality of service, are implicit in the *attitude*s, *affective motives* or *personal norms*, the direct effect of those contextual factors could not be explained and analysed using this theory.

Moreover, the psychology field proposes the NOA model (see Figure 5), which explain behavioural choices by three factors; the individual needs (e.g. travel with a specific purpose in a specific time of the day), the contextual opportunities (e.g. transport alternatives) and the abilities of the individual (e.g available budget, time availability or individual capacity) (Dijst, M., Rietveld, P. and Steg, L. 2013). On this model the motivation for a particular behavioural choice is build upon the individual needs (N) and the available opportunities (O), which in turn are related to the three lines of motivational factors theories explained above (Dijst, M., Rietveld, P. and Steg, L. 2013). Additionally, the NOA modal describes the feasibility of a behavioural choice based on individuals abilities and their contextual opportunities.

Figure 5. NOA model from psychology



Source: Vlek et al. (1997) cited on Dijst , Rietveld , & Steg (2013)

Instead, the travel behavioural choice from an economic perspective is based on the *random utility theory,* which assumes that an individual will choose the transportation alternative which maximizes its individual utility (Ortuzar, J. D. and Willumsen, L. G., 2011). This theory allows us to estimate the probability in which an individual will choose a mean of transport among a set of alternatives, based on its individual characteristics and the attractiveness of the available options. The assumptions, attributes and methods of this theory are explained in more detail in the following chapter 2.2.2.

Lastly, the behavioural choice from a geographical perspective is based on the cognitive process underlying the decision-making of the individuals related to the activities they desire to fulfil along the day, and its simulation is commonly called activity-based model (Dijst, M., Rietveld, P. and Steg, L. 2013). This theory recognizes that the daily trips of an individual are interrelated, so they cannot be analysed in isolation and should consider the sequence of trips. The connection of different activities of an individual, with its own socio-economic characteristics, also limit in both time and space the opportunities the individual has in terms of activities and means of transport to reach it (Ortuzar, J. D. and Willumsen, L. G., 2011; Dijst, M., Rietveld, P. and Steg, L. 2013). Based on this theory, travel behaviour can be predicted in terms of the set of opportunities to travel to activity places and participate in activities, within spacial, time social, and economic constraints (Ortuzar, J. D. and Willumsen, L. G., 2011; Dijst, M., Rietveld, P. and Steg, L. 2013). To simulate travel behaviour with this theory it is necessary a comprehensive database of the individuals' tours, activities, location and available time window and set of alternatives of transport (Dijst, M., Rietveld, P. and Steg, L. 2013), which is not usually accessible in cities.

The three theories explained above, based on three different disciplines (psychology, economy and geography), are complementary and they jointly built a comprehensive set attributes, either of the person, their context, the individual needs or the characteristics of the trip itself, that could influence travel behaviour. On Table 1 the relevant determinants used in the reviewed literature to explain travel behaviour were gathered and grouped on individual needs, contextual opportunities and personal abilities, under the umbrella of the NOA model, but including new attributes proposed by the economic and the geographical fields.

Table 1. Relevant determinants of travel behaviour

Category	**The determinant of travel behavior**
Individual Needs	Household composition
	Presence of children
	Work schedule
	Activities schedule per day and location of activities
	Need to carry goods
Contextual opportunities	Travel time to reach a destination: access time, waiting time, in-vehicle time, transfer time
	Travel cost of transport alternatives
	Parking cost and availability
	Speed of transport alternatives
	Level of service of transport alternatives
	Distance: Start and end location of trips

Category	The determinant of travel behavior
	Restriction/incentive related to transport alternative
	Accessibility to public transport facilities
	Accessibility to cycle paths and pedestrian infrastructure
	Influence of weather in the use of the alternative
	Status related to alternative
	Attitude towards alternatives use
	Emotion related to the alternative
Individual abilities	Age
	Gender
	Income
	Education level
	Available private means of transport
	Availability of driver license
	Lifestyle

Source: own elaboration based on Pas, E. I. and Koppelman, F. S. (1987), Ortuzar, J. D. and Willumsen, L. G. (2011), S. Bamberg et al. (2011), and Dijst, M., Rietveld, P. and Steg, L. (2013)

Considering, that the economic approach to travel behaviour allows us to measure and test the impacts of several attributes of a transportation alternative, it is regarded as the adequate method for the development of this study. The methodologies built on the framework of this approach, as discrete choice models (see chapter 2.2.2), will allow us to test on a statistical way the importance of the individual attributes and transportation alternatives attributes, in the choice of a mean of transport or the occurrence of a behavioural change, in this specific case the bicycle. However, the psychological and geographical approach will not be neglected, as the utility function of the bike could be complemented by the factors that represented them, as the social norm, attitudes and temporal restrictions among others.

2.2 Workplace travel plans and travel behaviour change

A workplace travel plan (WTP) is a package of measures that employers implement in order to promote more sustainable mobility in their employees' trips to work (Cairns, S., et al. 2010). They are intended to change the behaviour of those who use less sustainable means of transport, like the single occupation vehicle, but also reinforce or sustained the existent sustainable practices among employees like the use of the bicycle, walking or public transport. There are several motivations for companies worldwide to implement a workplace travel plan, which can vary depending on country regulation and company characteristics, following the some of the main ones (Roby, H., 2010):

- Follow the corporate social responsibility or sustainability agenda
- Increase recruitment and retention of employees
- Comply with national law or international standard
- Solve facilities management
- Reduce costs related to employees' daily commute
- Gain sustainability recognition or mitigate their environmental impact

- Increase health or wellbeing of employees

The main measures of workplace travel plans are presented following Table 2, categorized in policies, infrastructure and promotion programs.

Table 2. Workplace travel plans measures

Category	Measure	Description	Initial Investment Magnitude	Effectiveness magnitude
Policy	Pricing parking	Increase the price of parking in the company to reduce the attractiveness of car use.	$	●●●●●
	Parking supply caps	Control the amount of parking offered for car or/and motorbikes, according to car-use reduction goal.	-	●●●●
	Optimization home-job location	Allocate employees to the closest job office to their homes in order to reduce their travel time. It is mainly used in companies with several offices, like banks.	$	●●●●●
	Telework	It is a work arrangement, based on technology, that allows employees to work on off-site location, to reduce the need to travel to office among other benefits for both the company, and the employee.	$$$	●●●●●
	Compressed workweek	Alternative work schedule which reduces the number of days that employees go to work in a week, by increasing the daily number of hours per day.	-	●●●●
Promotion program	Bicycles user groups	Employees group of cyclists	-	●●
	Gamification strategy to promote active mobility	Behavioural change program based on gamification strategies, like games or contest, to motivate and engage employees in sustainable mobility habits.	$	●●●
	Carsharing program	Provision of car-shared system for business-related trips only.	$$$$	●●
	Carpooling program	A strategy that seeks to promote two or more employees to commute together in car.	$	●●
	Marketing for cycling, walking and using public transport	Use of marketing to increase the attractiveness of alternative means of transport promoting its daily use.	$	●●
	Subsidize transit	Pay totally or partially for the transit fares of employees.	$$$	●●
Infrastr	Parking for bicycles	Increase and improve the parking facilities for bicycles.	$	●●●●

Category	Measure	Description	Initial Investment Magnitude	Effectiveness magnitude
	Company shuttle bus	Provision of dedicated company bus, usually free for employees.	$$$$$	●
	Bike-sharing system	Provision of a shared-use system of bicycles to commute from and to work.	$$	●
	Changing facilities, lockers and showers	Improvement of physical facilities as changing rooms, showers or lockers to increase comfort among pedestrians and cyclists.	$$	

Source: Own elaboration based on Cairns, S., et al. (2010), Petrunoff, N. et al. (2015)

The implementation of a workplace travel plan (WTP), composed by one or more of the measures presented in Table 2, could result in; reduction of trips or millage by car single occupant, decrease of the number of trips to work, decrease of the average time to commute to work, reduction of carbon footprint related employees' commute to work, or increment of the trips on active means of transport (Cairns, S., et al. 2010, Brockman, R. and Fox, K. 2011). So on theory, trough the implementation of the measures mentioned above a WTP could change the contextual opportunities of the individuals, which in turn could increase the odds of an occurency of cycling behavior, as explained by the travel behaviour theory (See Chapter 2.1). Definitely, depending on the company motivation, budget and the measures implemented the level of impact on travel behaviour of employees could vary.

However, the impact and benefits of workplace travel plans go beyond the theory, as they have been proved on practice. Around the globe, several workplaces travel plans have been implemented, with different level of success according to the measures implemented and their context. Following, the key in the literature related to the level of effectiveness of WTP on the achievements of their objectives:

- Senior management commitment and leading by example are recognized as the critical element for the accomplishments of a travel plan objective (Cairns, S., et al. 2010; Petrunoff, N. et al. ,2015).
- Parking management strategies have proved to be the most critical factor to determine the degree of success of a workplace travel plan, regarding the reduction of car use to commute to work. (Cairns, S., et al. 2010; Petrunoff, N. et al. ,2015).
- The background characteristics of the enterprises influence the level of success of workplace travel plans, for example, location, size and salary levels of the company (Cairns, S., et al. 2010).
- A comprehensive strategy of a WTP should be supported by 4 pillars in order to ensure its effectiveness; 1. communication, 2. infrastructure, 3. policies and 4. education and culture (Petrunoff, N. et al. ,2015).
- A workplace travel plan will be more successful if employees are engaged in the planning process and there is a budget allocated by the company for the implementation of the WTP.

Additionally, the literature report that are specific factors that explain cycling use in the workplace:

- A workplace travel plan which includes parking management strategies is more effective in the promotion of active mobility than a one that is based only in encouragement strategies, however, the second one will also result in a significant increase of active mobility (Petrunoff, N. et al. ,2015).
- High levels of cycling use have been explicated mainly for high-quality off-site access, improvement and increment of cycling parking, provision of bicycle repairs service and presence of bicycle user group (Cairns, S., et al. 2010).
- An increase in travel distance decreases the chance to commute on a bicycle to work (Hainen et.al ,2013)
- A social-individual combined marketing campaign rises the trips made on active means of transport (Wen, L. M. et.al ,2005)
- Individuals who have never cycled nor never contemplated to do so, have a more negative attitude towards cycling (Gatersleben, B. et.al, 2007). Conversely, the more positive the attitude towards cycling, the more chances are that employees use the bike to travel to work (Hainen et.al ,2013).
- Social norm on the workplace, understood as the expectation of colleges regarding the individual transport choice, influence the decision of the individual. The more the colleges support car or other alternatives of the bicycle, the less likely an individual will choose the bike (Hainen et.al ,2013)
- The attitudes towards a bike of the part-time cyclists (non-permanent) used to be positive, and their level of cycling could be improved by positive feedback and social support (Gatersleben, B. et.al, 2007).
- An individual who has access to a free car or free public transport, as a benefit in the workplace, is less likely to use the bicycle to commute to work (Hainen et.al ,2013)
- Contributing to the costs of cycling increases the level of cycling (Hainen et.al ,2013)
- The need to travel during working hours has a negative effect on bicycle commuting mode choice (Hainen et.al ,2013)
- The access to bicycle storage inside a building, clothes changing facilities, and having a public transport stop within 500 m of the workplace increase the probability to choose the bicycle (Hainen et.al ,2013). The relationship between access to transport stop and level of cycling was explained by Hainen et.al (2013) by two possible reasons:
    - 1. Alternate bicycle use and public transport use among the days of a week, is more common than alternate bicycle and car.
    - 2. If an employee stimulates sustainable mobility option, as cycling or public transport, it is more likely he will use the bicycle.
- The need to carry goods reduce the probability an employee will choose the bicycle to commute (Hainen et.al ,2013)

In conclusion, it was possible to understand than a WTP is a package of measures, where cycling promotion is only one of them. Additionally, it was presented the complexity of the level of success of a WTP which varies among companies, as it depends on several factors like the commitment of the company, the type of measures implemented, its location, the culture of the company, the facilities/services offered to employees, the marketing campaigns, and even the already given benefits to employees as it is the parking space, among others. Lastly, the main factors for a successful cycling strategy were highlighted in order to understand the key elements which are needed to be evaluated in this research, in order to understand cycling behaviour.

2.2.1 Workplace travel plans assessment methods

Even if the workplace travel plan seem promising on reaching a more sustainable behaviour, both in theory and in practice, measuring their effectiveness on the adoption of new and more sustainable behaviours, is vital to really understand their impact and their room for improvement. Continuous evaluation of the WTP would result in a better strategy which could be dynamically improved according to their initial goals, the employees' response and the employees' needs , desires and context. Even more, knowing the impact of a WTP strategy, could allow identifying the factors responsible for the results, and in the long-term would allow spreading the knowledge among similar companies, scaling up the potential effects.

However, scientific literature has not yet converged to a single methodology to measure the impact of behavioural change programs, also called soft travel measure programs, as it is the WTP. On **Error! Not a valid bookmark self-reference.** a summary of studies that use different methodologies to evaluate workplace travel plans or corporate policies influence on travel patterns is presented. This table includes sample size, data collection method, research strategy, explanatory variables and lastly the limitation of each one of the studies which use different methodologies.

It is possible to observe that several methods have been used to assess the impact of a behavioural change program, where availability of information and, lack of a control group and sample bias are one of the barriers in achieving conclusive results. To make workplace travel plans more comparable among each other a standard method of impact measurement would be ideal, however, the lack of information, mainly ex-ante individual evaluation, and the peculiarities of the different WTP make this a difficult or even impossible. Nevertheless, given this studies summary also gives an overview of the various tools that can be used when those barriers are faced.

Table 3. Summary of relevant scientific literature on travel behaviour change measurement on workplaces

Author	Behavioural change measured	Study area	Sample	Data collection method	Research strategy	Explanatory variables	Results	Limitations
Heinen, E. et al. (2013)	The influence of work-related factors on the individual decision to cycle to work occasionally or cycles to work every day	Four (4) Dutch municipalities: Delft, Zwolle, Midden-Delfland and Pijnacker-Nootdorp	4299	Survey of commuting mode choice. A part-online part via letter	Two binary logit models: i. Being a commuter cyclist or not ii. Being a part-time commuter or full-time commuter	Socio-economic characteristics, workplace characteristics and policies, trip characteristics	The attitude towards cycling, colleagues' expectations, access to parking, changing facilities, and needing a bicycle during office hours have an impact on the probability to be a cyclist Cycling frequency is influence by commute distance, free public transport pass or free-parking for car	Does not capture the effect of a behavioural change but explain current behaviour.
Brockman, R. and Fox, K. (2011).	Effects of workplace travel plans on the level of active commuting	University of Bristol, UK	1998 (n=2292), 2001 (n=2332), 2003 (n=1950), 2005	Repeated bi-annual travel survey in a workplace setting from 1998 to 2007	Z-tests were used to examine the significance of trends in active commuting between 1998 and 2007	Gender, age, salary band	Increment in active commuting from 19% to 30% in the study period. Reduction of car drivers from 50% to 30%	Change within an individual is not detected, as cross-sectional surveys were used. Absence of control group does not allow to ensure the change on behaviour were due to transport travel plan, however the trends are divergent from the national ones.

Author	Behavioural change measured	Study area	Sample	Data collection method	Research strategy	Explanatory variables	Results	Limitations
			(n=2647) and 2007 (n=2829)				University trends show the opposite, and more sustainable, directions to the national survey	
De Bruijn, G. et al. (2009)	Habit strength of adult bicycle use	Amsterdam, Netherlands	n=317	Cross-sectional data using self-administered questionnaires	Hierarchical regression analyses and interaction analyses using simple slope analyses	Habit strength Intention Individual characteristics	Habit strength was the strongest predictor of bicycle use, followed by intention	The study cannot be generalized as the population study has specific characteristics and higher income than the average Not possible to identify causal patterns of study variables
Cairns, S., et al. (2010)	Change on commuter driving by workplace travel planning	United Kingdom	Unknown	Reports from 7 UK local authorities which actively support workplace travel plans	Comparison of the degree of change in-car use. Indicative analysis of the level of success related factors, based on literature evidence and interviewee feedback.	Parking management Improvement of alternatives to car Time and senior management support	A substantial change in travel behaviour can be achieved with the implementation of workplace travel plans	The results are based on subjective interpretation, so they only can be treated as indicative.
Petrunoff, N., et al. (2015)	Evaluate the effect of a three-year workplace travel plan intervention on increasing active travel to work	Worksite on Sidney, Australia	2011 (n=804), 2012 (n=904), 2013 (n=872), 2014 (n=687)	Annual cross-sectional on-line surveys	Statistical comparison to the baseline year	The proportion of employees travelling to work in active means of transport increase by 4%-6%	Workplace travel plans generate significant increases in active travel	Sample selection bias, due to on-survey method Absence of a control group
Ralph, K. & Brownb, K. (2016)	Drive to campus change due to better public transport information	UCLA campus, Los Angeles, California, USA	348(n): control group 296 (n): experimental group	On-line survey via e-mail	Treatment-control group experiment. The experimental group has access to comprehensive information about public transport	Individual characteristics Household location Travel patterns	Treatment group decreased by 7% more than the control group, the proportion of students who always drive to campus	Possible overestimation of the real effect of the treatment due to on-line survey sample bias
Tsirimpa, A., et al. (2007)	Impact of Information Systems on Travelers switching behaviour	Puget Sound Region (PSRC)	1191	Travel diaries where the sources and use of information were specified	Multinomial logit and a mix multinomial logit that accounts for correlation among observations from the same individual in the dataset	Socio-economic characteristics Travel pattern Technology characteristics	Travel pattern characteristics, time of information, source and content of information significantly affect commuter's response to information	The size of the sample could limit the predictive power of the model The model does not consider the attitudes and perceptions of travellers

2.2.2 Discrete choice modelling

To simulate the decision-making process behind the individual choice of a mean of transport, discrete choice model is the primary methodology used in the transportation field. The discrete choice models postulate that *"the probability of individuals choosing a given option is a function of their socioeconomic characteristics and the relative attractiveness of the option"* (Ortúzar & Willumsen, 2011). From an economic perspective the *random utility theory*, have been the primary method used to model activity and travel behaviour (Castiglione, Bradley, & Gliebe, 2015). The *random utility theory* assumes that an individual will choose the alternative, among a set of mutually exclusive options, which maximize its individual utility (Ortúzar & Willumsen, 2011).

The utility functions of the different alternatives represent the attractiveness of each option related to the socio-economic characteristics of the individual (Dijst , Rietveld , & Steg, 2013). The utility function of an individual *i* associated with a *j* alternative is represented as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad [1]$$

This function [1] is divided into two components, a deterministic one called indirect probability function or observed utility (V_{ij}) and a random one or error term ε_{ij} (Ortúzar & Willumsen, 2011). The observed utility function V_{ij} is defined as a linear combination of the attributes of a transport or destination alternative (i.e cost, speed, access time, etc. for transport alternative or population, employment or commercial opportunities etc. for destination alternatives) *j* and the individual socio-economic characteristics *i* as presented in the example [2] (Ortúzar & Willumsen 2011, Castiglione, et al., 2015). With the observed utility function is possible to understand the valuation and importance of the different attributes of an alternative for its users. The coefficients that accompanied each variable in the formula [2] explains the relative influence of the variables in the general attractiveness of the alternative (Ortúzar & Willumsen, 2011). The specific constant of the transport alternative in equation [2] captures the net influence of all the attributes of the particular option which were not observed or include explicitly in the utility function (Castiglione, Bradley, & Gliebe, 2015).

$$V_{ij} = \beta_1 in-vehicule\ time + \beta_2 \frac{travel\ cost}{income_j} + \beta_3(access\ a + egress\ time) + \beta_4 waiting\ time + Constant_j \quad [2]$$

The probability of choosing a specific alternative *j*, from a set of *n* alternatives, results by the comparison of the utilities of the set of alternatives, and can be express as follows (Castiglione, Bradley, & Gliebe, 2015):

$$P(j:C) = \frac{\exp(V_j)}{\sum_{i=1}^{n} \exp(V_i)} \quad [3]$$

Equation [3] is known as the multinomial logit model (MNL), which is based on the Gumbel distribution of the error term (Castiglione, Bradley, & Gliebe, 2015). This model is widely used to model transport choices, and it assumes that the error terms are independently and identically distributed (IID), that means that a change in an attribute of one alternative will have an equally proportional effect on the probabilities of choosing other options, if the rest remain constant (Castiglione, Bradley, & Gliebe, 2015).

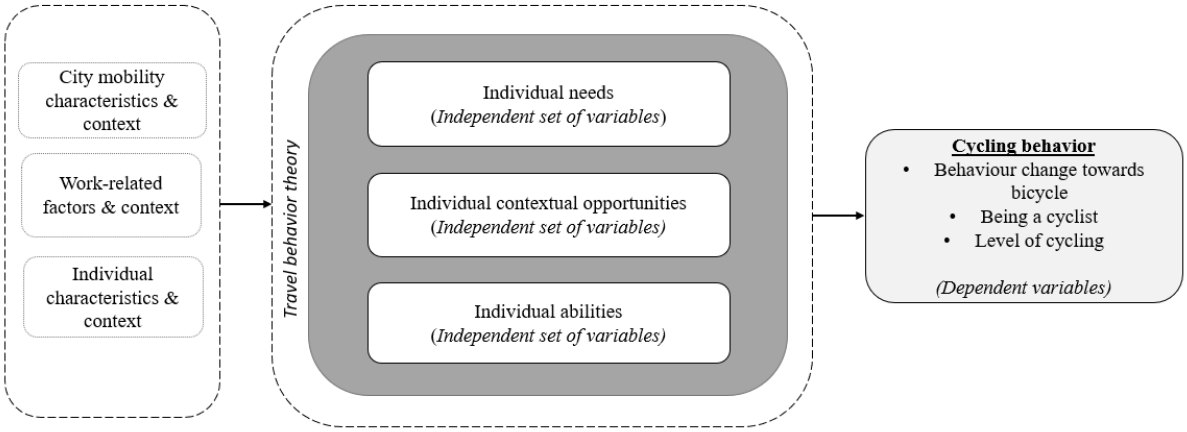
In the current study the discrete choice model theory will be used to model the probability of the occurrence of cycling behaviour, and also the presence of a higher or lower level of cycling among employees. Additionally, this theory will be used to understand the drivers of a change of behaviour, where employees dare for the first time to use the bicycle to travel to work, instead of their usual mode of transport. For the last one, unlike the typical use of discrete transport models that are limited to the choice of a specific mode of transportation, the

alternatives among which the user must choose to include change its current behaviour or don't change it, explained by the trip attributes, the cycling program of its company, the individual needs, and the socioeconomic characteristics of the individuals.

2.3 Conceptual framework

In order to understand the cycling behaviour on trips to work in Bogotá the conceptual framework presented in Figure 6 was established. Through this conceptual framework, the cycling behaviour to a workplace is explained by the employees' needs, contextual opportunities and abilities, aligned with the NOA model of the travel behaviour theory. These needs, contextual opportunities and abilities of the individuals are in turn shaped by the opportunities that the city offers to them in terms of mobility, like transport infrastructure and services, the opportunities and needs created by the companies in terms of culture, infrastructure, services and policies (called work-related factors from now on), and lastly, by the personal context of the individual. This conceptual framework recognise that both the city and the work-related factors, are embedded in the individuals' context, affecting their opportunities but also their needs, and in the long run its behaviour.

Figure 6. Thesis conceptual framework



Source: own elaboration

In order to explain the current cycling behaviour of the individuals under study, a deep understanding of the following dependent variables is consider needed:

1. Behavioural change towards bicycle: aims to analyse if a new cycling behaviour was adopted by users of other means of transport after the implementation of a workplace travel plan. If so, the drivers of behavioural change will be analysed.
2. Being a cyclist: aims to understand which factors are determinants for cycling to a workplace, compared with non-cyclist.
3. Level of cycling: aims to understand the intensity of cycling among cyclists, and which are the factors that result in a higher level of cycling.

To explain the three dependent variables the following independent variables will be considered:

1. Employees' needs: includes individual' restrictions when commuting to work. It consists of the needs generated by the workplace like the need to arrive on a particular hour or the need to carry goods for business purposes, and it also contains the personal needs of the individual as for example pick-up/leave someone on the way to the office.

2. Employees' opportunities refer to the set of opportunities an individual has on its own context to fulfil the need to commute to work. It considers the social norm regarding individual' travel choices (both on workplace and on the household), city' transport alternatives accessibility, cycling facilities available in the workplace, and individual' attitudes to transport alternatives.
3. Employees' abilities include the individual availability of time, money, skills and capacity for commuting to work.

Using this conceptual framework the determinants of the current cycling behaviour of individuals who commute to work in Bogota will be determined.

3 Research, design and methods

On this chapter, the overall methodology of this research is described and discussed. Firstly, the research questions are revised, based on the learning of the literature review. Following, the operationalization matrix of the research is presented, defining the most relevant indicators used in the study. Secondly, the research strategy with its data collection methods and sample characteristics are described in order to illustrate the process followed to answer the research question. Subsequent, the validity and reliability of the study is discussed. Lastly, the data analysis methodology and the instrument used to pursue this research are presented.

3.1 Revised research question

The research question and sub-question of the research are the following:

1. Main research question
- Which are the factors that explain the current *cycling behaviour* on commuting to work in Bogotá?
2. Research sub-questions:
- To what extent work-related factors, individual characteristics and city mobility conditions explain the *choice of cycling to work* of employees in the workplace?
- To what extent work-related factors, individual characteristics and city mobility conditions explain the *level of cycling* of employees in the workplace?
- Which are the drivers of a *behavioural change* towards *cycling* to work?

3.2 Operationalization: variables, indicators

As established in the conceptual framework of this research, the transportation choice to commute to work is influenced on an individual level by three main independent variables; individual needs, individual opportunities and individual abilities. In order to build the data collection instruments that allow us to measure the bicycle choice and its level of use one a workplace, in Table 4 the indicators for each of the variables (both dependent and independent ones) are defined and valued.

Table 4. Travel behaviour change: operationalization matrix

Variable	Definition	Indicator	Value
Cycling behaviour (Dependent variable)	Refers to the election and intensity of use of the bicycle to commute to work.	Being a cyclist	0: Individual had never used the bicycle to commute to work 1: Individual had used the bicycle to commute to work
		Type of cyclist	0: Occasional or ONE-time cyclist 1: Part-time or Full-time Cyclist
		Presence of a NEW cycling behaviour	0: No adoption of new cycling behaviour on the last 3,5 years 1: Adoption of a NEW cycling behaviour on the last 3,5 years

Variable	Definition		Indicator	Value
Individual opportunities	Presence of opportunities in individual context to fulfil the need to commute to work	Social norm: The transport mode in which the colleagues at work or the people in the household would expect a commuter to travel to work	The expected mean of transport by colleges at work	1: cycling
				2: public transport
				3: car
				4: other
			The expected mean of transport by other people in the household, friends and family	1: cycling
				2: public transport
				3: car
				4: other
		Awareness of consequences	Health benefits	1: Yes 0: No
			Cost savings	1: Yes 0: No
			Environmental benefit	1: Yes 0: No
			Time benefit	1: Yes 0: No
		Transport accessibility and affordability context	Distance to the closest cycle path from home	[0-10] Km
			Distance to the closest cycle path from work	[0-10] Km
			Distance to the closest BRT station from home	[0-10] Km
			Distance to the closest BRT station from work	[0-10] Km
			Assigned free private car by the company	0: No
				1:Yes
			The capacity of car & motorbike parking	[0%-100%] Employees
			Availability of parking for free in the company	0: No
				1:Yes
		Degree of attitude towards transport alternatives context	Perception of risk of travel accident in bicycle or walking	Linkert scale
			Perception of public safety on the journey work-home walking or cycling	Linkert scale
			Perception of the level of service in public transport	Linkert scale
			Perception of the level of congestion in streets	Linkert scale
			Perception of influence of plate-restriction on personal cycling use	Linkert scale
		Context of bicycle infrastructure and services in the company	Secure cycle path in office	0: No
				1:Yes
			Capacity of cycle-park	[0%-100%] Employees
			Access to changing facilities, lockers and showers	0: No
				1:Yes
			Access to bicycles user groups or accompanied trip	0: No
				1:Yes

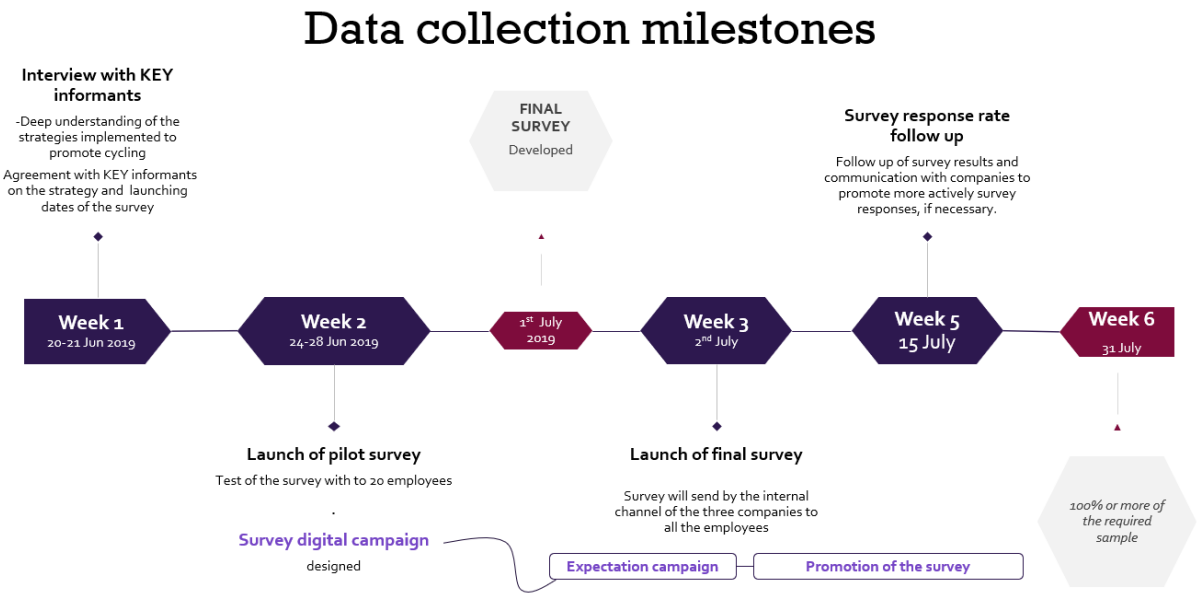
Variable	Definition	Indicator	Value
		Access to incentives to ride the bicycle to work	0: No
			1:Yes
Individual abilities	Individual availability of time, money, skills and capacity for travel choices	Personal salary in Euros	[250-2500]
		Age	[1-70]
		Gender	0: Men
			1: Women
		Household income category	[1-6] categorical variable
		Access to car/moto/bicycle available to use	0: No
			1:Yes
Individual needs	Individual needs of the commuter	Presence of children in the household	0: No
			1:Yes
		Commute distance	[0-100] Kilometers
		Need to travel in peak hour	0: No
			1:Yes
		Need to travel outside the office for business purposes	0: No
			1:Yes
		Need to carry stuff to or from work	0: No
			1:Yes
		Need to wear a suit, heals or special outfit considered no comfortable for cycling	0: No
			1:Yes
		Need to pick someone on the way to work or home	0: No
			1:Yes

3.3 Research strategy and data collection methods

In order to respond to the research question the *survey* was selected as the research strategy. According to Thiel, S. (2014) the *survey* strategy is suitable for research with a large number of variables (more than 20 in this research) and a large number of units (3067 employees of the 4 companies), as it is one of the most efficient ways to collect the data. Additionally, the results gathered with this strategy are suitable for statistical analyses which result in research findings with high levels of external validity. Lastly, with only a sample of respondents, the research finding could be generalized to the whole population under study.

Under the chosen research strategy, a mix of collection methods was used composed by a semi-structured interview to key informants and a questionnaire for employees. Together, and following the timeline of Figure 7, all the needed information from the companies, their mobility strategy and their employee´s travel patterns were gathered. Additionally, secondary data on shapefile format was requested to the municipality in order to determine the access of the individuals from home and work to city mobility facilities/services.

Figure 7. Data collection timeline



Source: own elaboration

Firstly, the semi-structured interview to key informants was developed via Skype to the four (4) leaders of the workplace travel plans (See the instrument in Annex 1). The leaders of the travel plans were selected as key informants as they are responsible for developing and following-up the strategies of the WTP, but also they have been involved in the entire implementation process, so they have a rich knowledge based on their own experience. The interviews were implemented with the following objectives:

1. Identify the characteristics of the company and its implemented workplace travel plan.
2. Identify the process of implementation, the key moments and successful strategies.
3. Understand the position of the bicycle promotion on the priorities of the workplace travel plan.
4. Identify the motivation of the company and the leader to implement a workplace travel plan on cycling promotion.
5. Overview of the main barriers that leaders of WTP face in cycling promotion on the workplace.

The questions of the interview were sent to the leaders of the workplace travel plans of the company one week in advance, so they could prepare the responses and collect the necessary additional information if needed. The interview space was also used to request the relevant documents to the leaders, as the WTP document of each company. The interviews of the key informants play a significant role in the triangulation and interpretation of the questionnaire results, but most importantly, the interviews were crucial on explaining the context under the workplace travel plans were implemented.

On the other hand, the survey for commuters to work was sent to all the employees of the four (4) companies using an on-line questionnaire method developed by the google forms tool. The questionnaire aimed to achieve the following objectives:

1. Identify the commuters' travel behaviour and their socio-economic characteristics.
2. Identify the influence of the workplace factors in commuter behaviour change and level of cycling.
3. Identify the level of cycling of the employees.

4. Identify commuter perception of alternative means of transport of cycling.
5. Identify the perception of cyclist about the cycling programme of the company

Before sending the online questionnaire among all employees, a pilot test of the instrument was implemented with 20 employees looking forward to avoiding inconclusive research resulting from a lack of variables or bias by respondent misinterpretation. Additionally, the pilot test was conducted to guarantee that the data collection instrument would cover the relevant aspects understudy, that all the options were included in the fixed set of possible answers, that the questionnaire is understandable by the respondents and that the response time is acceptable by them. After the pilot test, the final instrument was developed based on the feedback of the respondents (See Annex 2).

Once the final questionnaire instrument was ready to use it was sent to the employees of the four (4) workplaces through the internal channels of communication, under the umbrella of the digital communication strategy created to promote the response (See Annex 3). After two weeks of sending the questionnaire, a reminder was sent to the employees in order to increase the number of respondents. One month after opening the questionnaire it was closed with a total of 835 respondents, from which 793 were considered valid.

3.4 Sample size and selection

For this study the population was considered as the total number of employees working in the four companies with workplace travel plan implemented, which consist of 3.067 employees. These four (4) companies were chosen to represent diverse practices of the public sector in the implementation of workplace travel plan.

To develop this research a stratified random probability sample was used in order to guarantee that the results of the study are representative for the whole population. For this research the population is known and finite, therefore the size of the sample is calculated according to the formula [4] which assumes a confidence level of 95% (Yamane, 1967):

$$n = \frac{N}{1+N(e)^2} \quad [4]$$

Where,

$N: Population\ size$

$n: sample\ size$

$e: marginal\ error$

For 95% of confidence level, and a marginal error (e) equals to 5% representing the level of precision, the sample size of this study is estimated as 353 individuals. This probability sample is random, as the online survey will be sent to all the employees of the four (4) companies so it is up to them if they respond or not respond to the questionnaire. Considering the study contemplates four (4) companies, considered as four (4) homogenous groups, the sample size was stratified according to the weight of the size of each company on the total size of the company as presented in Table 5.

Table 5. Stratified Random Sampling distribution

	Company				
Stratum	A	B	C	D	**TOTAL**
Population Size	250	850	615	1352	**3067**
Sampling Fraction	8%	28%	20%	44%	**100%**

	Company				
Stratum	A	B	C	D	**TOTAL**
Final Sampling Size Results	**29**	**98**	**71**	**156**	**353**

Source: Own elaboration

3.5 Validity and reliability

According to Van Thiel (2014), the accuracy and consistency in which the research variable is measured define the level of reliability of the research. In this study the accuracy is reached by the implementation of an anonymous, standard and close-end survey to all commuters which include separately all the variables that the literature recognizes as determinants of cycling behaviour. By doing so, there is no space for subjective interpretation by the respondent or the researcher, there are no falsely and inaccurately responses as the survey is anonymous and the possible answers are fixed, and lastly there is no bias related to the target as it captures all commuters of the companies and not only the cyclist.

On the other side, the consistency of this research is expressed by a standard methodology with a fixed instrument, based on literature review, that can be implemented in any other company in order to measure the influence of its workplace travel plan in the cycling behaviour of its employees. This means, that the methodology can be replicated, and that it has scientific validity as its roots are in the legit scientific literature.

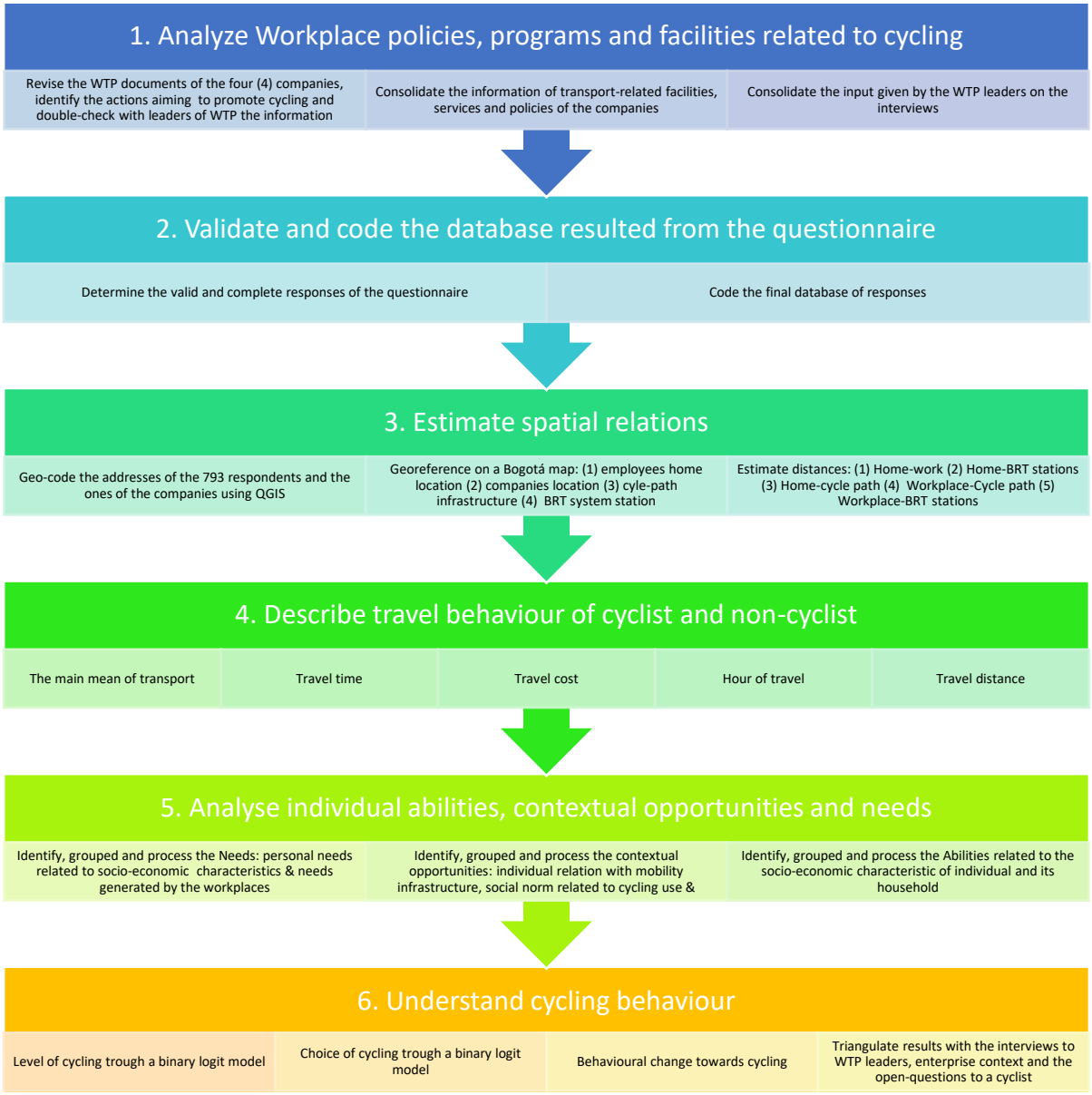
The validity of this research is reached by the statistical nature of its instruments and results. Both, the sample size and the data analysis instrument are based on statistical theory, allowing to test the statistical significance of the results, and hence the external validity of the study. In this research 353 responses where needed, but it was possible to capture 793 valid ones, which almost doubles the number of required responses, guaranteeing the validity of the research findings. Additionally, a similar instrument to measure travel behaviour have been used widely in legit scientific research, so this type of tool has been already validated by several researchers. Moreover, a pilot test of the instrument was developed which allow the researcher to improve the final data collection method.

Lastly, the findings of the research given by the quantitative method, were completed by the semi-structured interview to the leaders of the travel plans. Using that tool as a complementary method of the research the overall understanding of the context and the causalities of the research findings were increased. The interview was structured align with the literature review of work-related factors that could affect cycling behaviour, so also contribute to a significant manner to guarantee the validity of the findings.

3.6 Data analysis methods

To answer the research question the data was processed and analysed with the methodology presented in Figure 8.

Figure 8. Data analysis methodology



Source: Own elaboration

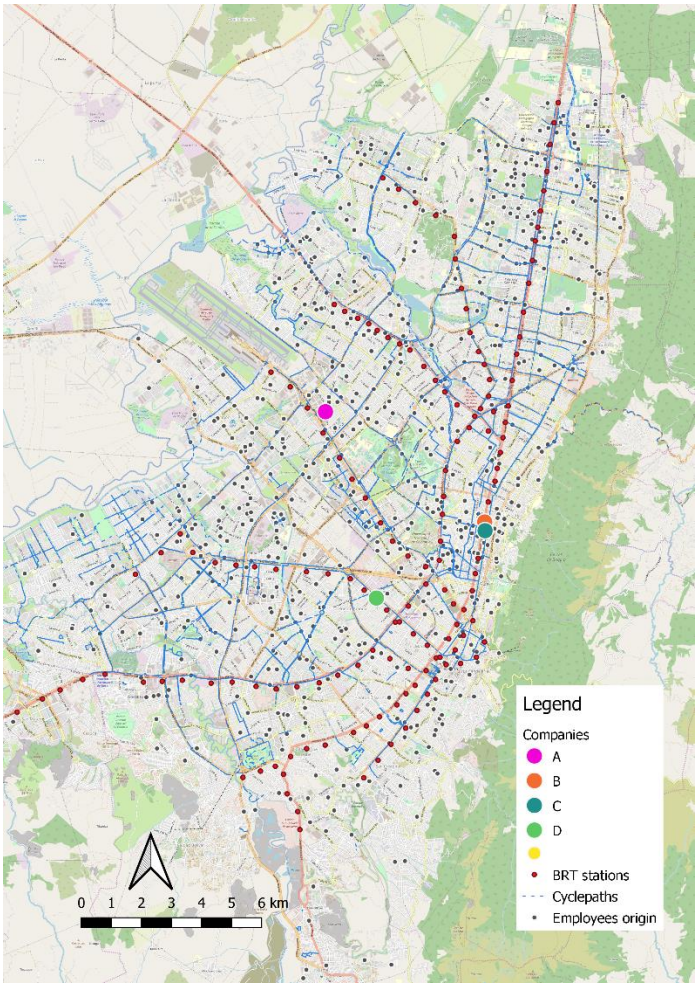
Firstly, workplaces information was gathered together and analysed to deeply understand the context where the commuters travel every day and the action made by the companies through the WTP related to cycling behaviour promotion.

Next, the results of the on-line questionnaire were translated (from Spanish to English) and codified using the values presented on the operationalization table (see Operationalization: variables, indicators on page 18). During this process the data was also reviewed, in order to identify irregularities or inconsistencies that could lead to more significant problems in the data analysis stage. To do so, the main descriptive statistics of each attribute was estimated, including; distribution of the values of each variable, minimum and maximum values, standard deviation, the average (if it is not categorical value), the mode and median. Looking into extreme values within these statistics was possible to identify invalid responses, which was taken out of the sample, consolidating a new dataset of the questionnaire.

Subsequent, using QGIS the address of the employees and the workplaces were geocoded in order to estimate their X and Y coordinates. Addresses that were not possible to geocode with QGIS tools were geocoded manually on google maps. However not all of them were complete

or founded, so the dataset was filtered again taking out the responses with incomplete or incorrect addresses. Following, the projected coordinates from the workplace and employees were projected on a map, which also included the BRT stations of the Transmilenio system and cycle paths obtained through the municipality.

Figure 9. Map of origin and destination of employees with cycle paths and BRT stations



Source: own elaboration

With this information on QGIS the following direct distances were estimated:

- Distance from employees' home to their company
- Distance from employees' home to the nearest cycle path
- Distance from employees' home to the nearest BRT station
- Distance from companies to the closest BRT station
- Distance from companies to the most adjacent cycle path

The estimated direct distances were affected by a diversion factor (1.3), given by the municipality, that considered the network detours compared to the direct distances. Next, taking into account the travelled distance by employees the speed of the commute was calculated for each individual and later compared with the average speed of each mean of transport. The responses with extreme values of speed were reviewed and analysed, and were excluded from the dataset if they were considered unreal or impossible.

With the filtered dataset ready, the current travel patterns of the respondents were identified. The main mobility indicators of the sample were processed, analysed and compared using Power BI. This tool allowed to easily visualize the differences among the four companies,

group of commuters, type of cyclists or any other group of individuals based on its revealed behaviour or the choice they made on the questionnaire. The dynamic visualization provided a more in-depth understanding of the data analysis process.

Following, the database of the questionnaire with the individuals' information was combined with the relevant data of the workplace support documents and WTP leaders' interviews, resulting in final database which includes all the needs, contextual opportunities and abilities of the individuals needed to model cycling behaviour. Therefore, the definitive database consists of the individual variables but also the company variables (ie. Parking capacity or existence of an incentives program), and contains all the categorical variables coded using effect coding. On effect coding the base level will take a value of minus one, -1, instead of zero as in dummy coding, and was selected because have the following advantages when compared to the classical dummy coding:

- The effects code variables will produce a unique value which is no longer entirely confounded with the alternatives ASC (Hensher, et al., 2015).
- The impact of the base level of effects code variables on the overall utility can be estimated as the sum of the parameters estimated for the other categories (Hensher, et al., 2015).With dummy variables is not possible to know this impact.

Lastly, using the final dataset three logit models were used to explain cycling behaviour; the first one aims to explain the determinants of cyclist when compared to non-cyclist, the second one the determinants of the level of cycling among cyclists, and lastly, the determinants to acquire a new behaviour (choosing bike) that did not exist before the WTP.

4 Research findings and analysis

4.1 Background characteristics of the companies and their workplace travel plans

The four companies under study share their nature as all of them belong to the public sector, under the same global directive of corporate policies, environmental assessment and human resources management. However, they are independent to choose the method, tools and resources to develop, adopt and implement internal policies. Even more, they possess different human and financial capital to do it, which consequently could lead to varying results of the implemented strategies on each company.

As a result of the analysis of the four interviews to the workplace travel plans leaders and the companies' documentation (mobility baseline and workplace travel plans), the differences among institutions and their workplace travel plans were identified. The four companies differ on size and location, but most importantly they varied on the year when they initiated action on employees mobility with a workplace travel plan, the seniority level of the coordinator of the mobility strategy and even more their motivation for the program (See Table 6). Company A implemented the WTP only with the purpose to follow a government directive, B and C aiming to contribute to environment or mobility, and D was aiming to gain public recognition on mobility commitment. Alike, seniority level of workplace travel plan coordinator also varies within companies, from the part-time coordinator with high seniority level as on company A, to full-time coordinator but with low seniority level as in company D, which partially shows the commitment level of the company with the mobility strategy. Additionally, as presented in Table 6, parking policies for motorized vehicles are really different on each of the companies, as for example A charge for parking, B does not offer parking, C and D have free parking but with different capacity. As discussed in the literature review, based on the work of Cairns, S. et al. (2010), parking management is one of the most critical factors to determine the degree of success of a workplace travel plan, so it is expected that such a variety of parking management strategies will conduce to a diversity of results in the 4 companies.

Table 6. Generalities of the workplace travel plans of companies understudy

		Company A	**Company B**	**Company C**	**Company D**
Company size	**Size (Employees)**	250	850	615	1352
	Nature	Public	Public	Public	Public
Generalities of the workplace travel plan	**Year of measurement of the mobility baseline**	2017	2016	2018	2016
	Year of development of a workplace travel plan	2018	2018	2019	2016
	The motivation for the workplace travel plan	Commitment to environment Government directive	To improve employee's well-being To mitigate the environmental impact of employees' commute	To improve city mobility To improve city air quality	To be the benchmark for sustainable mobility
	The seniority of workplace travel plan leader (1 for low seniority level and 5 for high seniority level as part of the management team)	5	3	2	2

		Company A	Company B	Company C	Company D
	Leader dedication for the workplace travel plan	Part-time coordinator	Part-time coordinator	Part-time coordinator	Full-time coordinator
	Leader type of contract	Long-term contract	Long-term contract	Freelance	Long-term contract
	Parking policy for cars and motorbikes	Pricing policy: monthly cost Supply: 14 parking for Car (For 6% of employees) 12 parking spaces for a motorbike (For 5% of employees)	There is no parking available for cars of motorcycles	Price: Free Supply: 90 parking for Car (For 14% of employees) 25 parking spaces for a motorbike (For 4% of employees)	Price: Free Supply: 47 parking for Car (For 3% of employees) 30 parking spaces for a motorbike (For 2% of employees)

Additionally, specific aspects of the cycling promotion program where ask to deeply understand the companies results. On Table 7, the comparison of cycling infrastructure facilities, promotion/motivation programs and special events approach of each company is presented. It can be highlighted that company A and D offer bigger capacity on the cycle-parking and more facilities to employees compared to the other 2 enterprises, that all companies give a free day to employees after they travel 30 times in bicycle to office, and that different type of permanent incentives programs are only implemented in company D. Additionally, public recognition is done on 3 of the 4 companies and is done on face-to-face events on two of those. Even more, all the companies declared to make special events, activities and caravans on the monthly car-free days for public entities (implemented by law), treating this day like a special one when more cyclist are expected on the company. Moreover, the workplace travel plan coordinators share by their own experiences that infrastructure improvements and incentives are the most effective tools to promote the bicycle in the company. Lastly, some of the coordinators express that lack of resources was one big obstacle to encourage cycling, others that the employees do not have time to participate in promotional activities, others that Colombian culture is pro-car and changing the chip is a difficult task, and all of them agreed that city safety is one of the biggest obstacles to promote cycling as employees declare to feel vulnerable on the street.

Table 7. Generalities of the workplace travel plans of companies understudy

		Company A	Company B	Company C	Company D
Cycling infrastructure	Parking facilities for bicycle	Yes. 68 cycle-parking (For 27% of employees). The parking facilities where upgraded on 2018	Yes. 55 cycle-parking (For 6% of employees)	Yes. 56 cycle-parking (For 9% of employees)	Yes. 142cycle-parking (For 11% of employees) The parking facilities of the company were upgraded on 2018, almost doubling their capacity
	Lockers	Yes	No	No	No
	Showers	Yes	No	No	Yes
	Surveillance	Yes	No	No	Yes
Cyclis	Marketing campaign	Yes	No	Yes	Yes

		Company A	Company B	Company C	Company D
	Incentives program related to cycling-use	Yes, 1 free day per every 30 days on the bicycle (Pro-bicycle National law)	Yes: 1. Sporadically, road safety elements for cyclist 2. 1 free day per every 30 days on the bicycle (National law)	Yes: 1. Sometimes, breakfast for the cyclists, and toolkits for the cyclists on special days (car-free day of the city) 2. 1 free day per every 30 days on the bicycle (National law)	Yes: 1. 1 free day per every 30 days on the bike (National law) 2. Since 2017. A year-based fidelity program for cyclist was implemented 3. Monthly on car-free day, breakfast for cyclist and surprise gifts
	Cyclist public recognition on internal communication channels	Yes, by digital newsletter and with an award breakfast event	Yes, by e-mail	No	Yes, at individual and department level, on special event and digital newsletter, respectively
Special events for cyclist	Actively promotion of bicycle use on the yearly city car-free day	Yes	Yes	Yes	Yes
	Actively promotion of bicycle use on the monthly car-free day of public companies	Yes	Yes	Yes	Yes
	Events on the special days related to bicycle	Cycling-caravans to travel to work Games and competitions related to bicycle use	Games through e-mail	Cycling-caravans to travel to work	Cycling-caravans to go to work
The opinion of program leader/team	The score of the importance of cycling on the workplace travel plan (1 the less importance to 10 the most important)	10	10	9	8
	Opinion about the more effective strategies to promote cycling use, by the program leader	Infrastructure improvements and cycling caravans	Incentives program and cycling infrastructure	Incentives program	Cycling caravans
	Main obstacles to promote bicycle	The mindset of the employees and their culture pro-car Safety on the city	Time available of employees to participate in promotional or educational activities related to cycling Safety on the city	Limited budget and limited team to developed and follow up the activities Safety on the city	Low participation of employees on activities during working hours Safety on the city

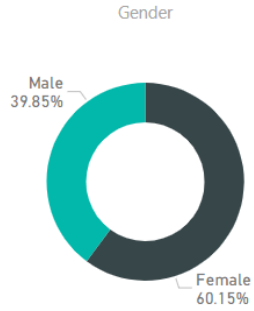
The presented background characteristics of the enterprises on Table 6 and Table 7 probably impact the level of cycling reached on each of the 4 companies, so it should be considered in order to do a comprehensive analysis of the study results.

4.2 Commuters behaviour

Aiming to understand the travel behaviour of the employees of the 4 companies under study and their level of cycling, 835 employees responses were collected with the on-line questionnaire instrument explained in chapter 3.6. From the collected data ,793 responses were valid; 19% from company A, 22% from company B, 14% from company C, and the remaining 45% from company D, which means a response rate of 59%, 20%. 19% and 26% from companies A, B, C and D respectively.

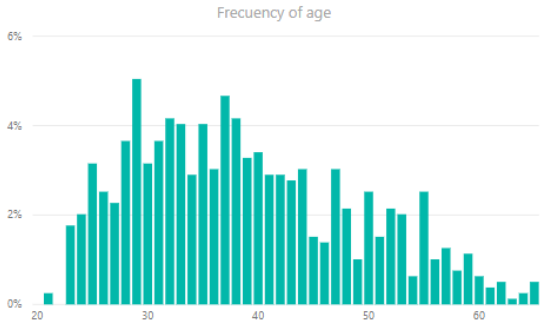
Approximately 40% of the sample were males and 60 females, with an average age of 39 years old and from which more than 60% live in households with 3 or more people (see Figure 10 , Figure 11 and Figure 12).

Figure 10. Sample gender



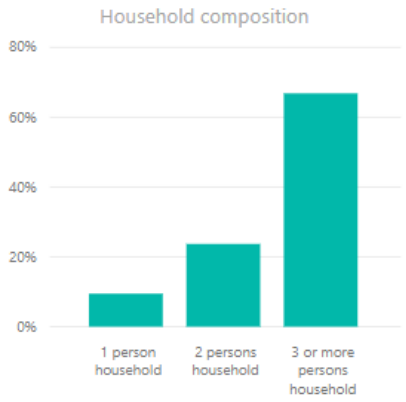
Source: own elaboration

Figure 11. Age distribution



Source: own elaboration

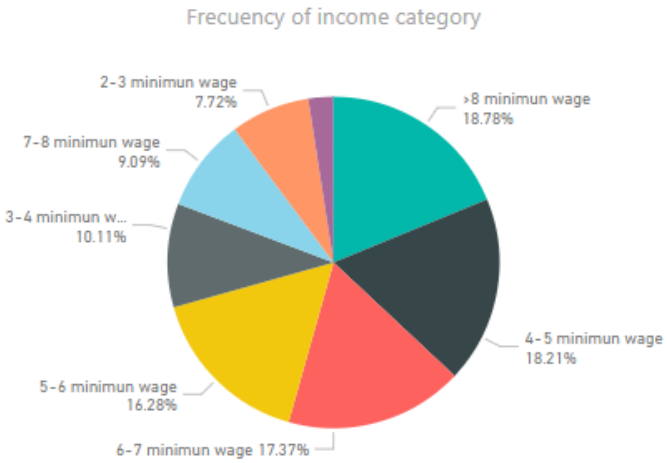
Figure 12. Household composition



Source: own elaboration

The sample has observations on all the individual income categories, from 1 minimum wage to more than 8 minimum wage, with more than 50% of responses of individuals with an income between 4 to 7 minimum wage.

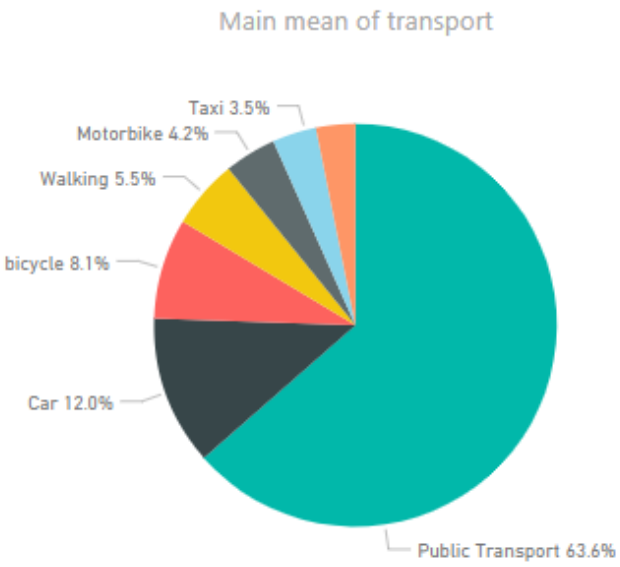
Figure 13. Individual income distribution



Source: own elaboration

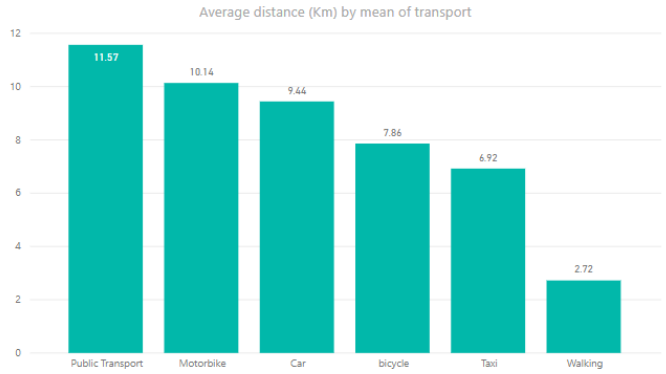
The main mean of transport of the commuters is public transport (63%), following by car (12%) and bicycle (8%), which is 3% higher than cycling participation on overall city modal share (See Figure 14) . To commute to work employees travel on average 10 Km,with an average travel time of 68 minutes (See Figure 15 and Figure 16). This means that on average an employee of these companies spent more than 23 days of the year commuting to work, more than the number of days of holidays they have by law.

Figure 14. The main mean of transport



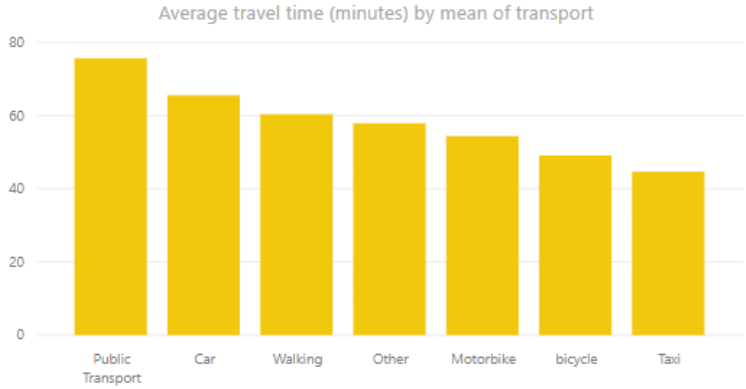
Source: own elaboration

Figure 15. Average distance travelled by mean of transport



Source: own elaboration

Figure 16. Average travel time by a mean of transport



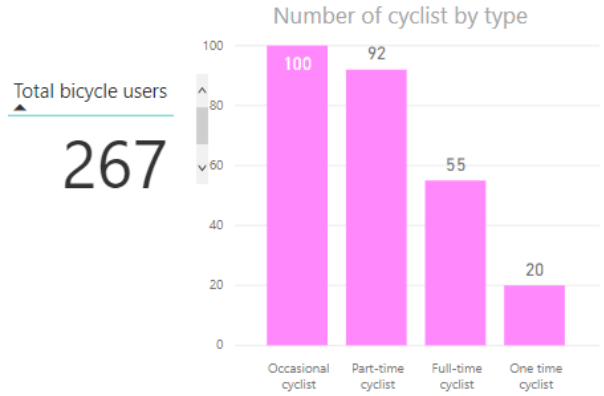
Source: own elaboration

Of all surveyed employees, 267 declare to have used the bicycle to commute to work, which it does not mean necessarily that bicycle is the main mean of transport but that it has been used at least one time to travel to work. From now on, this group of persons will be called cyclists.

The cyclists are categorized into four (4) types according to their monthly frequency. The *one-time cyclist* is the commuter that has only travelled one time on bicycle to work, the *occasional cyclist* travels from 1 to 3 times per month cycling, *the part-time cyclist* travel from 4 to 14 times per month in bike (at least one time per week on average) and lastly the *full-time cyclist* is the one which the main mean of transport is the bicycle and it is used 15 or more times per month. As illustrated in Figure 17, 7% of the cyclist are categorized as *one-time cyclist*, 38% as *occasional cyclist*, 35% as *part-time cyclist* and 21% as *full-time cyclist*.

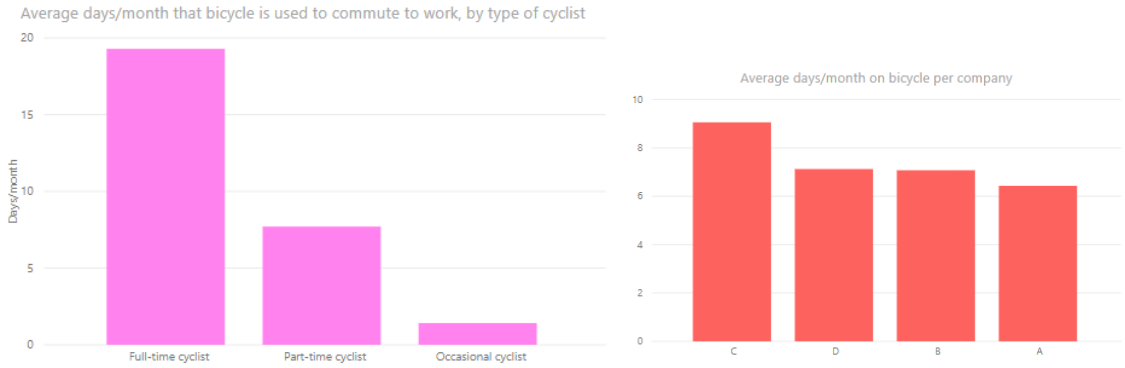
On company C, the average frequency of the cyclist is 9 days/month, almost 2 days/month more than the rest of the companies, which can be explained as the company has more full-time and par-time cyclist than the rest of companies (See Figure 18). However, even if the cyclist of company C travels more times per week, company C together with B, has the lowest percentage of employees which have ever commuted on bicycle 6%, compared to 20% for company A and 9% for D (See Figure 19)

Figure 17. Number of employees who have ever used the bicycle by type of cyclist



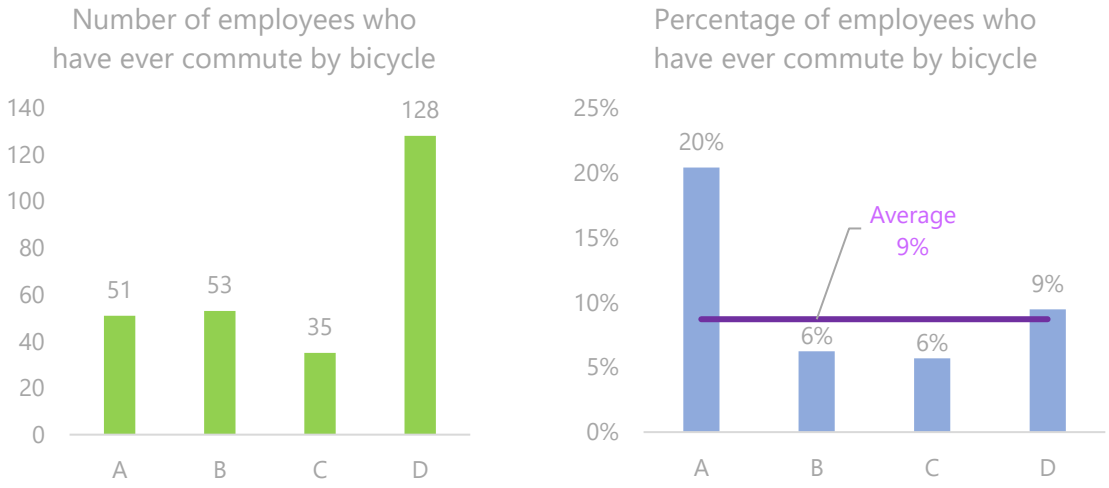
Source: own elaboration

Figure 18. Average days/month on bicycle by type of cyclist and by company



Source: own elaboration

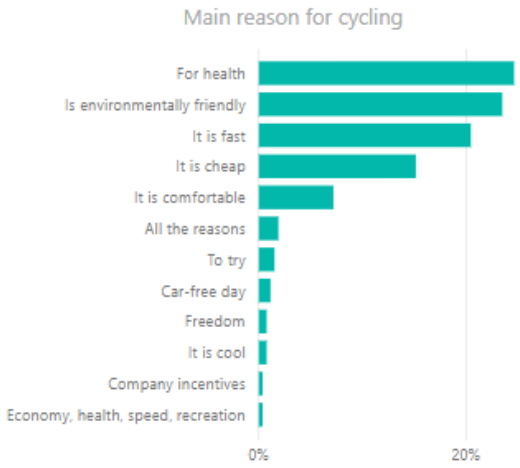
Figure 19. Amount and percentage of employees who have ever commute on bicycle by company



Source: own elaboration

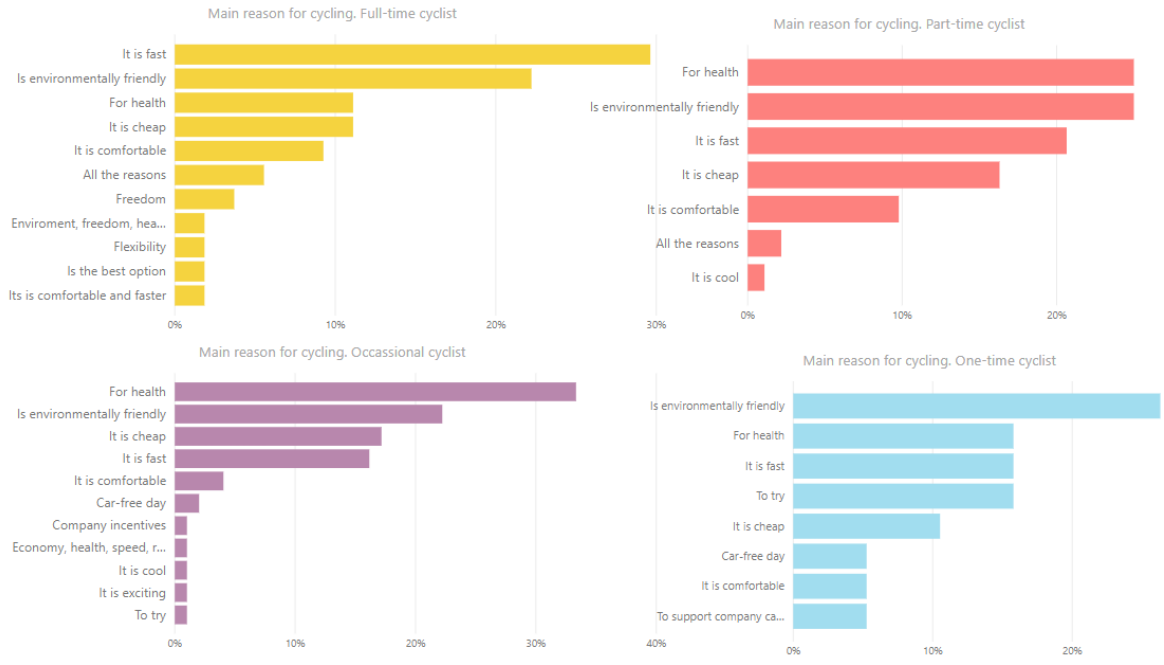
As shown in Figure 20, the main reasons for commuting on bicycle is health, environment, time savings and cost savings. However, the motivation changes importantly according to the type of cyclist as presented on Figure 21, where it is possible to observe that the full-time cyclist is the most aware about time-travel savings of bicycle, and the rest are more motivated to improve health and contribute to environment.

Figure 20. Main reasons to commute on bicycle



Source: own elaboration

Figure 21. The main reason for cycling by type of cyclist

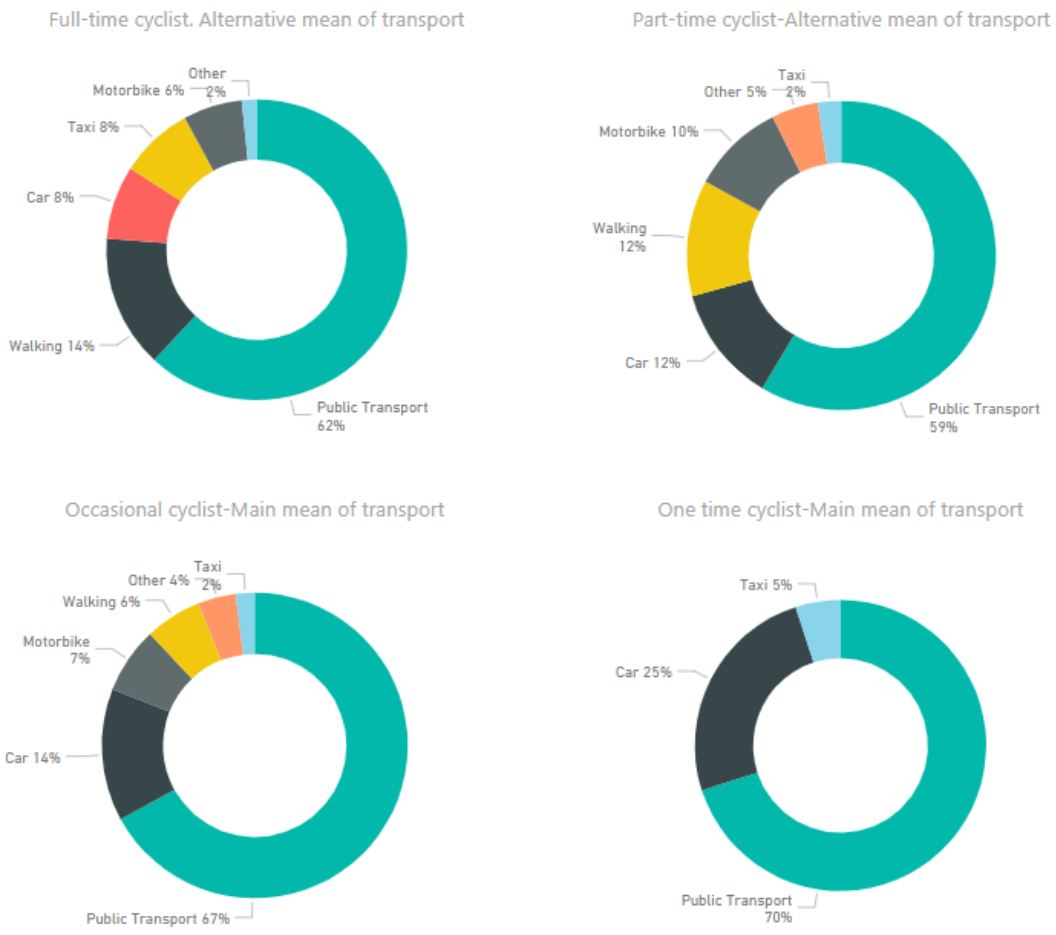


Source: own elaboration

35% of the cyclist started to use this mean of transport before 2016, which is before the time when workplace travel plans were implemented, so those cyclists for sure were not influenced by the program (See Figure 23). The remaining 65% represents the individuals who are new cyclist, those who may or may not be influenced by the WTP on the decision to start using the

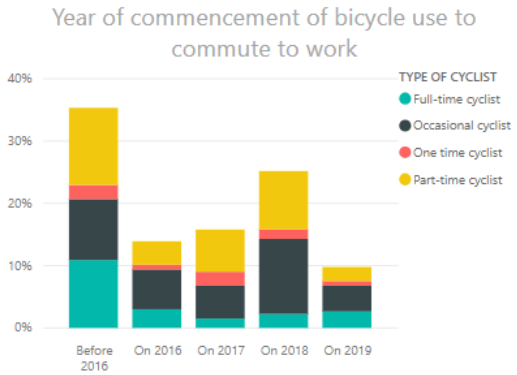
bicycle to work, either for high or low intensity of use. On the other side, the preferred alternative mean of transport of all the cyclists is public transport, followed by car for *one-time*, *occasional* and *part-time* cyclists and walking and taxi for *full-time cyclists* (See Figure 22), so this means that promoting cycling could also be a strategy to reduce car use in the city, mostly among part-time cyclists.

Figure 22. The alternative mean of transport of cyclist by type of cyclist



Source: own elaboration

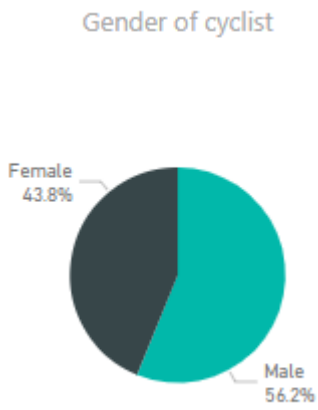
Figure 23. Year of commencement of bicycle use by type of cyclist



Source: own elaboration

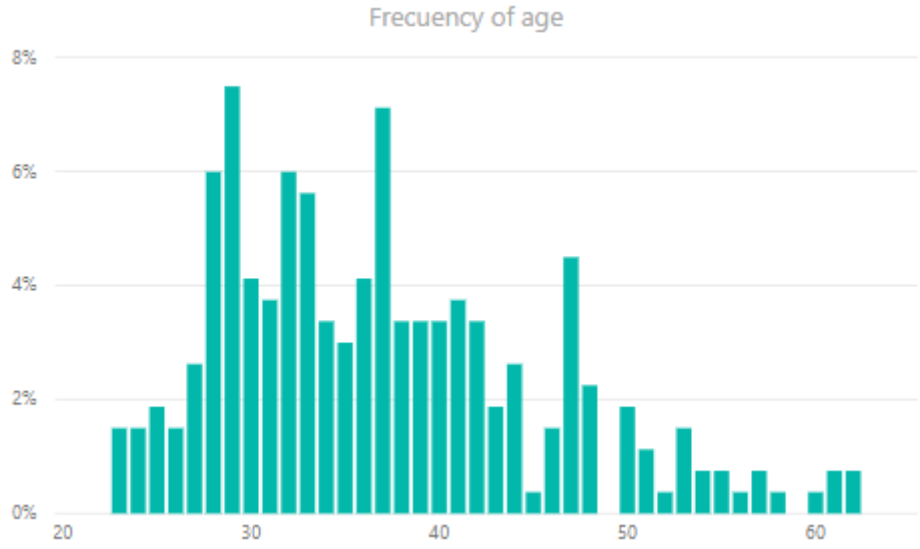
Diverging from the sample, the cyclists have more men representation than women, with 56% and 44% participation respectively (See Figure 24). The average age of the cyclist is 37, two years less when compared to the general sample (See Figure 25).

Figure 24. Cyclist gender



Source: own elaboration

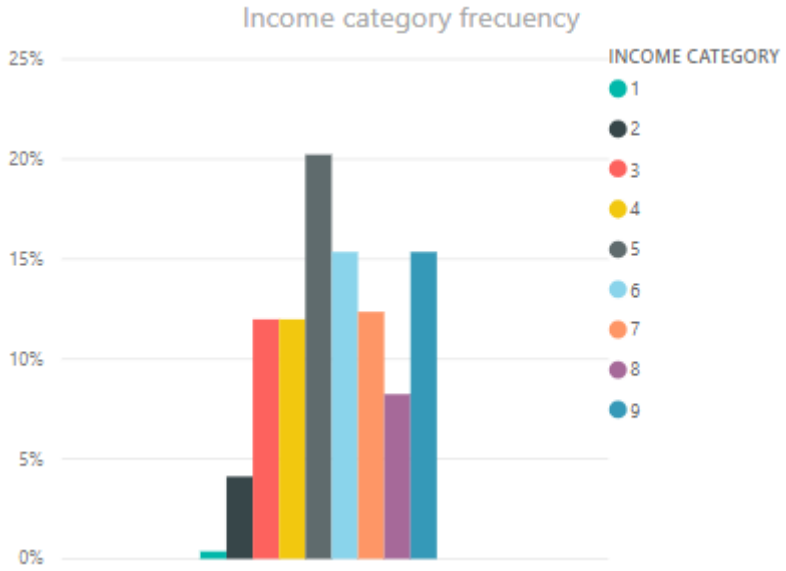
Figure 25. Age distribution of the cyclist



Source: own elaboration

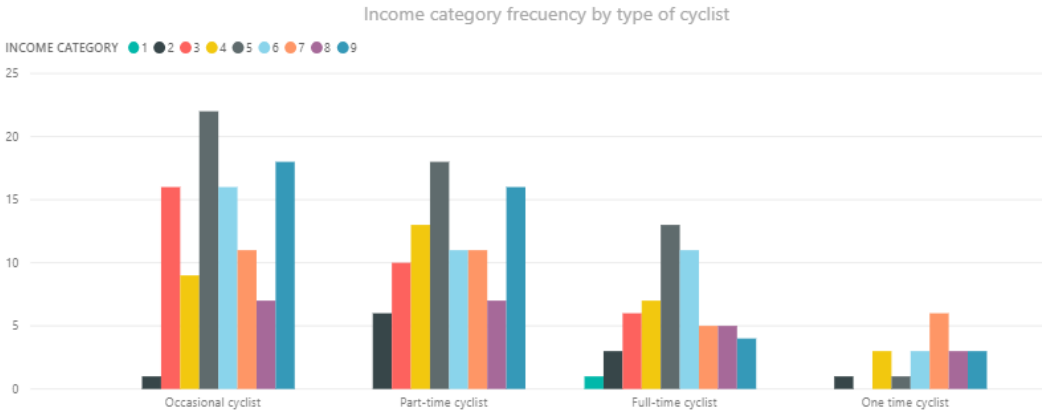
The overall distribution of individual income of the cyclists illustrates that individuals with middle and higher incomes are the primary users of this mean of transport, however the participation of higher incomes is important for part-time cyclists and occasional cyclist but is low for full-time cyclists. As individuals with higher income have higher abilities to afford other means of transport as car or taxi, they may choose this mean of transportation for some occasions, but they do not have to do it for all (See Figure 26 and Figure 27).

Figure 26. Individual income distribution of cyclist



Source: own elaboration

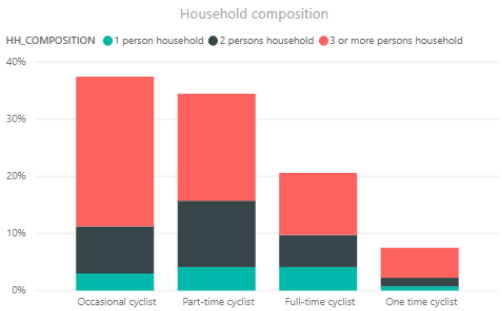
Figure 27. Individual income distribution of cyclist by type of cyclist



Source: own elaboration

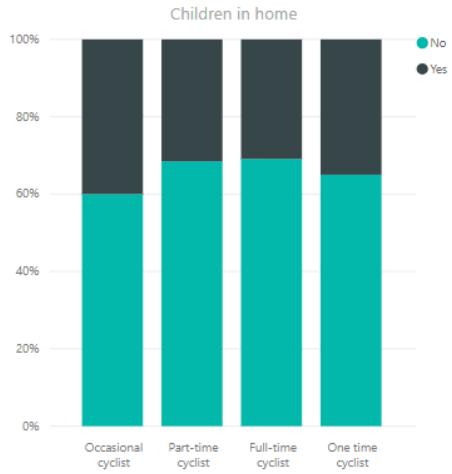
As it is possible to observe in Figure 28 and Figure 29, regarding household composition and presence of children, there are no essential differences among the different types of cyclists, so it seems that it is not a relevant factor to explain the different level of cycling among the cyclists.

Figure 28. Household composition by type of cyclist



Source: own elaboration

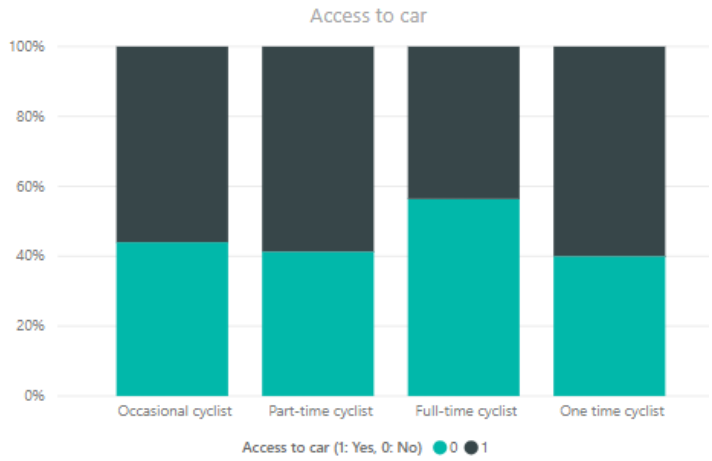
Figure 29. Children in home by type of cyclist



Source: own elaboration

On the other hand, access to automobile, another abilities of the individuals, was more significant for part-time and occasional cyclist when compared to full-time cyclist.

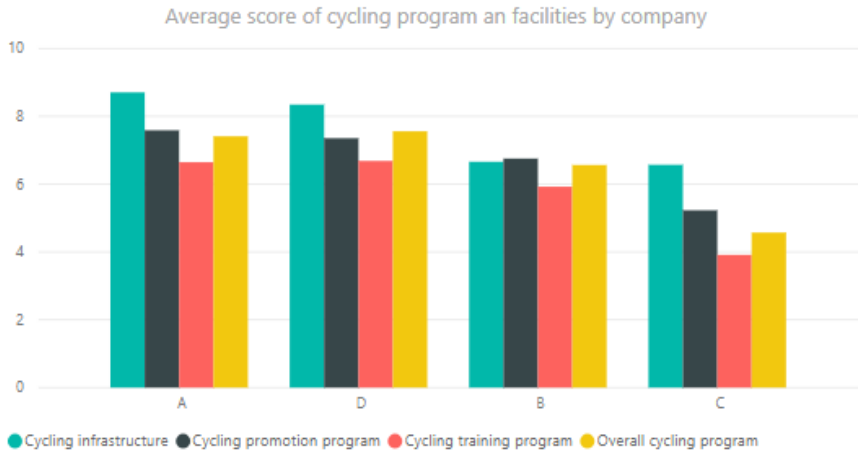
Figure 30. Access to car by type of cyclist



Source: own elaboration

As one of the measures of contextual opportunities, the perception of the quality of the company cycling infrastructure, cycling promotion program, cycling training program and the overall cycling program was measured on a linker scale, where 1 was the lowest perceived score and 10 was the best one possible. On Figure 31 it is possible to observe that company A was rated with the higher score given by the cyclists on each category, following by D, and the lower scores where given to companies B and D. These results were expected as company A and D have the cycle-parking with highest capacity, have made more efforts to promote cycling and they have workplace travel plans more oriented to cycling use when compared to the other two companies. On the other hand, it is possible to observe that the higher percentage of cyclist occur on the enterprises with the higher scores of the cycling-related infrastructure, promotion and training programs.

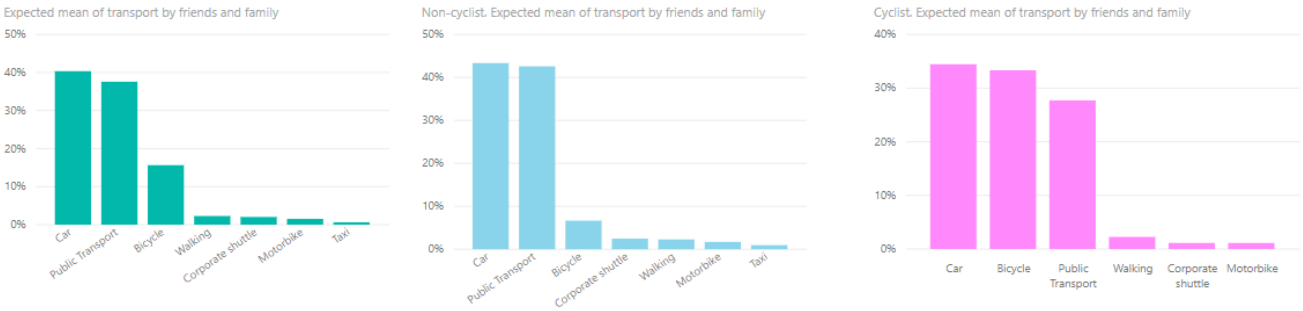
Figure 31. The average score of cycling facilities/strategies by company



Source: own elaboration

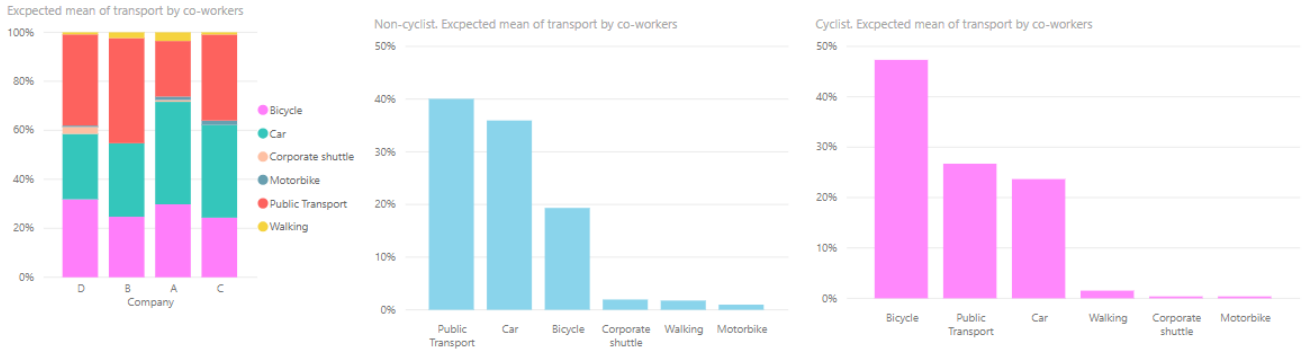
On the other side, regarding the expected mean of transport by friends and family, it can be seen in Figure 32 that non-cyclists were expected to travel more in car and public transport and cyclists were expected to go more on car and bicycle. Alike, the expected mean of transportation by coworkers, proxy of corporate culture regarding sustainable mobility, was also car and public transport for non-cyclists, but for cyclist the bicycle was the primary expected mode, followed by public transport and car.

Figure 32. Expected mean of transport by friends and family



Source: own elaboration

Figure 33. Expected mean of transport by co-workers



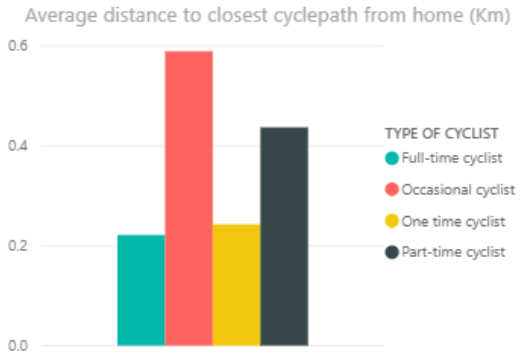
Source: own elaboration

Continuing with the contextual opportunities, it is shown in Figure 34 that the perception on transport alternatives is similar for all the types of cyclists and only the perception of public transport comfort seems to present an essential difference among type of cyclists. On the other hand, the distances from home to cycle-path are shorter for full-time cyclists when compared to part-time and occasional ones, which can indicate that the accessibility to cycling infrastructure could have an impact on level of cycling.

Figure 34. City transport perception

Source: own elaboration

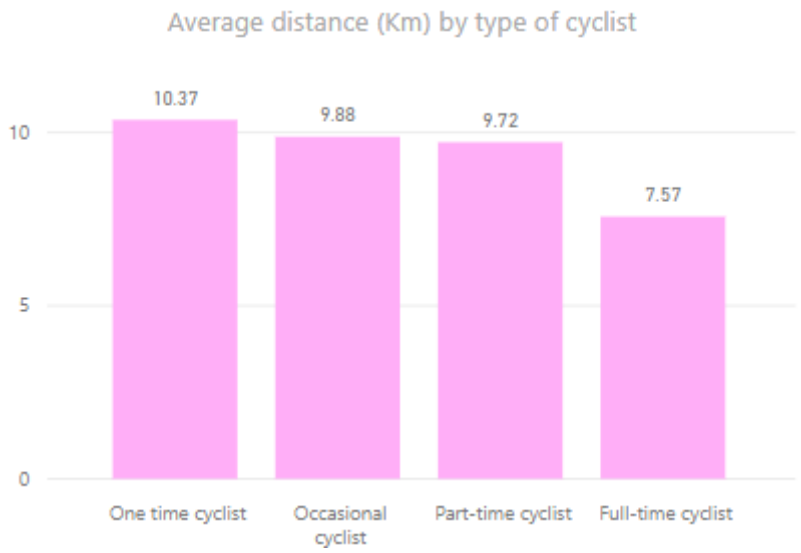
Figure 35. Cycling infrastructure proximity



Source: own elaboration

Concerning the individual needs, cyclists must travel less distance on average when compared to the rest of the commuters, even more the full-time cyclists had to travel 7.6km on average which is around 2-3 kilometres less than the rest of cyclist. These results can suggest that the intensity/frequency of cycling is higher for commuters that live closer to work, so this mean of transport is preferred for shorter distances which are aligned with the findings of Hainen et.al (2013).

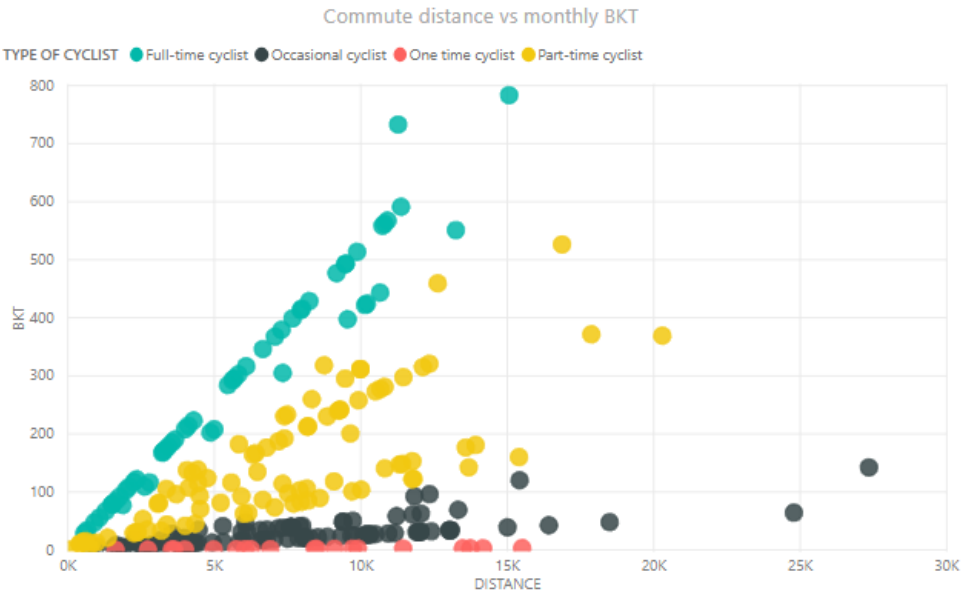
Figure 36. Average distance by type of cyclist



Source: own elaboration

As expected, the distance from home to work is directly related with the monthly Bicycle Traveled Kilometers (BKT) which is a measure of the intensity of the use of bicycle, estimated as the daily kilometres travelled multiplied by the monthly frequency of bicycle use. These relations seem to have different slope depending on the type of cyclists, so there is a higher scope for full-time cyclist, followed by part-time cyclists and occasional cyclists.

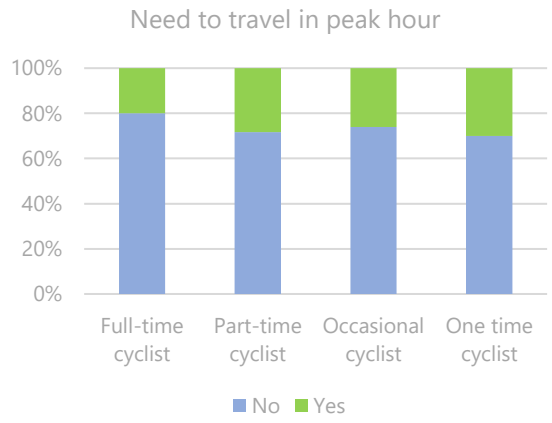
Figure 37. Commuting distance vs BKT



Source: own elaboration

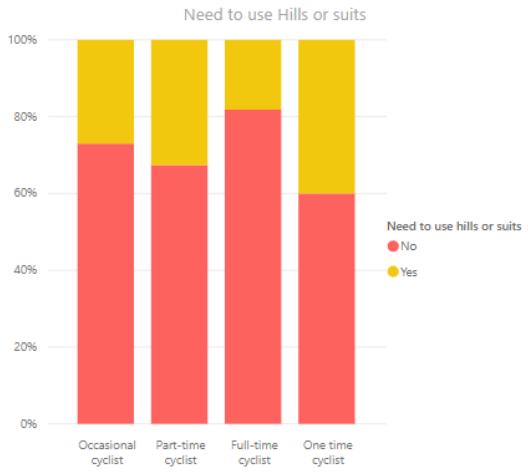
According to literature, there are other individual needs that can influence the travel behaviour of commuters. For example, the need to travel in peak hour, to wear formal clothes, to transport materials/equipment to work or the need to travel during the day for business purposes. The results of this study, shows that for the full-time cyclists these needs were lower than for the rest of the cyclist (See Figure 38, Figure 39, Figure 40 and Figure 41) .

Figure 38. Need to travel in peak hour by type of cyclist



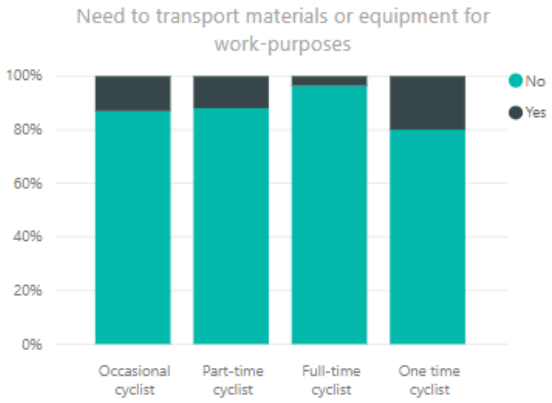
Source: own elaboration

Figure 39. Need to use hills or suits for work



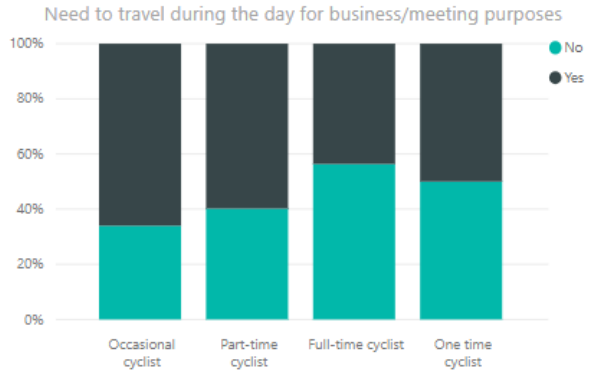
Source: own elaboration

Figure 40. Need to transport materials/equipment for work purposes



Source: own elaboration

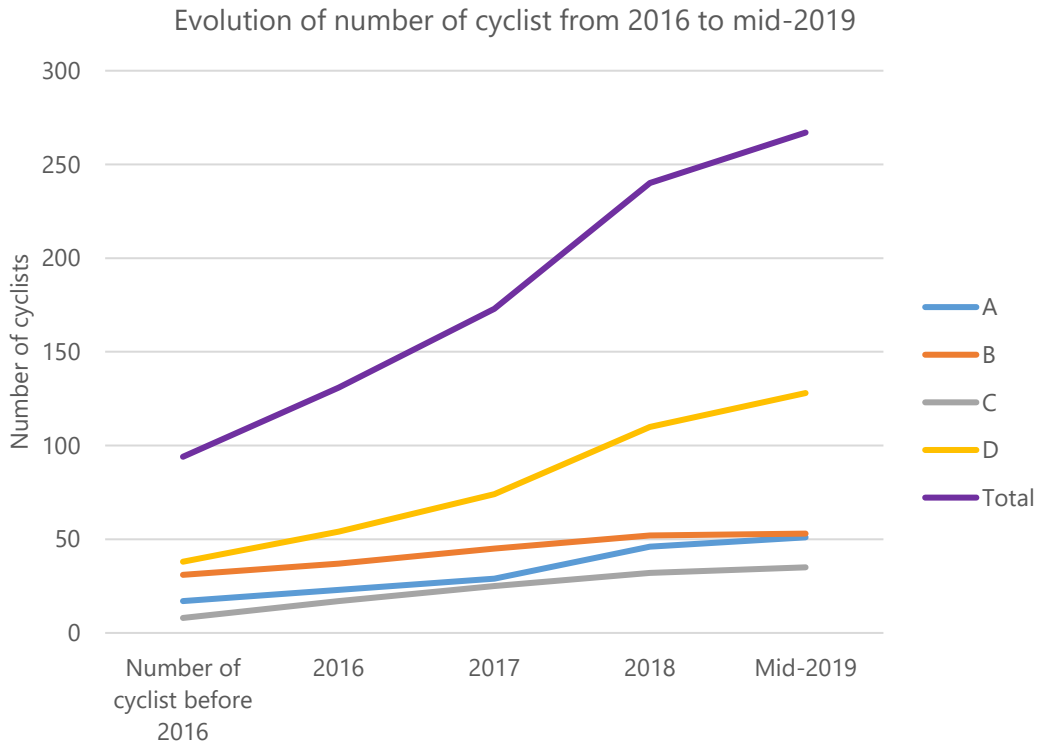
Figure 41. Need to travel during the day for business purposes



Source: own elaboration

Lastly, in Figure 42, the evolution of the number of cyclist from 2016 to mid-2019 is presented, illustrating the addition of new cyclist on each year and the peaks of cyclists on that period of time. It is possible to observe that the overall tendency is to increase the number of cyclists, however, not in all the companies the growth rate is the same. Company D and A present a steeper slope than B and C, which means that D and A had a more significant raise relative to their own baseline. Additionally, it is possible to observe that the most significant increases occurred in 2017 and 2018 for the whole sample. On 2017 company A implemented the fidelity program for cyclists and on 2018 both companies, A and D, applied and upgraded cycle-parking infrastructure, changing the contextual opportunities of the commuters, which may explain this peak of cyclist. Additionally, the companies with better results, A and D, are also those ones with the stronger high-level support which were materialized on effective assignment of a budget for infrastructure improvements and for fidelity programs.

Figure 42. Evolution of cyclists from 2016 to mid-2019



Source: own elaboration

4.3 Cycling behaviour

To explain cycling behaviour three (3) binary logit models were applied. Each of one aims to explain one of the dependent variables presented in Table 3 based on the individuals 'needs (N), contextual opportunities (O) and abilities. For the first model, "Being a cyclist", the complete dataset was used, which include cyclist and non-cyclist. The second one, "Level of cyclist", aims to find the factors which lead an individual to chose to use the bicycle *full-time* or *part-time* instead on an occasional or sporadically frequency, so only the dataset of cyclist was used. The third model, "New cycling" behaviour, aims to understand the drivers of the adoption of a new cycling behaviour on the last 3 and a half years, period of time when actions related to the WTP were implemented on the workplaces. For the last one, the full dataset filtered, excluding the observations of those cyclists which reported started utilizing the bike before 2016.

Table 8. Dependent variables of cycling behaviour

Model ID	Dependent variables	Values	N	% of Total
Model 1	Being a Cyclist	Yes: 1	267	34%
		No:0	526	66%
Model 2	Level of cycling	One-time cyclist & occasional cyclist: 0	120	45%
		Part-time cyclist & full-time cyclist: 1	147	55%
Model 3	NEW Cycling behaviour	Yes: 1	172	25%
		No:0	527	75%

Source: Own elaboration

Following in this chapter the research findings related to cycling behaviour are presented.

4.3.1 Being a cyclist model

Aiming to explain commuter decision to be a cyclist, either part-time, full-time, occasional or one-time cyclist, when compared to non-cyclist, a binary logit model was developed. With this model the probability that a commuter would choose the bicycle to travel to work could be determined as function of the individual needs, contextual opportunities and abilities. Following, the function [5] presents the final utility function of the alternative "Being a cyclist" and Table 9 shows the results of the binary logit with the coefficients that accompany all the variables of the utility function. To build up the model, initially all the variables related to the needs, contextual opportunities and abilities of commuters presented on the operational table of this research were included, and next one-by-one of the non-significant variables were excluded starting with the ones with higher p-values, leaving only the variables that were significant at least to 85% confidence level.

$$V_{being\ cyclist} = ASC + \beta_1 \times Male + \beta_2 \times Age + \beta_3 \times Age^2 + \beta_4 \times Children_{Household} + \beta_5 \times Income_{permonth} + \beta_6 \times Meeting\ Outside_{need} + \beta_7 \times CarryStuff_{need} + \beta_{7.2} \times DressFormal_{need} + \beta_8 \times CitySafety_{score} + \beta_9 \times Transit\ Confort_{score} + \beta_{10} \times CarAccess + \beta_{11} \times MotorbikeAccess + \beta_{12} \times BicycleAccess + \beta_{13} \times TravelDistance + \quad [5]$$

$\beta_{14} \times DistanceBRT + \beta_{15} \times DistanceCyclepath + \beta_{16} \times PaidParking + \beta_{17} \times CarParkingCapacity + \beta_{18} \times BikeParkingCapacity + \beta_{19} \times Friends\&FamilyCycling_{SocialNorm} + \beta_{20} \times CoworkersCycling_{SocialNorm} + \beta_{21} \times D_{Children}$

Table 9. Being a commuter cyclist: logit model results

```
Iteration 0:   log likelihood = -506.58399
Iteration 1:   log likelihood = -326.12067
Iteration 2:   log likelihood =  -317.7044
Iteration 3:   log likelihood =  -317.6211
Iteration 4:   log likelihood = -317.62105
Iteration 5:   log likelihood = -317.62105

Logistic regression                             Number of obs     =        793
                                                LR chi2(21)       =     377.93
                                                Prob > chi2       =     0.0000
Log likelihood = -317.62105                     Pseudo R2         =     0.3730
```

VARIABLES	Being a cyclist
Male	0.356***
	(0.108)
Age	0.186**
	(0.0849)
Age^2	-0.00254**
	(0.00103)
Children in household	-0.176
	(0.108)
Monthly Income (Eur)	0.000445*
	(0.000239)
Meetings Outside	0.179*
	(0.109)
Need to carry stuff (material or equipment)	-0.293*
	(0.156)
Need to wear suits or hills	-0.329***
	(0.110)
City general safety score	0.0925*
	(0.0528)
Transit Comfort Score	-0.0566
	(0.0553)
Car access	-0.0933
	(0.112)
Motorbike access	-0.187
	(0.174)
Bicycle access	1.270***
	(0.107)
Travel Distance (km)	-0.00653
	(0.0206)
Distance home to BRT station (km)	0.220**
	(0.108)
Distance home to cycle-path (Km)	-0.223*
	(0.117)

VARIABLES	Being a cyclist
Paid parking	0.219*
	(0.120)
Car parking capacity (%)	-5.112*
	(2.747)
Bike parking capacity (%)	1.464
	(1.545)
SN Friends&Family: Cycling	0.574***
	(0.151)
SN Coworkers: Cycling	0.279**
	(0.117)
Constant (ASC)	-4.344***
	(1.681)
Observations	793

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Stata model output results

The model results indicate, that both, personal and work-related needs have an impact on the likelihood to use the bicycle to work:

- Having children in house decrease the odds to be a cyclist but given the value of the coefficient its impact is low compared to the other variables.
- The need to carry materials/equipment to work and the need to dress formal reduces the likelihood to be a cyclist, which is aligned with the results of the research made by Hainen et.al (2013).
- The need to go out for meetings outside the office during the day increase the probabilities to be a cyclist, which is contrary to the findings of Hainen et.al (2013) on the Netherlands context. This difference could be explained by the different context, the efficiency of the bicycle against car on a city as congested as Bogota, or the use of company vehicles to go to the meetings. However, these theories need to be proved with further research.
- The longer the commute distance the lower the probabilities of choosing the bicycle to commute to work consistent with the findings of Hainen et.al (2013).

Regarding the individuals' contextual opportunities, it was found that the following variables have an impact on the choice of bicycle to commute to work:

- The individual context regarding the expectations of family, friends and coworkers, have an essential and positive influence on the choice of bike to commute to work, as commuters are more likely to use this mean of transport if they feel supported to so congruent with the findings made by Hainen et.al (2013). However, family and friend's opinion seem to have a more significant impact than co-workers one.
- Aligned with the research findings of Petrunoff, N. et al. (2015) parking management strategies proved to influence cycling behaviour. The results show that individuals that work on companies with a higher supply of cycle-parking, lower supply of car parking, and on those where they need to pay for parking, either because lack of capacity make individuals park outside or they charge for the use, will have bigger odds to choose cycling to commute to work.
- City mobility context also plays a role in cycling behaviour. The model findings suggest that individuals who have a better perception of city safety are more likely to use the

bicycle, and those to have better perception of the public transport comfort are less likely to do so.

On the other hand, regarding personal abilities the results of the model suggest that they do have an impact on the decision of an individual to be a cyclist. Following the main findings on this aspect:

- Men are more likely to be a cyclist than women.
- An increment of age would result on and increase of the odds to be a cyclist, however, based on the negative sign of the age^2, this effect of age will be reduced as people get older. This is aligned with the descriptive statistics of age of the cyclist (Figure 25) which shows that the number of cyclist increase with age, but only to a specific point and then start decreasing.
- Individuals with higher income are more likely to use the bicycle to travel to work, however, the sign of this result was different as expected. This result may be explained by the fact that the location of the household of low-income individuals, that usually are at the periphery of the city far from the CBD here housing prices are higher, reducing the feasibility and convenience to travel on a bicycle. However, further research would need it to understand deeply this unexcepted result.
- Individuals with access to car or motorbike are less likely to choose the bicycle to commute to work, and those who have access to the bike are more likely to do so.

Finally, the alternative specific constant (ASC) has a negative sign and a relatively higher value compared to the rest of variables, which means that commuters are more likely to choose other alternative than bicycle, all ese being equal. This is congruent with the revealed travel behaviour presented on chapter 4.2, where it was shown that cycling behavior was not the primary one.

4.3.2 Level of cycling model

To explain the level of cycling of full-time & part-time cyclist opposed to occasional and sporadically cyclist the utility function presented on table [6] was use. The process of building up the model was the same use on "Being a cyclist" model, were initially all the variables were included, and later the non-significant ones were excluded one by one. The results of the model are presented on Table 10 .

$$V_{Full\&Part-time\ cyclist} = ASC + \beta_1 \times Income_{permonth} + \beta_2 \times DressFormal_{need} + \beta_3 \times MotorbikeAccess + \beta_4 \times TravelDistance + \beta_5 \times DistanceBRT + \beta_6 \times PaidParking + \beta_7 \times Awarness\ Health_{benefits} + \beta_8 \times CiclingPromotion_{score} + \beta_9 \times CyclingTrainning_{Score} + \beta_{10} \times PlateRestriction_{influence_{score}} \quad [6]$$

Table 10. Being a Full-time/Part-time commuter cyclist: logit model results

```
Iteration 0:   log likelihood = -183.10444
Iteration 1:   log likelihood = -75.783574
Iteration 2:   log likelihood = -70.114615
Iteration 3:   log likelihood = -69.747876
Iteration 4:   log likelihood = -69.746452
Iteration 5:   log likelihood = -69.746452

Logistic regression                             Number of obs     =        266
                                                LR chi2(10)       =     226.72
                                                Prob > chi2       =     0.0000
Log likelihood = -69.746452                     Pseudo R2         =     0.6191
```

VARIABLES	Cycling full-time or Part-time
Travel Distance (km)	-0.0531
	(0.0477)
Monthly Income (Eur)	0.000862*
	(0.000492)
Need to wear suits or hills	0.370
	(0.250)
Motorbike access	-1.003***
	(0.354)
Distance home to BRT station (km)	0.362**
	(0.163)
Paid parking	2.743***
	(0.314)
Awareness health benefits	-0.515*
	(0.264)
Cycling promotion program score	0.390***
	(0.143)
Cycling training program score	-0.577***
	(0.152)
Car plate-restriction influence on individual cycling behaviour	0.161**
	(0.0747)
Constant (ASC)	-0.223
	(1.085)
Observations	266

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Stata model output results

Regarding to individual abilities the model results findings were surprising. The level of cycling is not explained by the gender, age, household composition of the individual nor the access to car. The wo individual ability founded significant to determine the level of cycling is the income and the access to a motorbike, where the probability to be a part-time or full-time cyclist would increase on individuals with higher incomes and decrease for those ones with access to motorbikes. Therefore, the intensity of cycling is determined mainly for the individual' needs and contextual opportunities.

Related to individual needs, the need to wear formal clothes to work increases the odds to be an intensive cycling commute opposite to occasional cyclist. This can be explained as frequent bicycle users does not see formal clothes as a barrier to cycle anymore, when compared to the more sporadically ones.

On the other hand, the need to pay for parking appeared as the most important determinant for level of cycling. When cyclists have the need to pay for parking if they choose other alternatives as car of motorbike, the level use of bicycle is intensified, which is aligned with the findings of Petrunoff, N. et al. (2015). Additionally, the car-plate restriction influence, which limit the use of car to three days a week by its plate number, also increase the level of cycling. So cyclists that report higher influence on plate-restriction on their on level of cycling use, will cycling more as probably they are using the bike a a substitute mode of transport when they are not allowed to use the car.

Regarding to awareness of consequences of bicycle, the only significant to explain level of cycling was the health benefits. The coefficient of this variable has a negative sign which means that the sporadically cyclists are the ones more concerned of this benefit between the two types of cyclists.

Lastly, the full-time cyclists seem to value more the promotion cycling program of the company, compared with the occasional cyclists. This can be explained as almost all the programs implemented by the companies reward the frequency of use, so the ones that uses the most are the ones that benefit from them and the ones that will value this program the most. Oppositely, frequent cyclists have a negative perception of the cycling training programs when compared to irregular cyclist, which has sense as training programs used to be targets to new users of potential user, but not for frequent user, so it content may be to basic for them or they do not consider it content relevant.

4.3.3 Behavioural change model

As presented in Figure 42 on the past three years and a half there has been an important increment of cyclist on the companies analyzed. This model pretends to understand the reasons for the emergence of the new cyclists, but most importantly the drivers of a new cycling behavior. Using the data of those who reported that a new cycling behavior was adopted on the last 3 and a half years and those who does not, the model present on Table 11 was developed, based on the utility function [7].

$$V_{NewCyclingBehaviour} = ASC + \beta_1 \times Income_{permonth} + \beta_2 \times DressFormal_{need} + \beta_3 \times BicycleAccess + \beta_4 \times Friends\&FamilyCycling_{SocialNorm} + \beta_5 \times CoworkersCycling_{SocialNorm} + \beta_6 \times Male + \beta_7 \times Age + \beta_8 \times Age^2 + \beta_9 \times CiclingInfrastructureUpgraded + \beta_{10} \times FidelityProgram \quad [7]$$

Table 11. New Cycling behaviour: logit model results

Logistic regression	Number of obs	=	699
	LR chi2(10)	=	275.73
	Prob > chi2	=	0.0000
Log likelihood = -252.15839	Pseudo R2	=	0.3535

VARIABLES	(1) new_c_behaviour
Monthly Income (Eur)	0.000651***
	(0.000244)
Need to wear suits or hills	-0.416***
	(0.124)
Bicycle access	1.175***
	(0.117)
SN Friends&Family: Cycling	0.539***
	(0.168)
SN Coworkers: Cycling	0.308**
	(0.130)
Cycling Infrastructure upgrade on the year or before the new behaviour occurred	0.868***
	(0.234)
Fidelity program on the company on the year when the new behaviour occurred	0.659***
	(0.239)
Male	0.140
	(0.123)
Age	0.0903
	(0.0943)
Age^2	-0.00145
	(0.00116)
Constant	-3.224*
	(1.801)
Observations	699

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Stata model output results

The development of the model led to the following findings:

- The age and income influence on a positive way the odds to acquire a new cycling behaviour.
- Males are more likely to acquire a new cycling behaviour when compared to females.
- Having access to bicycle increase the likelihood to acquire a new cycling behaviour.
- The needs to wear formal clothes to work reduce the probability of an adoption of a new cycling behaviour.
- When family, friends and co-workers expected than an individual commute on bicycle to work the probability he/she acquire a new cycling behaviour increase considerable.
- The existence of a fidelity program for cyclist has a positive and significant effect on a change of behaviour towards bicycle.
- The upgrade of cycling infrastructure is the most important driver for a behavioural change towards bicycle.
- Not the potential time savings and nor the economic savings resulting from bicycle use, when compared to the principal/previous mean of transport, were significant to explain the behavioural change. So time and financial savings were not the drivers of the new behaviour. This could be explained that frequently bicycle is not faster than motorized alternatives an even if is much cheaper the ones who could save the most relative to its salary are the individuals with lower incomes who live on the periphery, usually so far away from workplace that cycling is not feasible anymore.

5 Conclusions

This research studied the determinants of cycling behaviour to commute to work in Bogotá, by analyzing travel patterns on four companies treated with Workplace Travel Plans, where different strategies to promote cycling were implemented. Aligned with the travel behaviour theory the research found that individual needs, contextual opportunities and own abilities have an effect on cycling behaviour. Under contextual opportunities, work-related factors and expectation of the people around the commuters, were found as one of the most critical drivers of cycling behaviour.

Firstly, through a binary logit model it was possible to identify the determinant under the decision to be a cyclist. Result of that analysis the work-related factors appeared, as a whole, to be the more determinant ones. It was found that the corporate culture, expressed by the expectation of co-workers related to the individual choice of transport, influence on a positive way the cycling behaviour. This result could imply that cycle-friendly culture on a workplace could lead to an increment of the use of this mean of transport, or in the opposite way that a car-oriented culture could limit it. On the other hand, the parking management strategy of the workplace showed to be a key element in the choice of bicycle. For a bigger capacity of cycle-parking the probabilities of being a cyclist are increased, but for a bigger capacity of car-parking they are importantly decreasing. Additionally, when the need to pay for parking of autos or motorbikes exists the odds of using the bicycle increases. Therefore, workplaces parking policies seems to play a vital role in the promotion of sustainable mobility. Even more, the needs imposed by workplaces to individuals, as the need to transport material/equipment to work, or the need to wear formal clothes, also have an effect, on a negative way, on the likelihood of being a cyclist.

In addition, it was found that the distances from home to work, to cycle-paths and to BRT system stations also influence the choice of bicycle. Aligned to several theory findings, the commute distance has a negative effect on the decision to be a cyclist commuter so those who live closer to work should be the primary target for behavioural change programs. Relying on this finding, companies should aim to minimize the commuting distance when possible in order to promote more sustainable mobility. This may not be possible for all companies, but for those ones with several branch offices an optimization of workplace location based on commuting distances could be the ideal tool to increase the number of trips on bicycle. On the other hand, the distance from home to cycle-path also has a negative effect on the likelihood of commuting on bicycle, this was expected as the accessibility to a cycle-path network, composed by more than 500Km interconnected cycle-lanes, could increase the mode share of the bicycle, and oppositely a lack of it could reduce the attractiveness of this choice. This could imply that densifying and extending the existing network of cycle-paths would also increase the selection of bicycle. Oppositely, the distance from home to the BRT system, Transmilenio, has a positive impact on cycling choice, so the farther the stations are from the employee, the lower the attractiveness of the main public transport system, so more convenient it would be to consider the bicycle. Align with this finding was the public transport comfort score, which shows that when the comfort perception of public transport increases the odds to choose the bike decreases. The last two findings, related to the alternatives attractiveness (public transportation in this case) , are aligned with the random utility theory, which according to Ortúzar & Willumsen (2011), postulates that postulate that *"the probability of individuals choosing a given option is a function of their socioeconomic characteristics and the relative attractiveness of the option"*.

Even more, personal abilities as income, age and gender also proved to influence the choice of being a cyclist. This was not the case for the explanation of the higher level of cycling, where

socio-economic characteristics were not found as significant determinants to explain the choice to commute more frequently. The level of cycling was determined mostly by contextual opportunities and individual needs, than for individual abilities. Only the abilities associated with personal income and access of motorbike were found to be significant in explaining level on cycling, on a positive and negative way respectively.

One more time, work-related factors that influence contextual opportunities were found to be substantial, this time to explain the level of cycling. The need to pay for parking, and the individual rating of the workplace cycling promotion program influence on a positive way the frequency of cycling. Those findings reinforce the importance of both, parking management strategies and on the promotion of cycling programs, on sustaining a cycling behaviour, transforming it from hobby to habit.

Additionally, it was found that existing plate-restriction policy, which limits the number of days cars can circulate on the city according to its plate number, has a positive impact on the level of cycling. This finding may be explained because the bicycle may be the alternative for car users when this mean of transport is not available for them. This is an important finding, as all car users on the city are treated by the plate-restriction policy, so they also need a feasible alternative when the car use is restricted, given a perfect momentum to promote cycling. However, this finding may be applied only to an individual with access to only one car, as if they have more than one they could use the second one as a substitute when the policy applies.

Aiming to understand the significant increment of cyclists on the analysed companies a behaviour change towards bicycle was explained trough a binary logit model. The results show that one more time work-related factors seem to be determinant on cycling behaviour, in this case on the adoption of a new cycling behaviour. Again, aligned with the *theory of planned behaviour*, the expectation of others related to the individuals' behaviour has an impact on personal choices. It was found that the support of family&friends and coworkers on cycling use, would increase the chances that an individual would acquire a new cycling behaviour. Additionally, research findings demonstrate that the cycling infrastructure upgrades made on the workplaces and the inclusion of fidelity programs that reward the cyclists, had a significant and relevant impact for the increment of new cyclist. Those findings lead us to conclude that workplace interventions, whereas related to infrastructure, organizational culture or marketing strategies have a positive and relevant impact on the increment of cyclists commuters.

However it was also found that Workplace Travel Plans strategies are not a magic formula, but they need to be adjusted to workplace & employees' context, and more importantly they need high-level support and budget. It was shown that the workplaces who invest the most, in-kind with commitment and with financial resources to materialized the strategies, also obtain the more significant rewards on cyclists increments. Therefore, WTP effectiveness is not free, but sustainable mobility pays-off to the employee, the companies and the city.

The results of this research suggest that well-implemented WTP could transform mobility patterns and could also have an impact on city mobility, on a more immediate and cost-effective way than infrastructure improvements. These do not suggest that mobility infrastructure improvements on the city do not need to be made, but it suggests that regulation, promotion or encouragement of WTP massive implementation, could speed up the reach of more sustainable mobility in Bogota.

6 Annexes

6.1 Annexe 1. Interview to key informants

Good morning, *name of the key informant*. First, I will introduce myself, I am María Angélica Pérez a master student of Erasmus University and, with the support of the Secretaría de Movilidad, I am doing a research of the impact of workplace travel plans in the level of cycling in three public entities in Bogotá, and one of them is yours. This study will allow me to identify on a statistical way which are the key factors that lead to the success of a workplace travel plan regarding cycling use. These results could help your company and the other companies of the program "Cuando te mueves, Bogotá se mueve" to identify more effective strategies to promote cycling, so your participation is vital.

This interview should take around 30 minutes, so let's start.

1. Please tell me about you, your name, position and role in the company, and the general activities you are in charge of the company

2. Please tell me the mission, location and size of the company (in number of employees)

3. Now let's talk about your workplace travel plan, first tell me since when you have a workplace travel plan, and which was the motivation of the company to implemented.

4. On which stage do you consider the workplace travel plan is currently? Planning, partially-implemented, implemented, monitoring and evaluation, or other?

5. From your point of view, how important is the WTP for your company? Is one of the main priorities? Why do you think that?

6. Which physical facilities the company offers to employees regarding to cycling? When was this implemented?

    - Free parking for cyclist ¿How many?
    - Dressing rooms
    - Maintenance station

7. Which of the following promotion activities how you implement on your workplace on the last two years?

a. Marketing strategy
b. Learning how to cycle course
c. Road safety for cyclist course
d. Challenges or contest to promote cycling use trough competition
e. Other , Which one?

8. Which strategies have you planned, and have you effectively implemented to promote cycling? Do you have any supporting document you can send to me?

9. How was the process of implementation of the mention strategies? Which were the main obstacles and barriers that you find while implementing?

10. On which of the following activities did your entity actively participate in promoting the bicycle? Did you make special activities on these two days?
    a. Car-free day of the city
    b. Monthly car-free day for public entities

11. Which strategies do you think have been the more effective and why? Do you monitor the results? Do you have a document with the results of these strategies?

12. How is the parking policy in your company? How many spots and for whom? Which are the cost for employees?

13. There are additional benefits for the users of other means of transport like:

- Company driver or car. How many? To whom?
- Company cars for fieldwork or meeting during the day. How many? To whom?
- Subsidies for public transport
- Other ¿Which one?

Thank you for your time, I will contacting you if there is need for further questions.

6.2 Annexe 2. Online questionnaire

The on-line questionnaire was made in Spanish, and its original format it can be visualized in on the following link: https://forms.gle/gn9VEobG3SbYFkVB6

Logic on the survey was implemented, as not all the questions needed to be made to all employees. Following an explanation of the main sections of the survey and description of which employees response each of them.

Section 1. The introductory section of the survey, which explained to respondents the main objective of the survey and thanked them in advance.

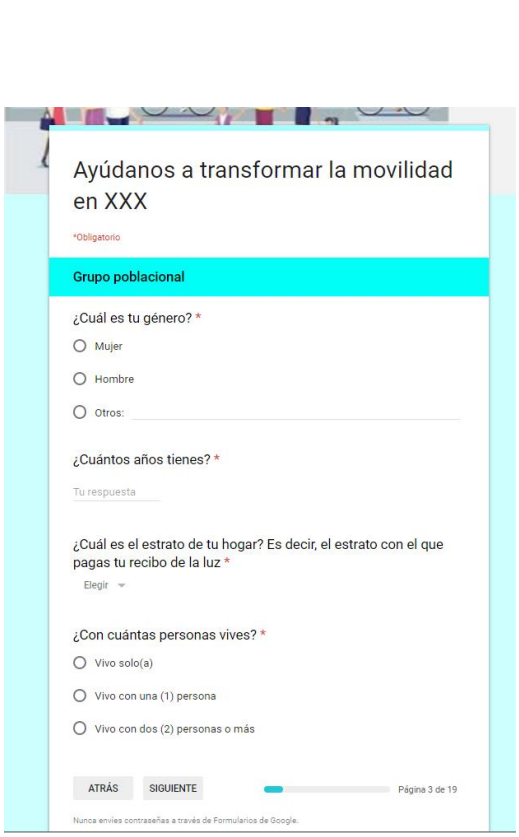
Who reads this message? All the respondents

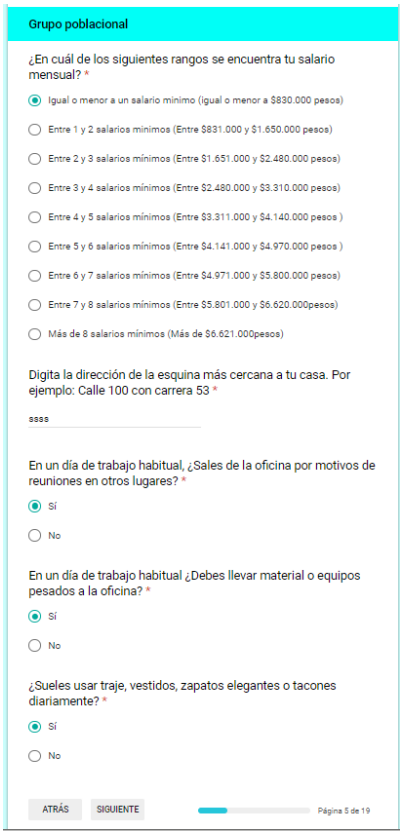
Section 2. An introductory note for the **section 3-Socio-economic characteristics** of the individuals. This section was made to explain to the respondents that their privacy is safe, remind them that survey was anonymous, and for what we need the information for, as delicate questions as the salary range was asked to respondents.

Who reads this section? All the respondents

Section 3. Socio-economic characteristics. This section aims to ask about the individual needs and abilities, questioning by the personal socio-economic characteristics, the household characteristics and also by the needs imposed by workplace, like formal dressing, fix working-schedule among others.

Who needs to respond to this section? All the respondents



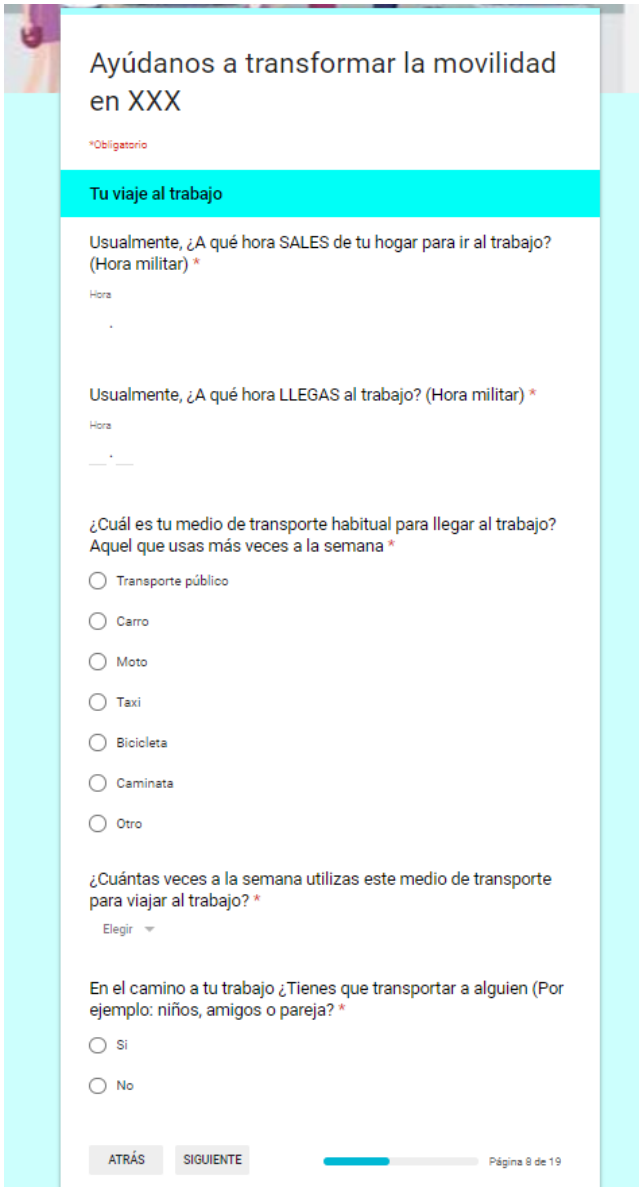


Section 4. Aims to capture the perception of the individual opinion about city mobility contexts, like road safety, public safety, comfort on public transport and congestion.

Who needs to respond to this section? All the respondents

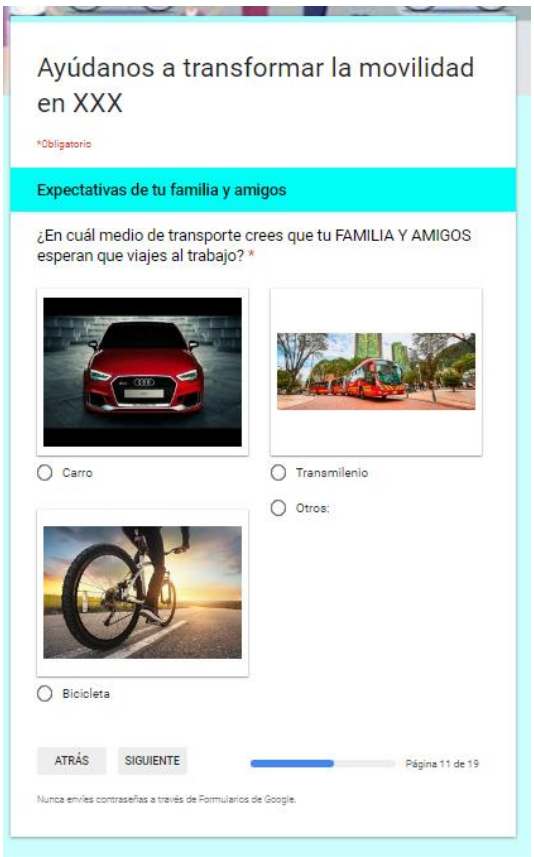
Section 5. Individual mobility patterns to understand the attributes of the daily commute to work of respondents.

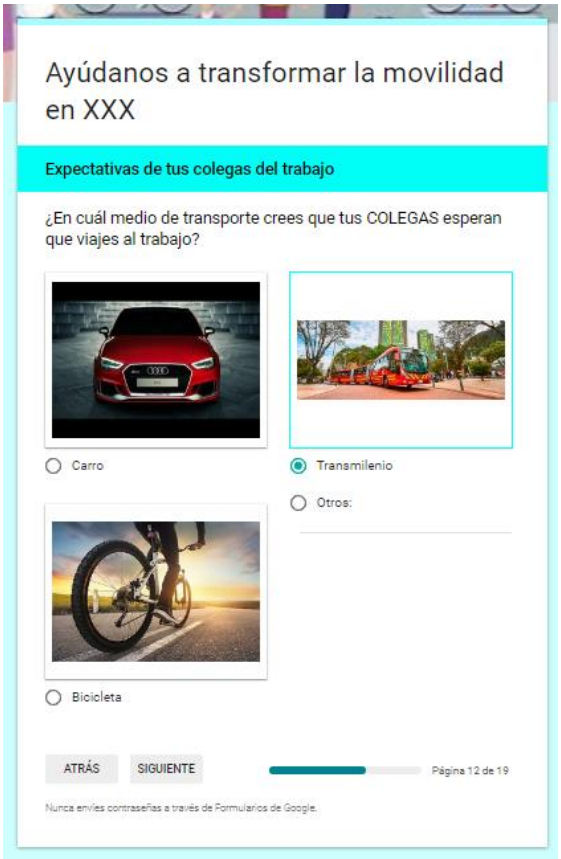
Who needs to respond to this section? All the respondents



Section 6. Section 6 looks forward to capturing the social norm, regarding the perception of the individuals regarding the expected means of transport by colleagues and family, Individual mobility patterns to understand the daily commute to work of respondents.

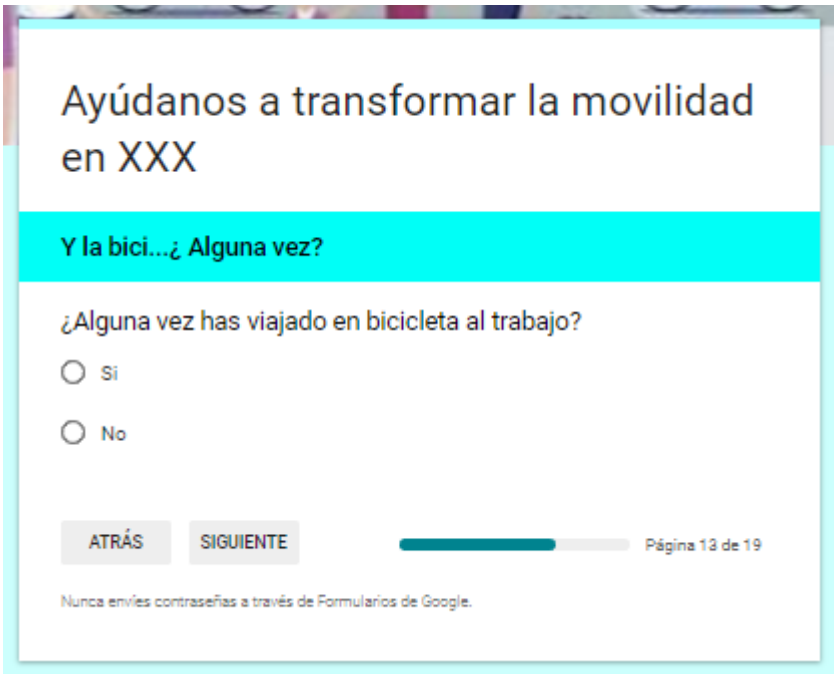
Who needs to respond to this section? All the respondents





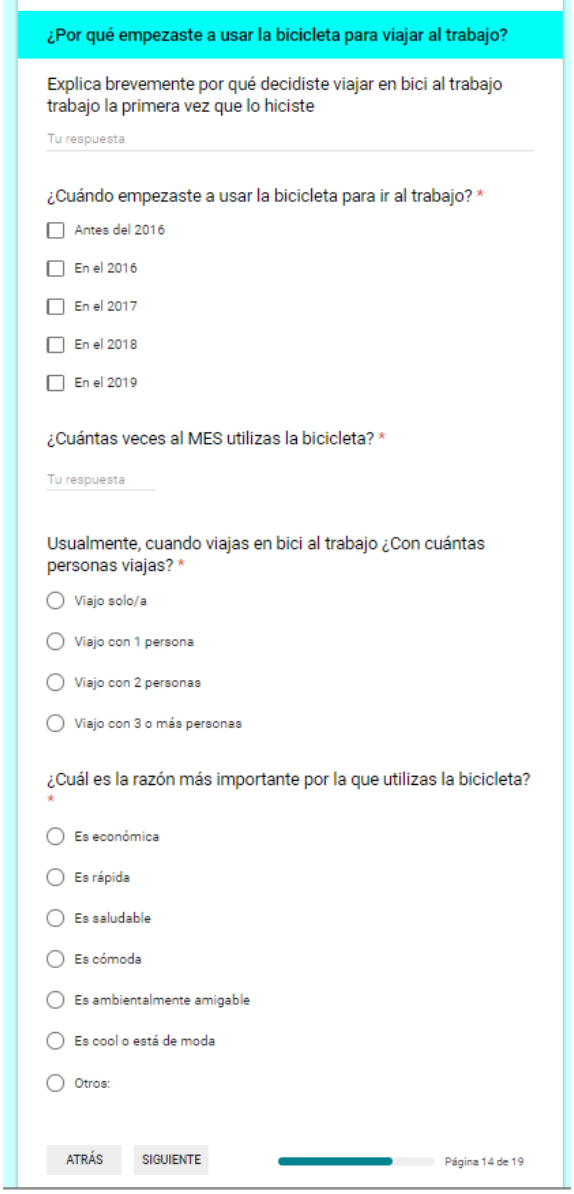
Section 7. This section ask the employees if they have ever travel on bicycle to the workplace.

Who needs to respond to this section? Only those respondent that do NOT choose a bicycle as the principal means of transport on Section 5.



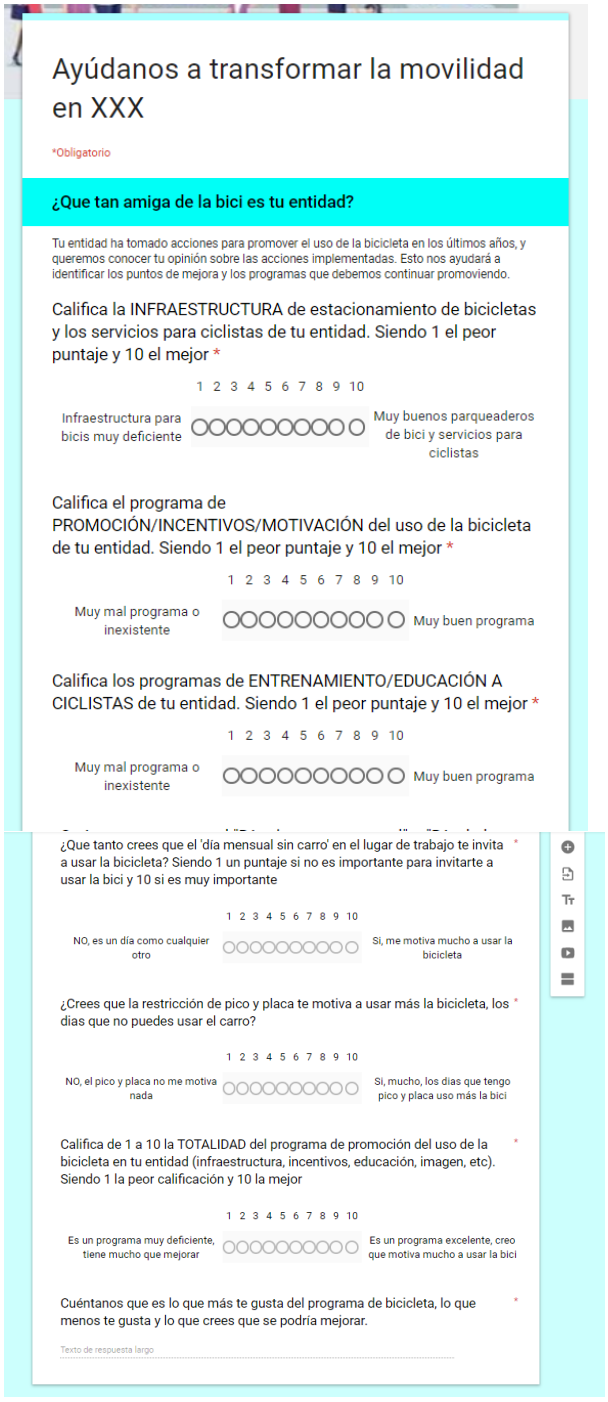
Section 9. This section asks full-time cyclist or any who have ever cycle to work, the reasons why they decide to use the first time the bicycle to commute to work (open question), the year they start to use this mean of transport, the monthly frequency of use , the number of people they travel with and lastly the main reason for cycling.

Who needs to respond to this section? Permanent cyclist and everyone who has ever used the bike to commute to work.



Section 10. This section ask respondents their opinion on the cycling programme implemented by the company, and also includes an open-ended question regarding to the favourite thing of the program and the components that can be improved.

Who needs to respond to this section? Permanent cyclist and everyone who have ever used the bike to commute to work.



Section 11. This section includes the closing message of the survey and gives contact e-mails to the respondents to wich to comment or ask something regarding to the survey.

6.3 Annexe 3. Survey marketing campaign

Reference list

Brockman, R. and Fox, K. 2011. Physical activity by stealth? The potential health benefits of a workplace transport plan. Public Health, 125 (4), pp. 210-216.

Cairns, S., Newson, C. and Davis, A. 2010. Understanding successful workplace travel initiatives in the UK. Transportation Research Part A: Policy and Practice, 44 (7), pp. 473-494.

Castiglione, J., Bradley, M. & Gliebe, J., 2015. Activity-Based Travel Demand Models: A Primer. SHRP 2 Report(S2-C46-RR-1), p. 181p.

De Bruijn, G., Kremers, S. P., Singh, A., Van den Putte, B., et al., 2009. Adult active transportation: adding habit strength to the theory of planned behavior. American Journal of Preventive Medicine, 36 (3), pp. 189-194.

Dijst, M., Rietveld, P. and Steg, L. 2013. Individual needs, opportunities and travel behaviour: a multidisciplinary perspective based on psychology, economics and geography. 2013. The transport system and the transport policy: an introduction. Edward Elgar Publishing. pp. 19-47.

Gatersleben, B. and Appleton, K. M., 2007. Contemplating cycling to work: Attitudes and perceptions in different stages of change. Available at: http://www.sciencedirect.com/science/article/pii/S0965856406001091 .

Heinen, E., Maat, K. and van Wee, B. 2013. The effect of work-related factors on the bicycle commute mode choice in the Netherlands. Transportation, 40 (1), pp. 23-43.

Hensher, D. A., Rose, J. M. and Greene, W. H., 2005. Applied choice analysis: a primer. Cambridge University Press.

Hilbrecht, M., Smale, B. and Mock, S. E. 2014. Highway to health? Commute time and well-being among Canadian adults. World Leisure Journal, 56 (2), pp. 151-163.

Mullen, C. and Marsden, G., 2015. Transport, economic competitiveness and competition: A city perspective. Available at: http://www.sciencedirect.com/science/article/pii/S0966692315001726

Oja, P., Titze, S., Bauman, A., De Geus, B., et al., 2011. Health benefits of cycling: a systematic review. Scandinavian Journal of Medicine & Science in Sports, 21 (4), pp. 496-509.

Ortuzar, J. D. and Willumsen, L. G., 2011. Modelling transport. John Wiley & Sons.

Pas, E. I. and Koppelman, F. S. 1987. An examination of the determinants of day-to-day variability in individuals' urban travel behavior. Transportation, 14 (1), pp. 3-20.

Petrunoff, N., Rissel, C., Wen, L. M. and Martin, J., 2015. Carrots and sticks vs carrots: Comparing approaches to workplace travel plans using disincentives for driving and incentives for active travel. Available at: http://www.sciencedirect.com/science/article/pii/S2214140515006544

Rissel, C., Petrunoff, N., Wen, L. M. and Crane, M., 2014. Travel to work and self-reported stress: Findings from a workplace survey in south west Sydney, Australia. Available at: http://www.sciencedirect.com/science/article/pii/S221414051300008X

Roby, H., 2010. Workplace travel plans: past, present and future. Available at: http://www.sciencedirect.com/science/article/pii/S0966692308001361

Seattle Department of Transportation (2008). Best Practices transportation Demand Management, Seattle Urban Mobility Plan. Seattle.

Secretaría Distrital de Ambiente (SDA), 2017. Observatorio de Movilidad de Bogotá. Available at: http://www.ambientebogota.gov.co

Secretaría Distrital de Movilidad (SDM), 2017, electronic dataset, Secretaría de Movilidad Institutional Repository, viewed 25 March 2019, < http://www.simur.gov.co/>

Secretaría Distrital de Movilidad (SDM) 2019, Cuando te mueves Bogota se mueve, Secretaría Distrital de Movilidad, viewed 06 Jun 2019, < http://www.bogotasemueve.co/>

Tsirimpa, A., Polydoropoulou, A. and Antoniou, C. 2007. Development of a Mixed Multi-Nomial Logit Model to Capture the Impact of Information Systems on Travelers' Switching Behavior. Journal of Intelligent Transportation Systems, 11 (2), pp. 79-89.

Thiel, S., 2014. Research methods in public administration and public management: an introduction. Routledge.

Vickerman, R.W.,(2003). Transport in integrating Europe: sustainable development and cohesion. Investigaciones Regionales 3, pp. 163–174.

Wen, L. M., Orr, N., Bindon, J. and Rissel, C. 2005. Promoting active transport in a workplace setting: evaluation of a pilot study in Australia. Health Promotion International, 20 (2), pp. 123-133.

IHS
Making cities work

Institute for Housing and
Urban Development Studies of
Erasmus University Rotterdam